I-81 Corridor Improvement Study

Tier 2 – I-77/I-81 Overlap

Transportation Technical Report

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Acronyms and Glossary of Terms

Government and Public Agencies

AASHTO	American Association of State Highway and Transportation Officials
DOT	Department of Transportation
DRPT	Virginia Department of Rail and Public Transportation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
TRB	Transportation Research Board
VDOT	Virginia Department of Transportation

Technical Terms

AADT	Average Annual Daily Traffic
AADTT	Average Annual Daily Truck Traffic
AAWDT	Average Annual Weekday Traffic
ADT	Average Daily Traffic
DHV	Design Hour Vehicle
EA	Environmental Assessment
EIS	Environmental Impact Statement
I-77	Interstate 77
I-81	Interstate 81
IMR	Interchange Modification Report
ITS	Intelligent Transportation Systems
LOS	Level of Service
MP	Milepost
mph	Miles Per Hour
N/A	Not Available
NEPA	National Environmental Policy Act of 1970
OD	Origin-destination
ROD	Record of Decision
TMC	Turning Movement Count
TSM	Transportation Systems Management
vpd	Vehicles Per Day
vph	Vehicles Per Hour

Data Sources

GIS	Geographic Information Systems
HCM	Highway Capacity Manual
HCS	Highway Capacity Software Version 4.1
MUTCD	Manual on Uniform Traffic Control Devices
REMI	Regional Economic Models, Inc.
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program

Organizations

AAA	American Automobile Association
ATA	American Trucking Association
VHB	Vanasse Hangen Brustlin, Inc.

1 Introduction

In November 2003, the Federal Highway Administration (FHWA) and the Virginia Department of Transportation (VDOT) entered into a Process Streamlining Agreement to follow a tiered decision-making process for the I-81 Corridor Improvement Study. As discussed in detail in the I-*81 Corridor Study Tier 1 Environmental Impact Statement* (*Tier 1 EIS*), tiering addresses broad programs and issues in an initial (Tier 1) or systems-level analysis and analyzes site-specific proposals and impacts in subsequent tier studies. The *Process Streamlining Agreement Between the Virginia Department of Transportation and the Federal Highway Administration on the Interstate 81 Corridor National Environmental Policy Act Process* defines the decisions to be made and the approvals to be granted at specific milestones of the tiered environmental process and defines the study approach, process, and elements to be included in each stage of the tiered analysis. As specified in the agreement, upon completion of Tier 1, decisions were made on:

- The improvements concepts to be advanced;
- Advancing I-81 as a toll pilot facility under Section 1216(b) of the Transportation Equity Act of the 21st Century (TEA-21);
- Projects with independent utility and logical termini to be studied in Tier 2;
- The types of Tier 2 NEPA documents;
- The location of the corridor for studying alignments in Tier 2; and
- Possible purchase of certain right-of-way parcels on a case by case basis.

Upon completion of Tier 2 studies, decisions would be made on individual projects and would include:

- Approval of design features for improvements (*e.g.*, the typical section) for components identified in Tier 1;
- Authority to use Federal funds on final design of the improvements;
- Authority to acquire right-of-way;
- Eligibility for Federal funding of construction; and
- Approval to modify access to I-81.

The Tier 1 Record of Decision (ROD) was approved by FHWA on June 6, 2007. The ROD defines eight Sections of Independent Utility for further study in Tier 2. Section of Independent Utility #2 includes I-81 from Interchange 72 to Interchange 81; the portion of I-81 that overlaps with I-77. This Section of Independent Utility has been selected by VDOT as the first of the Tier 2 studies to be completed.

As an Appendix to the *I-77/I-81 Overlap Study Environmental Assessment*, this *Transportation Technical Report* presents the transportation analysis conducted in support of the proposed alternatives. This report presents baseline daily and peak period traffic conditions along the corridor, existing safety and geometric conditions, forecasts of future 2035 traffic and freight activity, and projections of future corridor operations.

1.1 Corridor Description

Interstate 81 (I-81) is a 325-mile highway that runs in a north/south direction through western Virginia from the Tennessee border north to the West Virginia border. I-81 is predominantly a four-lane limited access highway that was one of the earliest interstate highways constructed in the Commonwealth of Virginia. The I-81 corridor is heavily relied upon for both local travel and interstate travel along the east coast. For interstate travel, its location provides an easy connection between the heavily populated northeast and the mid-southern states, as well as routes that connect to the Texas-Mexico border. No other interstate corridors offer such a southwest-to-northeast alignment on the east coast.

Interstate 77 (I-77) is a 67-mile highway that runs in a north/south direction through western Virginia from the North Carolina border to the West Virginia border. I-77 is also predominantly a four-lane limited access highway and serves as a strong connection between the southeastern coastal states and the Ohio River Valley, which is evidenced by a large volume of tourist and recreational vehicles.

In the area of Wytheville, where I -81 and I -77 overlap, a six-lane cross-section is currently provided. This approximately nine-mile section provides the region with important transportation links to other economic production centers and markets in the northern, eastern, and southern United States. While the majority of I-81 through Virginia was constructed in the 1960s and 1970s, this key connection was built in the 1970s and 1980s and was the final link of I-81 built in Virginia. The last construction project for the present facility was completed in 1987.

The following characteristics distinguish the I-77/I-81 overlap:

- Two interstate corridors and two United States primary routes (U.S. Route 11 and U.S. Route 52) share a common facility through the study area.
- There are three major truck stops and a host of long-haul and tourist related developments within this relatively concentrated study area.
- Traffic counts along the I-77/I-81 overlap are among the highest within the state for all four routes traversing the overlap.
- I-77 and I-81 form a wrong-way concurrency. I-77 North is signed with I-81 South and vice versa.

1.1.1 National and Regional Context: System Linkage

Both I-81 and I-77 are corridors of national significance within the eastern United States. I-81, following the spine of the Appalachian Mountains, is approximately 855 miles long extending from I-40 in Dandridge, Tennessee through Virginia, West Virginia, Maryland, Pennsylvania, and New York to the Canadian border. I-77 is approximately 610 miles in length and extends from Columbia, South Carolina through North Carolina, Virginia, West Virginia and Ohio to I-90 in Cleveland. Figure 1-1 provides a map of I-81 and I-77 within the overall interstate system.

I-81 provides important system linkage to twelve major interstate highways, including:

- I-40 near Dandridge, Tennessee
- I-77 in Wytheville, Virginia
- I-64 near Lexington and Staunton, Virginia
- I-66 near Middletown, Virginia
- I-70 in Hagerstown, Maryland
- I-71 in Carlisle, Pennsylvania
- I-83 in Harrisburg, Pennsylvania
- I-80 in St. Johns, Pennsylvania
- I-84 in Scranton, Pennsylvania
- I-78 in Bordersville, Pennsylvania
- I-88 in Binghamton, New York
- I-90 in Syracuse, New York

I-77 provides important system linkage to 10 major interstate highways, including:

- I-20 in Columbia, South Carolina
- I-85 in Charlotte, North Carolina
- I-40 in Statesville, North Carolina
- I-74 near Mount Airy, North Carolina
- I-81 in Wytheville, Virginia
- I-64 near Tilden, West Virginia (I-64 and I-77 are co-located from Tilden north to Charleston, West Virginia)
- I-79 in Charleston, West Virginia
- I-70 near Spring Valley, Ohio
- I-76 in Akron, Ohio (I-76 and I-77 are colocated through Akron)
- I-90 in Cleaveland, Ohio

Virginia's portion of both interstates is critical to the overall national system linkage. Furthermore, it provides important local access to rural communities and

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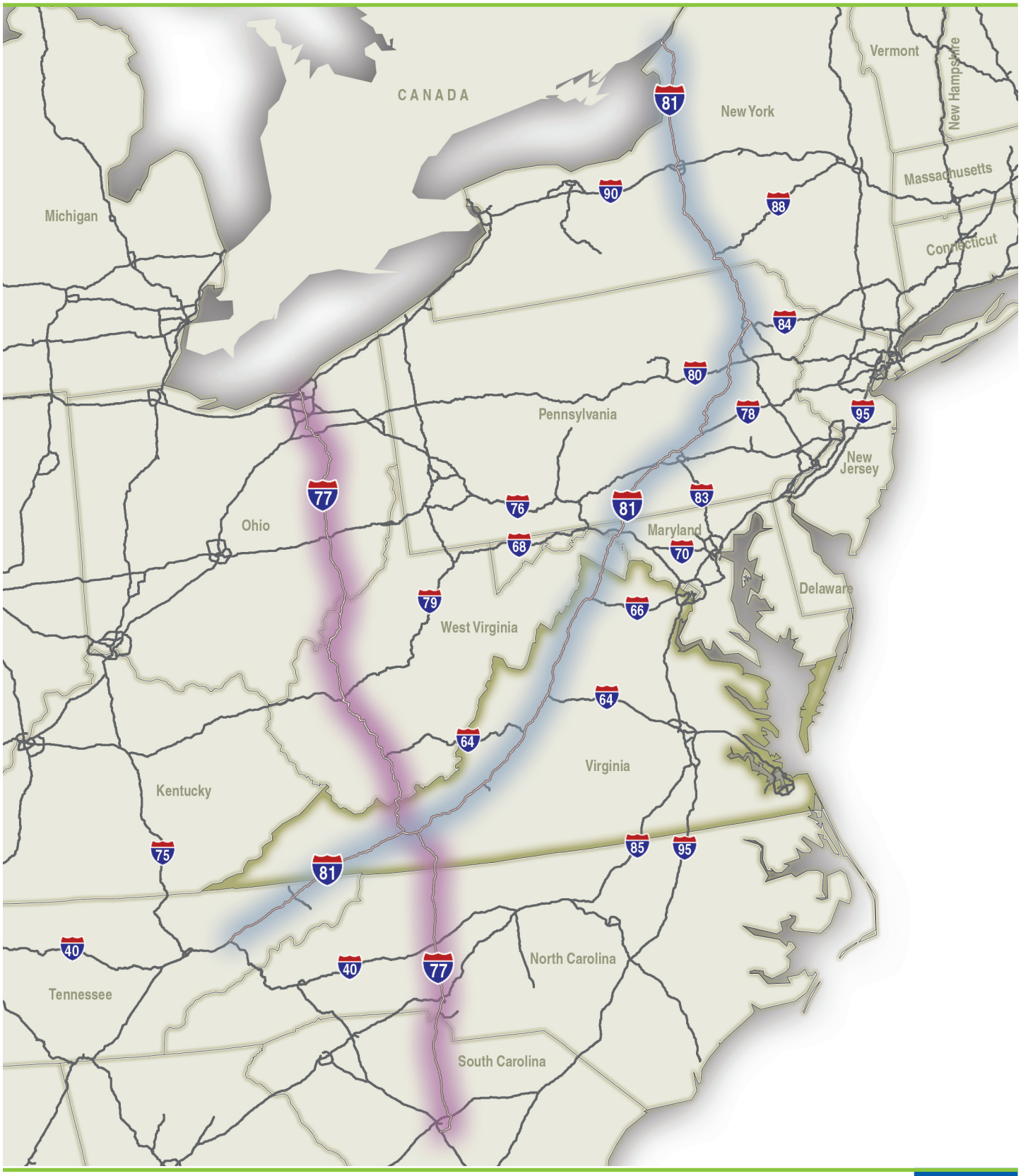

I-81 Corridor Improvement Study
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I-77/I-81 within the Eastern United States Interstate System

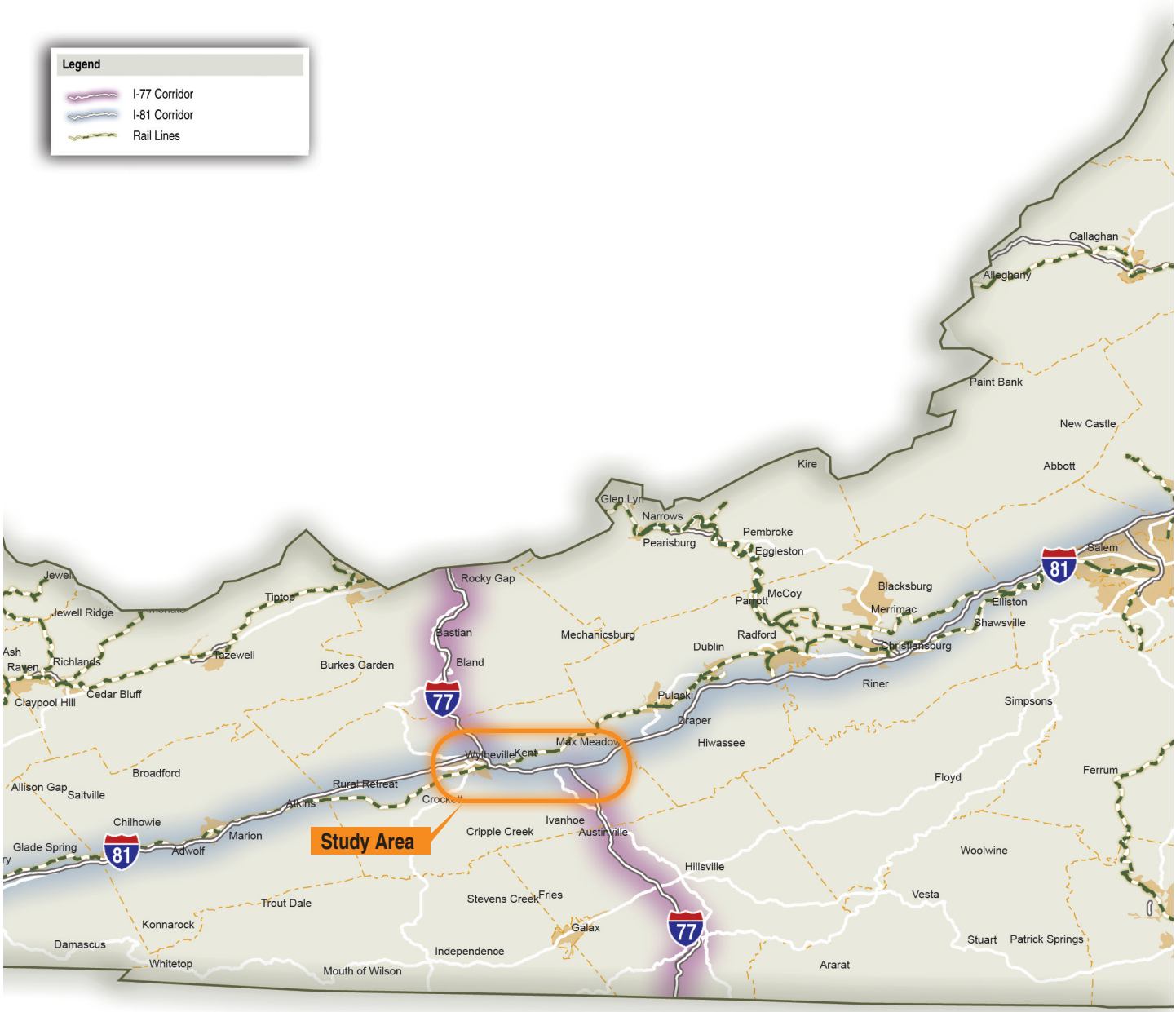
Figure **1-1**

smaller cities/towns, such as Bristol, Marion, Wytheville, Christiansburg, and Roanoke. Figure 1-2 presents the study corridor as it serves the Commonwealth of Virginia.

1.1.2 I-77/I-81 History

By 1975, the majority of I-81 construction was complete from Tennessee to the Canadian border. I-77 construction was completed in Virginia by 1987, but was not completed nationally until 1995. The final incomplete section of I-77 in Virginia was 4.7 miles of the overlap corridor between Wytheville and Fort Chiswell. This section, then known as U.S. 11/U.S. 52, was reconstructed between 1985 and 1987 to an expressway with continuous service roads. Simultaneously, the remainder of the 8.01 mile overlap was upgraded to six-lane interstate standards; thus completing construction of both I-81 and I-77 within Virginia.

The overlap corridor has been a portion of an important transportation route for centuries. Native Americans used a trail known as the Indian Warriors' Path or Shenandoah Hunting Path, which evolved into the Great (Philadelphia) Wagon Road by the mid-1700s and facilitated settlement of North Carolina, Kentucky, and Tennessee. In the mid-1800s, the main highways in the Great Valley of Virginia included the Southwestern Turnpike between Buchanan in Botetourt County and the Tennessee state line via Wytheville, Marion, and Abingdon. The Southwestern Turnpike was among the first Virginia highways to be surfaced with macadam pavement.



I-77/I-81 I-81 Corridor Improvement Study
Tier 2 I-77/I-81 Overlap

VDOT Virginia Department of Transportation

Figure
1-2

I-77/I-81 Overlap Corridor

2 Data Collection

This chapter summarizes the data that were collected as part of the I-77/I-81 Overlap Study and the analysis completed to account for daily and seasonal variations of traffic flow. The raw data collected for each section of this chapter can be found in Appendix A to this technical report.

2.1 Traffic Data Collection

Mainline, ramp, and intersection traffic volumes are necessary to assess the traffic operations along the I-77/I-81 study corridor. VDOT continually monitors traffic flows on the overlap (northbound and southbound) at a permanent count station in the center of the study area. There are also monitoring stations on both I-81 and I-77 north and south of the overlap area. In addition, VDOT has been conducting and reporting supplemental traffic counts along the corridor for more than three decades.

2.1.1 VDOT Traffic Data

Over the past several years, VDOT has undertaken comprehensive levels of study in three locations along the overlap. These studies include the:

- I-81 Corridor Improvement Study
- Exit 77 Interchange Modification Report
- Exit 80 Interchange Modification Report

As part of these studies, a substantial amount of traffic data has been collected along the overlap, at interchanges, and at local intersections. To assess the usefulness of these data (given the effects of recent economic and energy trends), 2007 and 2008 average annual daily traffic volumes (AADT) at three permanent count stations were reviewed – two stations on I-77 north and south of the overlap; and one station within the I-77/I-81 overlap.

Average Annual Daily Traffic

As shown in Table 2-1, the historical count data at the permanent count location on the overlap show about a three percent annual growth from 1978 through 2008. At the I-77 permanent count stations, an average growth of 5.6 percent was realized north of the overlap and 4.0 percent south of the overlap. The higher growth along I-77 reflects the completion of interstate construction in 1987; when volume on I-77 grew from a few thousand to several tens of thousands.

Average Annual Daily Traffic (AADT) along the corridor declined between 2004 and 2008, which reflects numerous economic factors. This downtrend in daily traffic is reflective of similar trends during the early 1980s, 1990s, and in 2001. The effects of the downtrend on the forecast of future conditions is discussed in Chapter 4 of this technical report. The downtrend also affects the existing traffic conditions analyzed as part of this study. These effects are discussed in the following section. Generally, when compared to 2004, the following daily traffic volume trends were noted:

- AADT along the overlap declined by about 10 percent over four years.
- AADT on I-77 in the southbound direction (both north and south of the overlap) was the same when compared to 2004.
- AADT on I-77 northbound averaged about a six percent decrease over the four years.
- Truck traffic decreased on I-81 (about four percent annually) but is increasing on I-77 (about two percent annually).

Table 2-1 Existing Traffic and Historical Traffic Volume Growth: 1978-2008

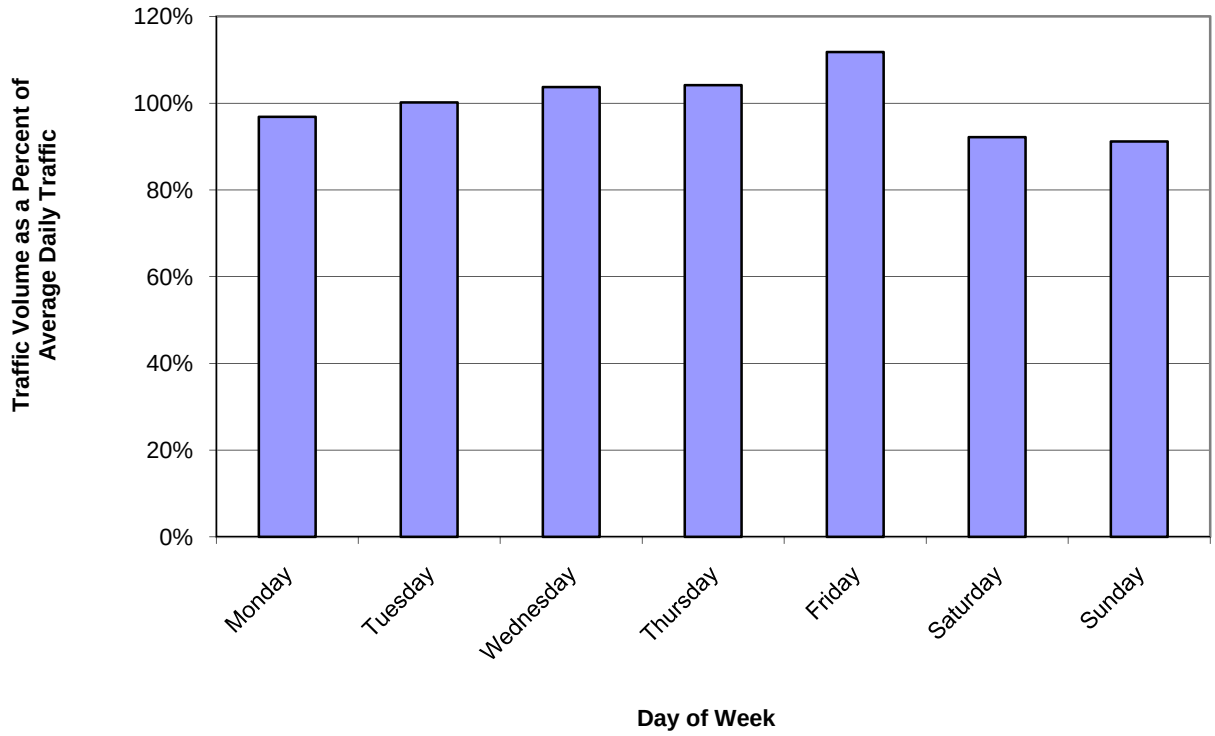
	AADT Volume				Truck Percentage		Percent Growth Rate (1978-2008)	
Permanent Count Location (from South to North)	1978	1997	2004	2008	2003	2008	Annual Average	Aggregate
U.S. Route 11 to North Corporate Limit of Wytheville (I-77/I-81 Overlap)	21,400	46,800	51,900	50,800	26	25	2.9	137
North of Overlap	7,100	36,000	39,000	37,000	20	21	5.6	421
South of Overlap	8,200	28,000	28,000	27,000	15	25	4.0	229

AADT – Average Annual Daily Traffic

Day of Week Patterns

The variation of traffic volumes along the overlap remains similar to the variations discussed previously in the *Tier 1 EIS*. These data are summarized in Figure 2-1. Based on the daily variation data, Thursday and Friday are the heaviest travel days during a typical week (averaging four to 12 percent heavier than average daily flows, respectively). Conversely, Saturday and Sunday are generally the lightest traveled days in the I-81 corridor (approximately nine percent lower than average daily flows). As noted below, during peak holiday and summer travel times volumes were observed to be as high as (and occasionally higher than) Friday conditions.

Figure 2-1 I-81 Average Daily Variations in Traffic



Source: VDOT 2003 Daily Count Data at representative locations along I-81 corridor

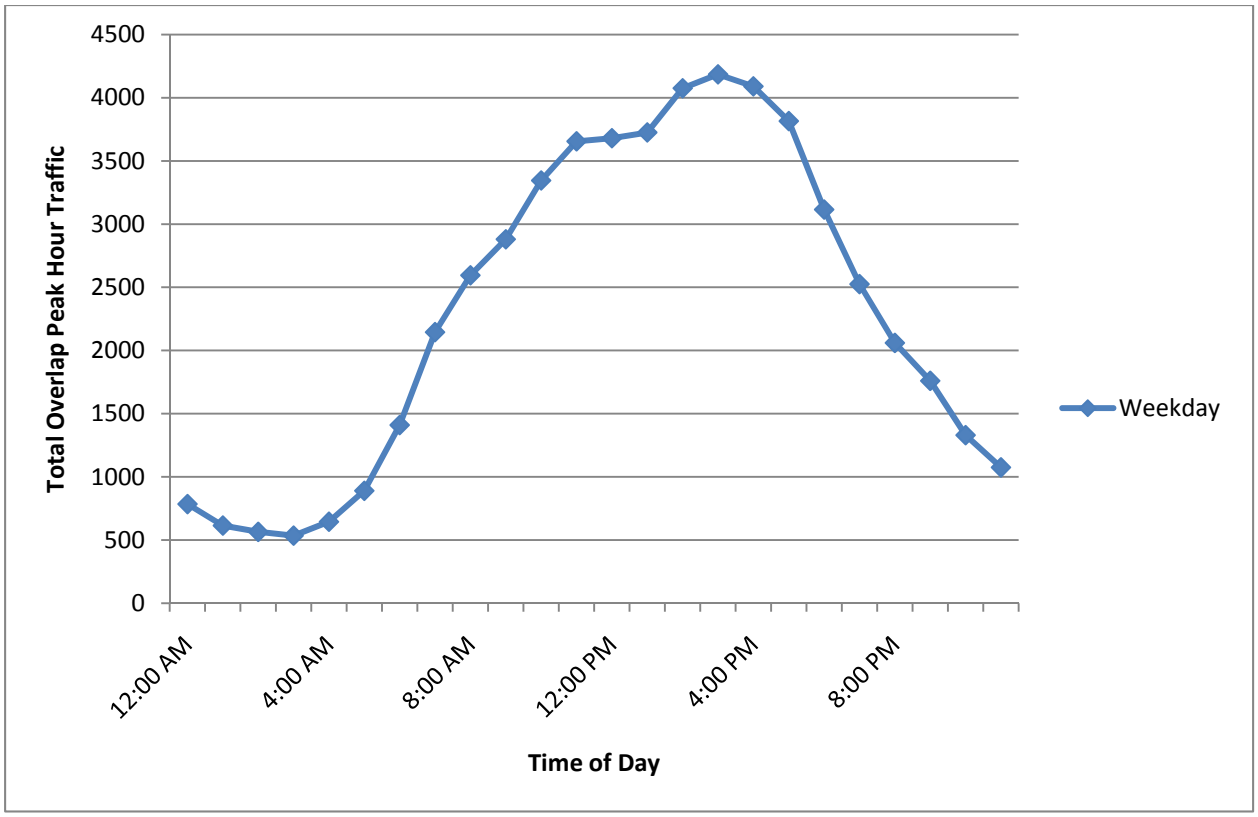
Daily Variations

Extensive VDOT daily traffic volume data were also reviewed and analyzed to determine the weekday daily peaking characteristics of traffic volumes along the I-77/I-81 overlap section. In comparing volumes over the entire week, typically the weekday evening peak hour represents the overall peak traffic condition along the corridor. Typically, traffic flows during

the weekday exhibit two distinct peaks during the morning and evening peak periods. However, as can be seen in Figure 2-2 traffic flows on the I-77/I-81 overlap section exhibit more gradual peaking characteristics. This is likely a reflection of the recreational nature of traffic using I-77. Weekend traffic flows are similar to that of weekday volumes, with a gradual peaking of traffic during the midday and evening peak hours.

Because of the nature of regional and national traffic that places demands on the corridor throughout the day and week, and the times of day they travel, the weekday evening peak hour typically represents only five to ten percent of the average annual daily traffic along the mainline (generally referred to as the "k factor"). This k factor range is considered low, particularly compared to I-81 north and south of the overlap and other corridors experiencing heavy commuter traffic; although some individual ramp locations experience considerably higher k factors (up to 25 percent). The weighted average k factor for the overlap section is 6.9; 7.1 percent northbound and 6.5 percent southbound.

Figure 2-2 Average Hourly Peaking Characteristics of I-77/I-81 Corridor Traffic



Source: VDOT 2008 Daily Count Data on the I-77/I-81 Overlap Section

The I-77/I-81 overlap section has been observed to experience heavier traffic volumes than other sections of I-81 during weekends (particularly holiday weekends) and peak summer travel times. As such, there is concern that the use of a design hour volume (DHV) would not

adequately reflect the potential future congestion along this stretch of highway and that the use of a DHV to determine the number of lanes (on either an existing or proposed new alignment) capable of accommodating typical 2035 traffic volumes would result in roadway cross-sections that would not be sufficient to handle the overlap traffic volume during these weekends and peak summer travel times. A sensitivity analysis was, therefore, conducted to determine the implications of the use of higher seasonal volume along the I-77/I-81 overlap section.

The results of this analysis show that traffic volumes at the two I-77/I-81 interchanges (Exit 72 and Exit 81) are higher during a weekend summer condition than during a typical weekday. However, heavy vehicle volumes are 40 to 50 percent lower on a Friday than during the mid-week and have been about 30 percent lower on Sunday. Because of the significantly reduced heavy vehicle percentages, weekend traffic operations associated with a 2015 and 2035 weekend condition are expected to be about the same as weekday traffic operations. These analyses can be found in Appendix A to this technical report.

Vehicle Classification

Vehicle classification counts from the VDOT permanent count station on the I-77/I-81 overlap section were also reviewed. As shown in Table 2-2, heavy vehicles account for 26 percent of the AADT volume on the corridor today.

Table 2-2 I-81 Vehicle Classification Summary

VDOT Permanent Count Station Location	Total AADT	Heavy Vehicle AADT	Heavy Vehicle Percentage
I-77 overlap section (North Corporate Limit of Wytheville)	50,800	13,500	26.5
I-77 north of overlap section	37,000	7,800	21.1
I-77 south of overlap section	27,000	6,800	25.2

Source: VDOT 2007/2008 Permanent Count Station Data

Selected hourly traffic volume data along the I-77/I-81 overlap section were also reviewed for vehicle classification. The peak hour data suggest that the morning and evening peak hour heavy vehicle percentages along the overlap section are approximately 20.4 and 18.4 percent of the overall traffic stream, respectively.

Peak "Design" Hour Traffic Comparison

Based on the policies and procedures outlined in the *2000 Highway Capacity Manual*[1], the traffic analysis performed as part of the I-77/I-81 Overlap Study is based on peak or "design" hour traffic volumes. Specific methodology related to how traffic networks were developed and analyses were performed can be found in Chapter 3 of this technical report.

To identify peak "design" hour traffic volumes, the 2008 permanent count station data and previous data collected as part of the *Tier 1 EIS* were reviewed. Both sets of data indicate that the evening period continues to be the peak travel hours for traffic on the I-77/I-81overlap section. As discussed previously, a comparison of daily data indicate traffic volumes have declined since 2004. However, despite daily trends, traffic volume trends during the peak hours (generally the basis for the *Tier 1 EIS* determinations) have been stagnant, varying less than one percent since 2004. This is an important distinction when considering the effects of declining traffic volumes on the future forecasts for the interstate. Given that peak hour traffic volumes have remained unchanged since 2004, those presented in the *Tier 1 EIS* are considered to be the 2008 baseline condition for this study.

Seasonal Adjustment

When limited data sets are available, traffic counts collected during a specific time of year are often adjusted to annual average conditions to account for seasonality on a particular roadway. This adjustment ensures that the transportation assessment of traffic growth and the analysis of each of the potential concepts are consistent and reflective of the average annual daily traffic along the corridor.

Since there is a permanent count station on the overlap section, daily traffic volumes for the entire year between May 2007 and May 2008 were available for use for analysis purposes. Since the average of these data were inclusive of all months and weeks of the year, no further seasonal adjustments were necessary.

[1] 2000 Highway Capacity Manual Special Report 209, Transportation Research Board, Washington DC, 2000.

3 Analysis of Existing Conditions

An effective evaluation of existing conditions along the I-77/I-81 overlap section requires an understanding of current traffic volumes, operations, and geometric conditions. The existing conditions evaluation focused on daily and evening peak hour traffic volumes, recent crash history along the corridor, and an inventory of highway and interchange geometry.

3.1 Traffic Volumes

Daily and peak hour traffic volumes for the I-77/I-81 overlap section and entrance/exit ramps at the five study area interchanges were analyzed, as well as peak period turning movement volumes at local street intersections with Interchange 77 and Interchange 80.

3.1.1 Existing Traffic Network

As discussed in Section 2.1.1, based on the peak hour volume data from 2007/2008, the evening peak hour was chosen as the "design" peak hour because it generally represents the highest (or worst case) condition along the corridor. Therefore, all volume data used for this study are based on the annualized weekday evening peak hour traffic volume data and the adjusted ramp counts.

These data were first disaggregated by passenger cars and trucks to generate individual networks for each vehicle type. The traffic volumes along the overlap section were balanced based on the entering and exiting ramp volumes to ensure that traffic volumes between each interchange are equal. The data collection process can sometimes result in volume imbalances because of minor variations in traffic flow and unavoidable time lags between interchanges; this phenomenon is normal and expected. These imbalances are smoothed (manually adjusted to provide more natural agreement with other interchange volumes and/or historical data) at individual interchanges to provide a consistently balanced network for the entire I-77/I-81 overlap section. The resultant

2008 existing daily and peak hour traffic volume networks for passenger cars and trucks are presented in Figures 3-1 and 3-2.

3.1.2 Mainline and Ramp Volumes

The adjusted and smoothed existing daily traffic volumes along the I-77/I-81 overlap section are shown on Figure 3-1. Approximately 50,000 to 55,500 vpd travel along the overlap section (24,700 to 28,000 vpd in each direction). Peak hour mainline volumes are listed in Table 3-1 and shown in Figure 3-1. Ramp volumes are also presented in Figure 3-1.

I-81 is a heavy freight corridor with up to 35 percent of the daily traffic comprised of through trucks. Average daily truck traffic accounts for approximately 26 percent of traffic along the I-77/I-81 overlap section the corridor, while peak hour truck percentages range from 20 to 30 percent. Traffic networks depicting the daily and peak hour heavy vehicles are presented in Figure 3-2.

During the "design" peak hour, northbound traffic ranges from 1,750 to 2,050 vph, with the heaviest flow occurring between Interchanges 73 and 77. Southbound traffic volumes range from 1,600 to 1,800, with the heaviest flow occurring between Interchanges 81 and 80. The exit ramps at the junctions of I-77 and I-81 experience heavy daily and design peak hour flows, and often cause congestion during peak times and holidays.

Table 3-1 Existing (2004) I-81 Traffic Volumes

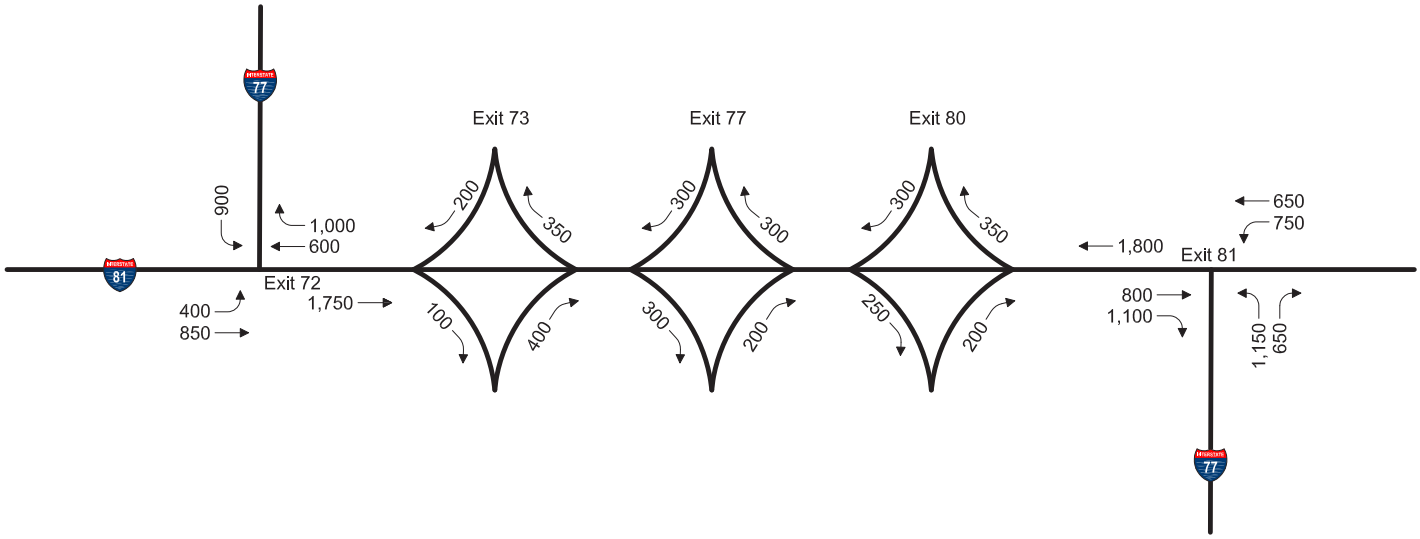
	Northbound		Southbound	
Location	Design Peak Hour (vph[1])	Daily (vpd[2])	Design Peak Hour (vph)	Daily (vpd)
Interchange 72 to Interchange 73	1,750	25,500	1,600	24,700
Interchange 73 to Interchange 77	2,050	28,000	1,750	27,500
Interchange 77 to Interchange 80	1,950	26,900	1,750	27,300
Interchange 80 to Interchange 81	1,900	26,800	1,800	27,100

1 Vehicles per hour
2 Vehicles per day

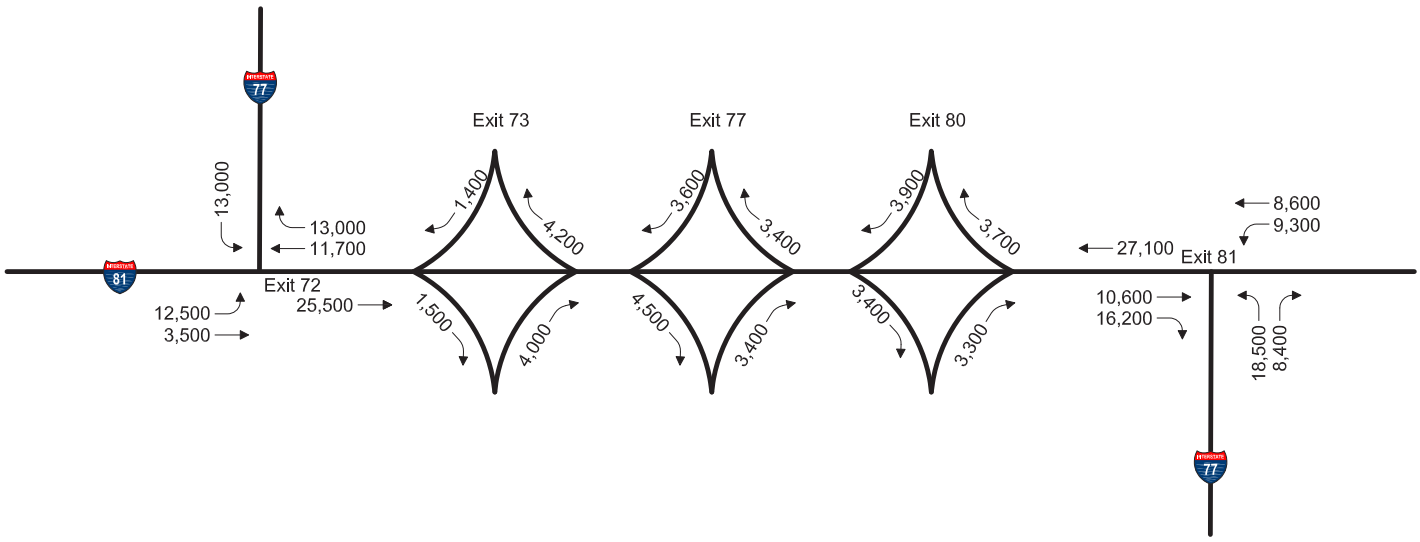
3.1.3 Peak Period Turning Movements

Peak period turning movement counts (TMCs) where I-77/I-81 ramps meet with local streets (at Interchange 77 and Interchange 80) were obtained from the Interchange Modification Reports at each location. These volumes were adjusted to match the peak hour selected for this study, which focused on the peak demands of the interstate rather than the local street.

Existing Peak Hour



Existing Daily



I-77/I-81 **I-81 Corridor Improvement Study**
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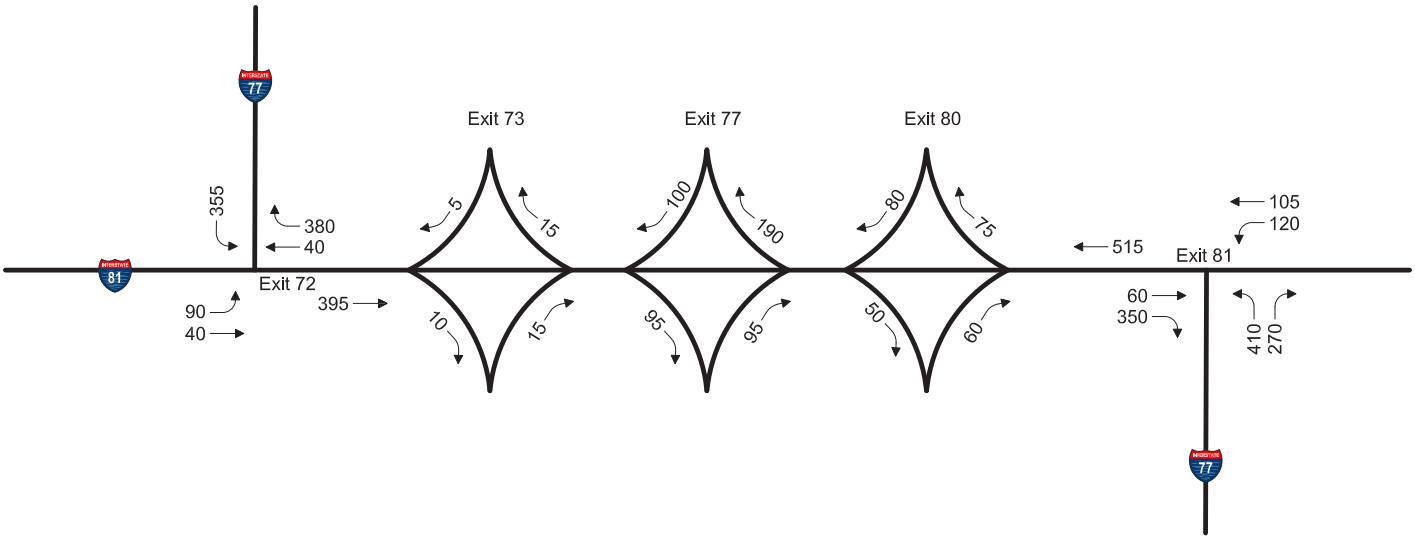
VDOT Virginia Department of Transportation

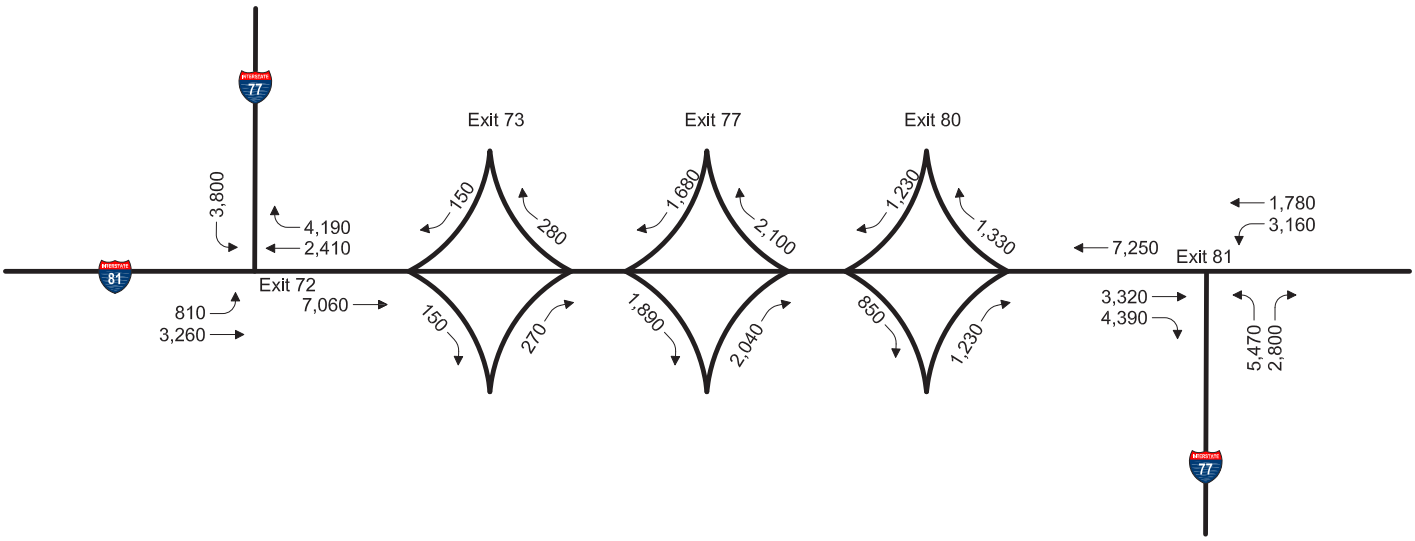
2008 Existing Volumes

Figure **3-1**

Existing Peak Hour



Existing Daily



I-77/I-81 **I-81 Corridor Improvement Study**
Tier 2 I-77/I-81 Overlap

VDOT Virginia Department of Transportation

Figure **3-2**

Existing Heavy Vehicle Volumes

The peak hour volumes were used to calculate levels of service and evaluate existing operations at areas adjacent to the interstate.

The VDOT historical traffic volume information used to determine the seasonal traffic variations at the ramps were also applied to the local street ramp termini. Local street turning movement counts were all factored to average annual conditions. These turning movements have been further adjusted to conform with ramp volumes at the interchanges, which reflects the design hour of the interstate facility rather than that of the local street system. This results in slightly higher ramp volumes than reported in the previous studies.

3.2 Traffic Operations Analysis

Understanding the relationship between demand and supply is a fundamental consideration in evaluating how well a transportation facility or service fulfills its objective to accommodate the traveling public. From the standpoint of a freeway facility, this assessment is usually accomplished by conducting a level of service (LOS) analysis in which "peak" traffic demands are compared with the available freeway capacity. The peak demand used for this analysis is generally based on hourly traffic flows. For multi-lane, divided highways, such as I-81, these flows are analyzed by direction.

To assess existing traffic operating conditions along the I-77/I-81 overlap section, levels of service were analyzed for mainline segments between interchanges, ramp diverges and merges, and weaving sections during the evening peak "design" hour. The following sections discuss the capacity analysis assumptions and results.

3.2.1 Mainline and Ramp Operations

The ideal capacity of a freeway segment can be affected by a number of factors, such as the number of travel lanes, amount of heavy vehicles (large trucks or recreational vehicles) within the traffic stream, the terrain (grade), lane widths, the presence of obstructions adjacent to the highway, the drivers (regular or infrequent users, which is an indication of a driver's familiarity with the highway), and the prevailing speed of the traffic flow. Other non-recurring factors, such as inclement weather and traffic accidents or incidents, can also have a substantial effect on congestion, particularly on highways operating at or near capacity. Although these latter factors are not formally considered in the calculation of the freeway's capacity, they are important to the operations of the freeway, as both have the potential to substantially affect vehicle speed.

The other major factor affecting the capacity of a freeway is the interaction of vehicles at interchanges, where traffic on the mainline can be substantially affected by the "friction"

between vehicles merging into the traffic stream and vehicles slowing to exit from the traffic stream. According to the *Highway Capacity Manual (HCM)*,[2] this interaction can reduce the capacity of a freeway segment by the amount of merging vehicles, especially if there is inadequate distance provided by the acceleration/deceleration lanes on the freeway. Where acceleration/deceleration lanes do not meet current design standards, capacity along the freeway segment will be further affected as vehicles will need to use part of the freeway to accelerate and decelerate. This methodology is particularly relevant to the I-77/I-81 overlap section since interchanges 41 (on I-77), 72 and 73 are closely spaced (interchange 41 is about one-half mile north of interchange 72 and interchange 73 is about 1.5 miles to the south) and acceleration lanes at interchanges 72, 73, and 77 are largely deficient. The implications of the safety deficiencies are discussed in Sections 3.3 below and in Chapters 4 and 5, as their affects begin to compromise interstate operations.

The existing cross-section for I-81 along the overlap section includes a two- to four-foot inside shoulder, three 12-foot travel lanes, and one 10-foot shoulder.

Mainline Level of Service Criteria

The study methods outlined in Chapter 23 (Basic Freeway Segments) of the *Highway Capacity Manual*[3] were used for the level of service analysis of the various I-81 segments within Virginia.

The term level of service is used to define the operational characteristics of traffic flow along a given highway. A letter grade from LOS A (representing free-flow traffic conditions) to LOS F (representing a forced breakdown in traffic flow) is assigned to a specific segment of the highway, as can be seen in Table 3-2. Level of service represents reasonable ranges in the three critical flow variables: speed, density of vehicles in the traffic stream, and the flow rate of the vehicles. Basically, as the density of vehicles per mile of highway increases, the speed of the vehicles on the highway tends to decrease and the flow rate of the vehicles correspondingly decreases. A six-lane freeway can process approximately 2,300 passenger vehicles per lane per hour (6,900 vehicles per direction) under optimal conditions (12-foot travel lanes, 2-foot median lateral clearance and 6-foot right lane lateral clearance, level terrain, no heavy vehicles, and a driver population consisting of mostly regular users) in urban areas. These volumes would result in LOS E operations, the point at which a highway is considered to be operating at capacity.

2 Ibid.
3 Ibid.

Table 3-2 Level of Service (LOS) Summary of Conditions

Level of Service	Traffic Conditions	Description of Operations
LOS A (best LOS)	Free Flow	Vehicles almost completely unimpeded in their ability to maneuver within the traffic stream.
LOS B	Reasonable Free Flow	The ability to maneuver within the traffic stream is only slightly restricted.
LOS C	Stable Flow	Freedom to maneuver within the traffic stream is noticeably restricted.
LOS D	Approaching Unstable Flow	Freedom to maneuver within the traffic stream is more noticeably limited.
LOS E	Unstable Flow	Operations at capacity. No usable gaps in traffic stream.
LOS F (worst LOS)	Forced or Breakdown Flow	Queues form behind breakdown point and volume to capacity ratio exceeds 1.0.

Note: Description based on AASHTO and HCM standards.

A Policy on Geometric Design of Highways and Streets[4], published by the American Association of State Highway and Transportation Officials (AASHTO), is referenced in the Code of Federal Regulations and is used to provide the LOS standard for highways on the National Highway System, which includes I-81 and I-77. The level of service standard for mainline operations along the overlap section, which for highway classification purposes is considered urban, is LOS C. Based on ideal conditions, plus a free-flow speed of 70 mph the design capacity of the three-lane section necessary to maintain LOS C is approximately 4,500 vehicles per hour per direction as illustrated in Table 3-3. Taking into account the various factors that influence a highway's capacity, including peak hour factors, the presence of heavy vehicles, geometry, grade, and lateral clearance from obstructions along the highway, the effective capacity of the overlap section is further reduced from these thresholds. (This adjustment does not take into account any reduction in freeway capacity which occurs at the Interchanges along the I-77/I-81 overlap section, as subsequent sections of this report present information on operations at interchange ramps.)

Table 3-3 Level of Service Comparison by Number of Lanes[1]

	Vehicles (per hour per direction)	
	3 lanes	
Level of Service	Rural	Urban
LOS C	5,000	4,500
LOS E (freeway at capacity)	7,200	6,900

1 Optimal Conditions as defined above.

4 *A Policy on Geometric Design of Highways and Streets*, 4th Edition, American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C., 2004

Once the capacity of a highway is determined, the density can be calculated and the level of service can be determined. The *Highway Capacity Manual* (HCM) does not recommend a specific level of service for design purposes but does describe the conditions associated with each level of service. The manual describes LOS C as providing for flow with speeds at or near free flow speed; freedom to maneuver within the traffic stream is noticeably restricted; lane changes require additional care and vigilance; and queues may begin to form behind any substantial blockage.

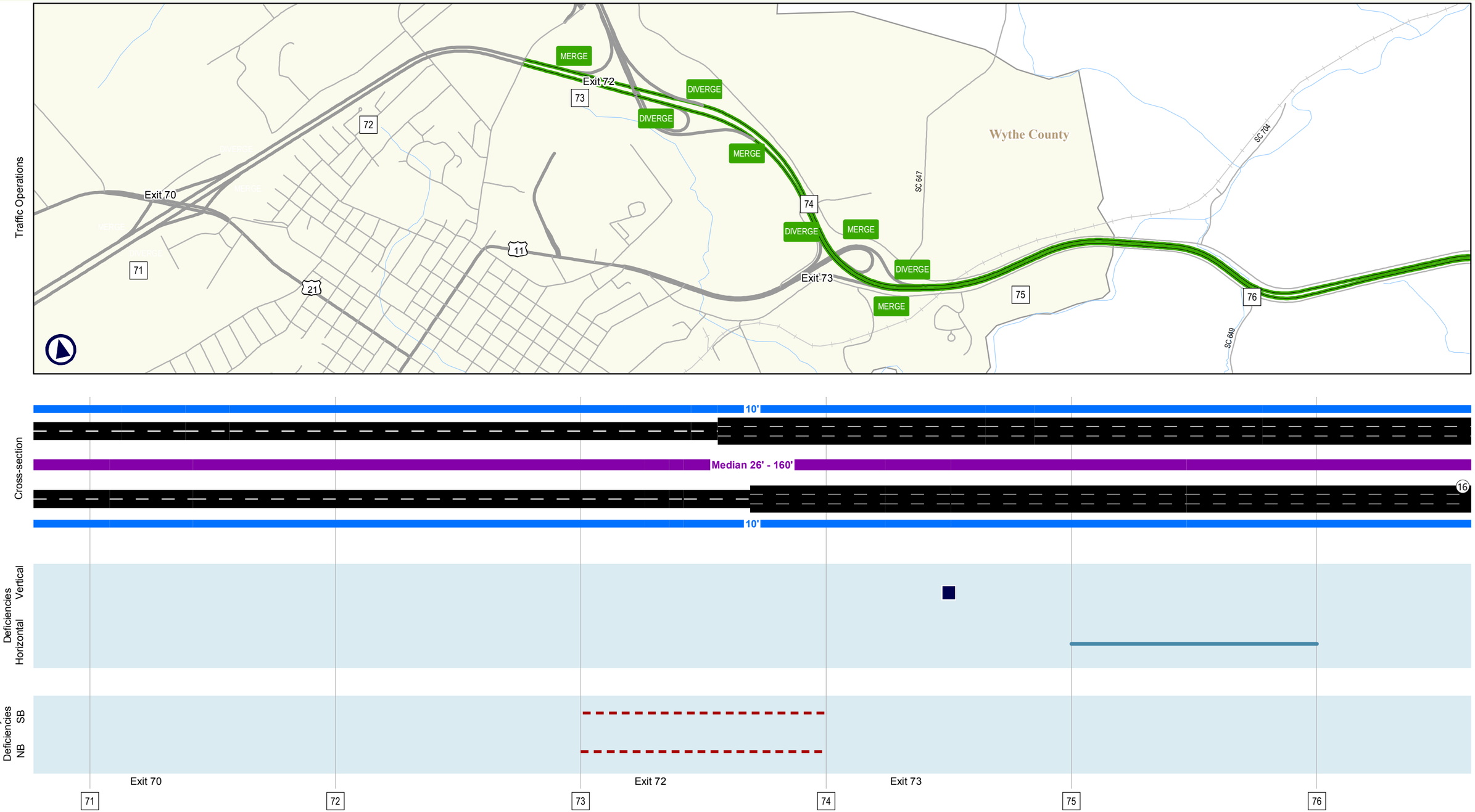
As conditions deteriorate to LOS D, the HCM describes conditions as unstable flow; freedom to maneuver within the traffic stream is more noticeably limited; and a driver experience of reduced physical and psychological comfort levels. The HCM indicates that the higher the design level of service, the more the highway facility can absorb additional atypical amounts of traffic and still function at a satisfactory level.

Heavy Vehicles

The effect of heavy vehicles on traffic flow depends on grade conditions as well as traffic composition. Traffic flow on freeways with a mix of vehicle types must be adjusted to an equivalent flow rate (expressed as passenger cars per hour per lane). This adjustment is made by calculating a passenger car equivalent for each heavy vehicle based on the procedure outlined in the *Highway Capacity Manual*. Passenger car equivalents are based on the grade and length of grade along a freeway segment and represent the number of passenger cars that would use the same amount of freeway as one heavy vehicle under prevailing highway and traffic conditions. Using the calculated passenger car equivalents and the percentage of heavy vehicles, an overall adjustment factor is used to determine flow and level of service.

Operational Results

The results of the level of service analysis conducted for the I-77/I-81 overlap section are presented in Table 3-4 and shown on Figure 3-3. All freeway segments along the overlap section meet the level of service standard.



0 2,000 feet

Milepost

Ramp LOS

- Ramp MERGE A/B
- Ramp MERGE C Urban
- Ramp MERGE C Rural
- Ramp MERGE D
- Ramp MERGE E/F

Mainline LOS

- A/B
- C Urban
- C Rural
- D
- E/F

Cross-section

- SB Shoulder
- SB Roadway
- Median
- NB Roadway
- NB Shoulder

Vertical Deficiencies*

- Grade Exceeds Standard
- Insufficient Sight Distance
- Substandard Vertical Curve
- Substandard Vertical Clearance

Horizontal Deficiencies*

- Segment
- Location

See Table 3-4 for Interchange Deficiencies

Safety Deficiencies (2000-2002)

- Fatal Crash
- High Crash Segment

*Source: I-81 Concept Studies

I-77/I-81 I-81 Corridor Improvement Study
Tier 2 I-77/I-81 Overlap

Existing Corridor Conditions

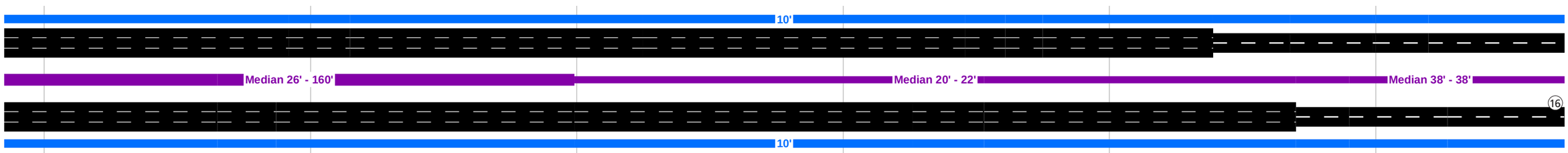
Sheet 1 of 2

VDOT

Figure 3-3

Traffic Operations

Cross-section



Geometric Deficiencies

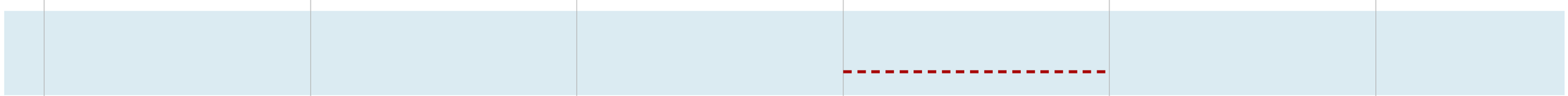
Vertical

Horizontal

Safety Deficiencies

SB

NB



Exit 77 Exit 80 Exit 81

77 78 79 80 81 82

0 2,000 feet

Milepost

Ramp LOS

- Ramp MERGE A/B
- Ramp MERGE C Urban
- Ramp MERGE C Rural
- Ramp MERGE D
- Ramp MERGE E/F

Mainline LOS

- A/B
- C Urban
- C Rural
- D
- E/F

Cross-section

- SB Shoulder
- SB Roadway
- Median
- NB Roadway
- NB Shoulder

Vertical Deficiencies*

- Grade Exceeds Standard
- Insufficient Sight Distance
- Substandard Vertical Curve
- Substandard Vertical Clearance

Horizontal Deficiencies*

- Segment
- Location

See Table 3-4 for Interchange Deficiencies

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- Fatal Crash
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*Source: I-81 Concept Studies

I-77/I-81 I-81 Corridor Improvement Study
Tier 2 I-77/I-81 Overlap

Existing Corridor Conditions

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VDOT

Figure 3-3

Table 3-4 Existing I-81 Freeway Operations Summary

Segment			Northbound		Southbound	
From Interchange	To Interchange	Number of Lanes	Volume[1]	LOS[2]	Volume	LOS
72	73	3	1750	B	1600	A
73	77	3	2050	B	1750	B
77	80	3	1950	B	1750	B
80	81	3	1900	B	1800	B

1 Vehicles per hour
2 Level of Service

3.2.2 Ramp Operations

The analysis of merge and diverge operations at interchange ramps is based on procedures in Chapter 25, *Ramps and Ramp Junctions*, of the *Highway Capacity Manual*.[5] The procedure focuses on the interaction between freeway mainline through traffic and traffic merging from or diverging to ramps. The analysis takes into account the length and taper of the acceleration/deceleration lanes, free-flow vehicle speed along the freeway, and the number of vehicles in the right-most (or left-most for left interchanges) two lanes of the freeway. The focus of the analysis is at the ramp junction with the mainline where entering vehicles attempt to find gaps in the adjacent traffic stream. The action of this merging traffic creates vehicle turbulence along the mainline which can affect freeway operations. The converse of this action is the diverge movement which forces exiting vehicles to shift in advance and occupy the right travel lane to exit the freeway causing some turbulence as the vehicles shift lanes and decelerate. According to the HCM, the influence area for both of these movements is approximately 1,500 feet before the diverge areas and beyond the merge areas (including acceleration and deceleration lanes).

Ramp Level of Service

The results of the ramp analyses are summarized in Table 3-5 and shown on Figure 3-3. The operational standard for all ramps is LOS C. The analysis of existing conditions indicates that all ramps meet the level of service standard.

5 Ibid 1.

Table 3-5 I-81 Ramp Level of Service Analysis Summary

	Northbound Ramps			Southbound Ramps		
	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS
Interchange 72 Exit Ramp	400	7.1	A	1000	2.9	A
Interchange 72 Entrance Ramp	900	13.7	B	400	1.4	A
Interchange 73 Exit Ramp	100	18.0	B	350	15.0	B
Interchange 73 Entrance Ramp	400	12.1	B	200	4.6	A
Interchange 77 Exit Ramp	300	12.7	B	300	12.1	B
Interchange 77 Entrance Ramp	200	10.2	B	300	13.6	B
Interchange 80 Exit Ramp	250	11.1	B	350	15.1	B
Interchange 80 Entrance Ramp	200	9.2	A	300	11.9	B
Interchange 81 Exit Ramp	1100	5.9	A	750	8.2	A
Interchange 81 Entrance Ramp	650	10.1	B	1150	9.8	A

1 Ramp volume expressed in vehicles per hour (vph)
2 Density expressed in passenger cars per mile per hour
3 LOS - Level of Service

As seen in Table 3-5, some ramps have volume in excess of 1,000 vph and exhibit better levels of service than ramps with much lower volumes. This is due to the influence of the upstream (previous) ramp traffic merging onto the interstate and affecting a motorist's ability to enter the right lane and exit downstream. As volumes increase over time, this influence area would become more predominate.

While the ramps associated with Interchanges 77 and 80 are exhibiting adequate freeway operations, congestion along the local roadway has been observed to affect these operations during the peak hours, particularly the operations of exit ramps. Vehicles exiting the highway were observed to queue along the ramp and occasionally extend to the interstate. These effects are exacerbated by the proximity of the Frontage Roads to the ramp intersections with local streets. As part of the Six-Year Transportation Plan, modifications to interchanges 77 and 80 were completed in August 2009. These improvements are expected to alleviate extended queues.

Weaving Operations

A weaving movement is defined as the interaction between the crossing of two or more traffic streams traveling in the same direction without the aid of traffic control devices. There are no weaving areas along the I-77/I-81 overlap section.

3.2.3 Intersection Level of Service

The capacities at intersections near the I-77/I-81 overlap interchanges were analyzed to assess the existing quality of traffic flow. Capacity analyses indicate how well an intersection serves the traffic demand. Operating conditions are classified by calculated levels of service as described below. Six intersections were evaluated as part of the existing conditions analysis:

Intersection Level of Service Criteria

Intersection level of service is the term used to denote the different operating conditions which occur at a given intersection under various traffic volume loads. It is a qualitative measure of the effect of a number of factors, including roadway geometrics, speed, travel delay, freedom to maneuver, and safety. Level of service provides an index to the operational qualities of an intersection. The operational standard at intersections is generally LOS C, per AASHTO standards.

Level of service designation is reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of each lane or lane group entering the intersection and the level of service designation is for overall conditions at the intersection. For unsignalized intersections, the analysis assumes that traffic on the mainline is not affected by traffic on the side streets. The level of service is only determined for left turns from the main street into the minor or side street and all movements from the minor street. The overall level of service designation is for the most critical movement, which is most often the left turn from the side street.

The evaluation criteria used to analyze area intersections are based on Chapter 16, *Signalized Intersections*, and Chapter 17, *Unsignalized Intersections*, of the *2000 Highway Capacity Manual*[6]. Interchanges having directional ramps (where only right turns can be made to/from local streets) are not included as part of this analysis. These locations often operate under yield locations and have lower delay.

6 Ibid 1.

Unsignalized Intersections

Capacity was analyzed at two unsignalized intersections in the study area using Highway Capacity Software (HCS)[7] intersection analysis software. Unsignalized intersection level of service results are based on the average delay experienced by vehicles exiting the minor or side street. The results of the unsignalized intersection capacity analyses are presented in Table 3-6. As the table shows, the Interchange 77 southbound ramp intersection with Routes 11/52/336 operates worse than the level of service standard. The deficient movement is the turn from the interstate exit ramp onto the adjacent local street.

Signalized Intersections

Signalized intersection capacity was analyzed at four study area intersections using HCS intersection analysis software. As shown in Table 3-6, all signalized intersections operate above the level of service standard. As noted previously, programmed Six-Year Transportation Plan improvements were complete in August 2009. It is expected that these improvements would return traffic operations at the interchange 77 southbound ramp to acceptable LOS C conditions. However, the complete affects of the improvements are not known at this time.

Table 3-6 Existing Intersection Operations Summary

		Existing Conditions	
Intersection[1]	Critical Movement[2]	Delay[3]	LOS[4]
Interchange 77 NB Ramps @ U.S. Routes 11/52/Route 336	NB Exit Ramp LTR	16	C
Interchange 77 SB Ramps @ U.S. Routes 11/52/Route 336	SB Exit Ramp LTR	35	E
Interchange 80 NB Ramps @ U.S. Routes 52/121	**Intersection**	8	A
Interchange 80 SB Ramps @ U.S. Routes 52/121	**Intersection**	21	C
Route 121 at E Lee Highway	WB LTR	14	B
Route 52 at Chapman Road	**Intersection**	17	B

Note: Shaded sections are locations where substandard LOS is indicated.
1 Signalized Intersections are displayed in bold print, and delay and LOS data listed applies to the overall intersection.
2 Delay and LOS listed for unsignalized intersections are for either the critical movement on the cross street or the minor (exit ramp) approach.
3 Delay - Average delay, expressed in seconds per vehicle.
4 LOS – Level of Service.

The methodology for intersection analysis does not account for interaction between adjacent intersections and any delay incurred from the proximity of frontage roads to the interstate. These interactions must be observed and reported as a qualitative assessment of traffic operations. Visual observations indicate that motorists likely notice a small increase in delay (over the results provided in Table 3-6) because of the close intersection spacing, particularly

7 Highway Capacity Software Version 4.1e, University of Florida, Gainesville, 2003.

at Interchange 77, where the ramps and frontage road intersections are unsignalized. As traffic increases, this delay could worsen and affect traffic operations on the ramp, frontage road and further along Routes 52 and 336. While it is not possible to quantify these results, they are important to consider because they have a direct impact to traffic operations that would not necessarily be represented with poor level of service distinctions.

3.3 Safety

Safety was analysed along the I-77/I-81 overlap section to determine if the traffic demands, combined with the geometric conditions of the highway or its ramps, have resulted in unsafe operating conditions. Safety data for the three-year period from January 2005 to December 2007 (the most recent period available at the onset of this study) were analyzed as part of this study. Typically, a three year period is sufficient to have enough data to both establish trends in crash history and substantiate the benefits of any improvements. The following section summarizes this safety data. The detailed analysis can be found in Appendix B of this report.

Crash statistics for the three-year period from January 2005 to December 2007 revealed a total of 178 crashes along the I-77/I-81 overlap section. No fatalities occurred, but 67 crashes (37.6 percent) involved personal injury to 108 persons. Major crash types include:

- Forty-two (42) percent of crashes involved collisions with a fixed object;
- Twenty-five (25) percent were sideswipe crashes between two vehicles traveling in the same direction;
- Thirteen (13) percent involved rear-end type collisions;
- Five (5) percent involved deer or other animals.

The 2007 statewide weighted crash score for interstate highways in Virginia was 212 crashes per 100 million vehicle miles of travel. The I-77/I-81 overlap section has a lower crash rate than the overall statewide average, with a weighted crash score of 132 crashes per 100 million vehicle miles of travel. Table 3-8 provides the combined (northbound and southbound) weighted crash score for each segment along the I-77/I-81 overlap section.

Based on available crash data from 2000 through 2007, there are two high crash segments (a segment which exceeds the statewide crash rate) along the I-77/I-81 overlap section, between Milepost 73 and Milepost 74 and between Milepost 80 and Milepost 81 (northbound only). Table 3-8 does not identify Milepost 80 to 81 as a high crash segment because it is not possible to calculate weighted crash scores separately for each interstate direction with the data available.

Table 3-8 Existing I-77/I-81 Overlap Crash Scores

Begin Mile Marker	End Mile Marker	Combined Weighted Crash Score[1]
72	73	197.65
73	74	225.94
74	75	113.86
75	76	120.97
76	77	106.74
77	78	95.70
78	79	88.20
79	80	78.81
80	81	157.85

1 Based on crash data for 2003 to 2007 and existing condition AADT.

No reported fatalities occurred on the overlap in the three-year period analyzed. As a point of comparison, the fatal crash rate on other portions of I-81 slightly exceeds the statewide average (0.53 versus 0.52 fatal crashes per 100 million vehicle miles of travel) indicating that when crashes do occur elsewhere on I-81, they tend to be more severe.

Some segments of the overlap sections are more than 30 years old and do not meet AASHTO[8] geometric design criteria for vertical clearance, sight distance, shoulder width, and lengths of acceleration and deceleration lanes. A detailed review of the geometric conditions was completed as part of VDOT's previous I-81 preliminary engineering studies. These studies, combined with a field review performed as part of this study, found that:

- The entire nine-mile length of the I-77/I-81 overlap section has inside shoulder widths that do not meet AASHTO geometric design criteria, based on the volume of heavy vehicles using the roadway.
- Two locations have horizontal and/or vertical sight distances that do not meet AASHTO geometric design criteria because of the alignment of the highway (Milepost 74.5 northbound and southbound).
- Between Milepost 75 and 76 northbound and southbound, mainline horizontal curves do not meet geometric design criteria.
- Two Interchange 72 ramps and one Interchange 81 ramp have deficient ramp design speeds (less than 25 miles per hour).
- At Interchange 80, interchange ramp termini spacing on the service road is less than geometric design criteria and the short ramps do not meet geometric design criteria.

[8] Ibid 4.

- Three bridges have substandard horizontal clearance:
  - The I-81 northbound bridge over I-77 at Milepost 72.
  - The I-81 southbound bridge over I-77 at Milepost 72.
  - The I-77 northbound overpass bridge over I-81.
- Four bridges have substandard vertical clearance:
  - Cove Road over I-81 at Milepost 73.
  - U.S. 52 southbound (Fort Chiswell Road) over I-81 at Milepost 80.
  - The I-77 northbound bridge over I-81 at Milepost 81.
  - The I-77 southbound bridge over I-81 at Milepost 81.

These geometric conditions, when combined with the traffic demands placed on the overlap section (including substantial truck traffic), speeds, and weather conditions may contribute to safety problems. Close spacing of interchange ramps and local frontage roads at Interchanges 77 and 80 are not addressed as part of this study. However, construction would not preclude modifications to the distance between the local frontage roads and ramps as a separate initiative if conditions warrant them in the future.

To determine whether geometric deficiencies could be contributing factors to crashes along the two northbound segments that exceed statewide crash rates, comprehensive State police crash records were reviewed for patterns of crash type, frequency, and/or cause. Time of day and weather conditions during a crash were also reviewed, but the data illustrate that these factors did not contribute to crashes along either segment.

A combination of traffic congestion, high speed ramp movements, and short distances between interchanges appear to be a factor in the crashes occurring along the overlap section between Milepost 73 and Milepost 74. While no specific pattern or frequency is apparent, the source of many crashes along the segment was cited to be general congestion on the roadway. Secondary to congestion, a number of crashes between Milepost 73 and Milepost 74 were incidents of out-of-control vehicles entering the I-77/I-81 overlap section (northbound) at Interchange 72, striking fixed objects or other vehicles, and then overturning. These incidents may be attributed to the high speed of vehicles entering from the I-77 southbound to I-81 northbound entrance ramp, to recreational motorists who are commonly unfamiliar with the geometry of the ramp, and traffic congestion along the overlap section. Substandard sight distance noted at Milepost 74.5 northbound may also contribute to vehicular slowdowns between Milepost 73 to Milepost 74 and, ultimately, crashes along this upstream segment.

Along the northbound segment between Milepost 80 and Milepost 81, general traffic congestion along I-81 again appears to be the primary cause of many crashes; where vehicles slowed or were stopped in traffic when the vehicle was struck from behind by an inattentive motorist. The influence of the ramp system immediately downstream (Interchange 81) from

this segment could be a contributing factor to congestion as drivers make the decision to exit to I-77 southbound or continue northbound on I-81.

Based on a review of the crash data, the safety concerns along the I-77/I-81 overlap section appear to be primarily related to capacity. These concerns could worsen by 2035 as volumes increase, the operating conditions deteriorate, and the existing geometric conditions remain. This may be of particular concern at locations noted above, where traffic operations at larger interchanges are affecting traffic exiting and entering the I-77/I-81 overlap section at the smaller, local interchanges.

Public Perception of Safety on I-81

During the Scoping Meetings held in December 2008 as part of this study, citizens were given the opportunity to discuss issues and concerns on many topics. A number of citizens noted that safety along the I-77/I-81 overlap section is of great concern, particularly as it relates to freeway congestion. Some of the specific concerns include:

- A lack of enforcement regulating speeds and left-lane truck prohibition.
- A lack of sufficient shoulder widths and acceleration/deceleration lanes.
- An increased number of trucks excessively tailgating and/or speeding.
- A concern for the safety of local traffic as interstate congestion spills onto local frontage roadways.
- A feeling of loss of control as trucks “whiz” by.

4

Analysis of Future No-Build Conditions (2015 and 2035)

This chapter describes the future transportation conditions that can be expected within the study area if no improvements are made along the I-77/I-81 overlap section. Subsequent chapters analyze transportation conditions that could be expected with various improvements. This chapter summarizes the methods used to develop No-Build traffic projections, the projected traffic demands, and the expected impacts of these demands on the operations of the corridor. The years 2015 and 2035 were selected because it is envisioned that the improvements that may emerge from this study could be completed by 2015 and have a useful life of at least 20 years beyond completion.

4.1 Forecast Methods

The forecast of traffic growth for the I-77/I-81 overlap section is based on a variety of historical data from 1978 through 2008; as well as recent transportation and socioeconomic indicators. Several key activities were part of this forecast methods analysis:

- The historical average daily traffic and truck volume data on the I-77/I-81 overlap section.
- Forecasts previously completed for the I-81 corridor (including the 2020 VDOT Trendline analyses for the I-77/I-81 overlap section; 2020 forecasts on the overlap section from the previous I-81 Concept Studies; Exit 77 and Exit 80 Interchange Modification Reports).
- Various economic forecasts.
- A review and analysis of freight forecasts.

A detailed discussion of how these components comprise the 2035 traffic volume forecasts is provided in the *Tier I EIS Traffic Technical Report*. This report summarizes traffic growth, focuses on any changes to the 2035 forecasts, and describes the development of 2015 traffic volumes.

4.1.1 Review of Historical Traffic Volumes

As discussed in Chapter 3, daily traffic volumes along I-77 and I-81 have declined since 2004. This is partially due to an increase in gasoline prices and the current economic recession. However, observed traffic volumes during the evening peak hours have remained constant since 2004, which indicates that outside influences do not affect the primary users of the roadway. As discussed in the *Tier 1 EIS Traffic Technical Report*, the trend lines on which the 2035 traffic volumes are forecast include recessionary periods during the 1980s, 1990s, and 2001. The forecasts also include traffic data during the oil embargo in the late 1970s. These periods of downtrending traffic volumes help to moderate the overall projected growth rates over time and allow for instances similar to the current recession to occur without major changes to horizon year forecasts. Traffic volume forecasts for the I-77/I-81 overlap section and Greater Wytheville area were reduced by about one-half percent per year (16 percent total) as part of the *Tier 1 EIS* process when compared to previous studies. The reduction took place to bring growth on the overlap section within the range of current population and employment forecasts and provide a level of correction for anticipated growth that had not yet materialized.

In addition to historical and economic data, the traffic volume forecasts for the I-77/I-81 overlap section use population and employment statistics generated by the Commonwealth for a future forecast year. In the Wytheville area, these forecasts have been amended to include additional growth related to continued expansion of the Progress Park area. While no specific development program has been made public at this time, preliminary discussions indicate that the expansion could be substantial and would likely offset the regional downtrend in traffic in the Wytheville area.

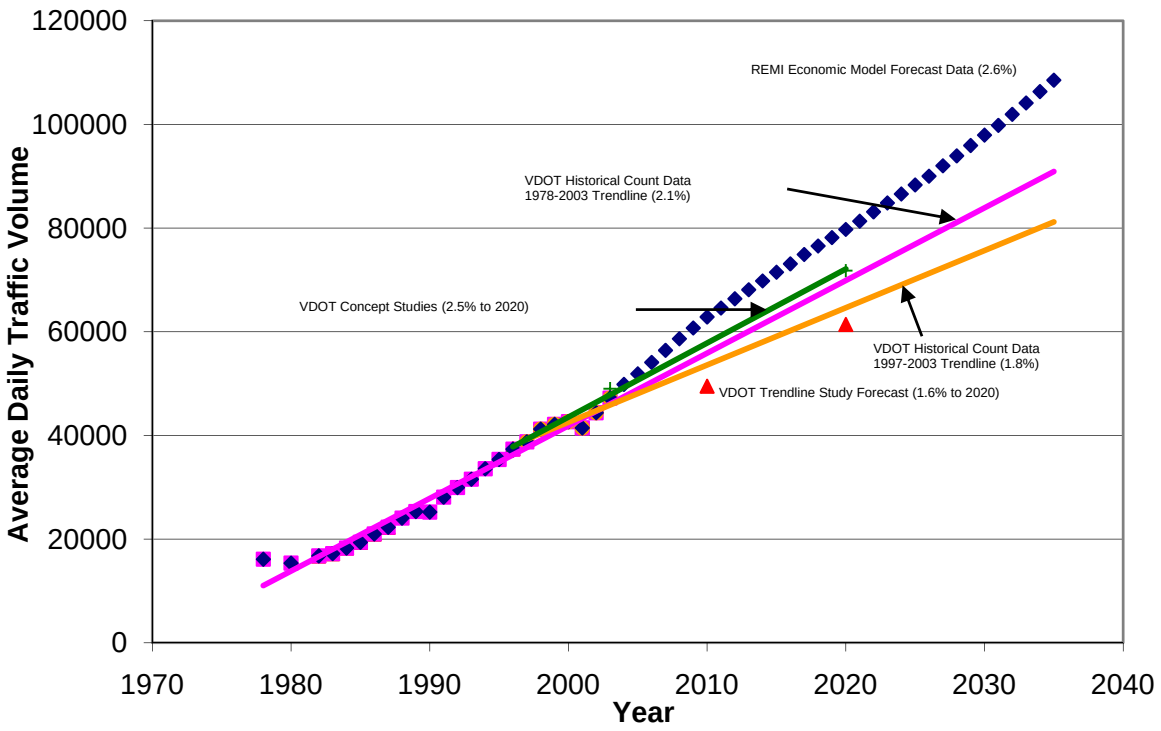
Standard transportation practices require reporting aggregate growth (the growth over time) as average annual growth (growth by year over a number of years). For example, this traffic study is based on an average annual growth of about 2.0 to 2.1 percent annual growth per year over 30 years (*note*: this is an average for all vehicles. The growth rates used for trucks and different trip patterns (local versus long distance) varies, as discussed further below). This equates to an aggregate growth of about 85 percent over the 30 year period from 2005 to 2035. But it is not practical to assume that the annual growth would be the same each year. Rather, some years would be higher and some lower, averaging to about 2.1 percent annually (or 85 percent total) by 2035. As discussed in detail in the *Tier 1 EIS Traffic Technical Report*, factors that contribute to the fluctuation in growth include the economy of the United States and Virginia as well as a diminished scale over time (adding traffic volume to an increasing base number will result in a lower percentage growth annually).

Finally, the data show that while growth in truck traffic is slowing regionally on I-81, it is growing on I-77, putting forecast truck traffic on the overlap section on target based on the *Tier 1 EIS* estimates.

Given these collective factors, the 2035 traffic volume forecasts established as part of the *Tier 1 EIS* remain the 2035 No-Build traffic volumes that form the basis of this study. This represents an annual average growth of 2.1 percent over 30 years (2005-2035) or 2.3 percent over 27 years (2008-2035). As a point of reference, the Interchange Modification Reports (IMRs) for Interchange 77 and Interchange 80 also use approximately 2.3 percent average annual growth between 2008 and their design year of 2031. These IMR data, completed independently from the *I-81 Corridor Improvement Study*, support the previous growth analysis and both are consistent with the Commonwealth's Statewide Planning System.

Figure 4-1 highlights the various forecast sources used and indicates that a range of annual growth rates from 1.4 to 3.0 percent could be expected. The REMI Economic Model forecast for I-81 traffic volumes projected the highest growth rate, while the trend line analysis based on the most recently available data (1997 to 2008) predicts the lowest. The previous VDOT Concept Studies predict a slightly higher growth rate (2.4 to 2.6 percent) than the historical VDOT count trend line growth rates (1.7 to 2.1 percent); however, the Concept Studies only forecasted to a 2020 design horizon and dampen somewhat (to approximately 2.0 to 2.3 percent) when extrapolated for 2035 forecasts.

Figure 4-1 Comparison of 2035 Annual Average Daily Traffic Forecasts on I-81 in Virginia



4.1.2 Forecasting for Special Conditions

As described above, traffic projections for the 2035 No-Build are based on traffic and economic information on the I-77/I-81 overlap section and in the vicinity of Wytheville. A one-hour time period is typically used to evaluate operating conditions on highways and to set future design requirements. To create 2035 No-Build traffic volume networks that could adequately represent expected growth along overlap section, a design hour volume (DHV) was used instead of a traditional peak hour volume. The DHV refers to the one-hour period in the future design year that most appropriately assesses operating conditions and the functional requirements of a facility. The purpose for selecting a DHV below the maximum and above the average demand levels is to avoid over-designing or under-designing a transportation facility.

Typically, the traffic volumes occurring during the 30th, 50th, or 100th highest hour (over the course of a year) are considered for design purposes. A review of hourly traffic volumes along the I-77/I-81 overlap section over the course of a year (2008) showed that the majority of the top 30 hours occur on holidays and heavily traveled summer weekends and that use of the 30th highest hour would, in fact, be designing for a special condition. The 50th and 100th highest hours appear to occur on more typical days of the year. Therefore, using the projected 2035 daily volumes, the 2035 design hour traffic volumes were based on approximately the 50th highest hour, which translates into about nine percent of the 2035 daily projections.

4.1.3 2015 No-Build Traffic Volume Forecasts

In addition to the future horizon year 2035, an interim year was chosen for traffic analysis to reflect how the facility (or facilities) ultimately constructed would operate on opening. Based on guidance from FHWA, an interim year 2015 was chosen for this analysis.

A review of economic forecast information, the Virginia Statewide travel demand model land use forecast, and planned/permitted projects within Wythe County was completed to determine how much of the projected 85 percent growth could be realized by 2015. If a large portion of the planned growth was expected before 2015 then the traffic volume increases would be similarly weighted. However, little of the planned growth has been identified for specific target years. Therefore, a relatively linear relationship to traffic increase was assumed and two percent traffic growth per year for 15 years was subtracted from the 2035 condition to create 2015 No-Build traffic volume networks.

Development of No-Build Traffic Volume Network

Starting with the 2008 traffic volume networks, traffic volumes for through passenger vehicles, all heavy vehicles, and local ramp traffic were grown individually using a range of growth rates between 1.7 (local passenger car traffic) and 2.8 percent (trucks) per year through 2035 (the average growth rate for all vehicle types is 2.0 to 2.1 percent annually). These separate

networks were then added. After combining the separate mainline vehicle class volumes and ramp volumes, the network was then balanced throughout to ensure that traffic volumes at successive interchanges agree and that all corridor traffic is accounted for at the entry and exit points. The resultant 2035 and 2015 daily and peak hour traffic volumes can be seen in Figures 4-2 and 4-3 respectively.

4.2 Future No-Build Traffic Operations

The following sections present the results of the various 2015 and 2035 No-Build levels of service analyses.

4.2.1 Mainline Level of Service

The projected future No-Build levels of service for the mainline and ramp sections were calculated according to the *Highway Capacity Manual* methodologies described in Chapter 3. These analyses were based on the projected No-Build traffic volumes discussed above and represent expected conditions if no improvements are made to the I-77/I-81 overlap section.

Mainline Operations

Traffic volumes and the associated levels of service along the I-77/I-81 overlap section freeway segments are summarized in Tables 4-1 and 4-2 and shown in Figure 4-4.

Compared to existing levels of service, traffic operating conditions decline along the mainline during the 2015 design peak hour. However, all segments of the I-77/I-81 overlap section are projected to operate better than the level of service standard.

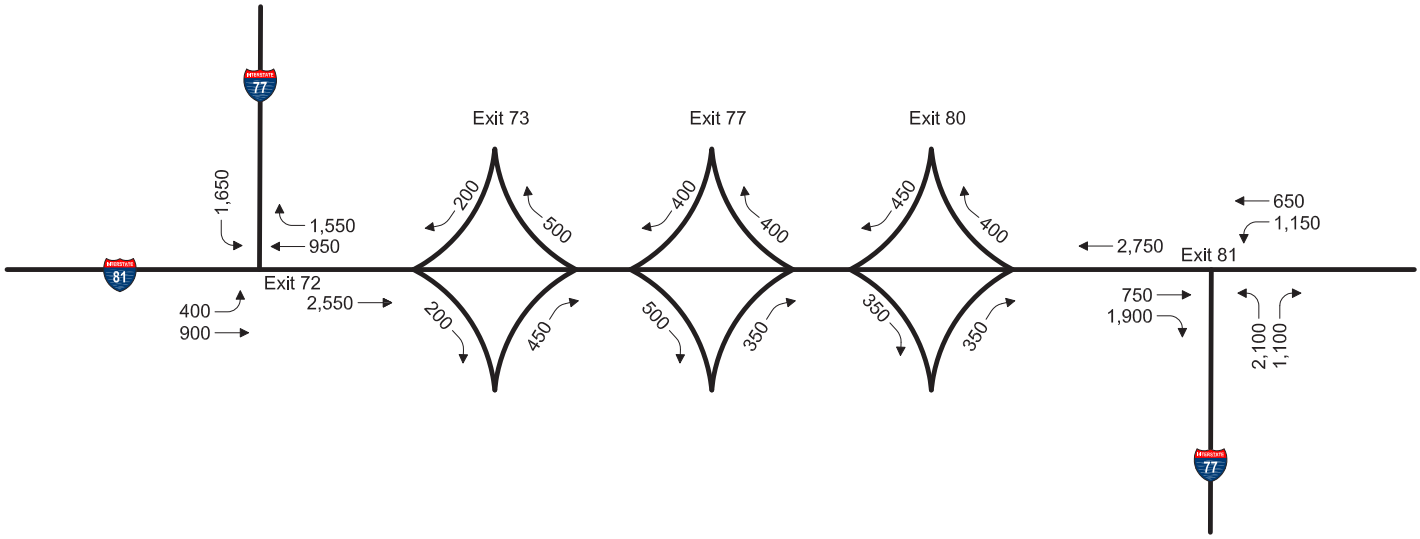
Table 4-1 2015 I-77/I-81 Freeway Operations Summary

Segment			Northbound				Southbound			
			2008 Peak Hour		2015 Peak Hour		2008 Peak Hour		2015 Peak Hour	
From Interchange	To Interchange	Number of Lanes	Volume[1]	LOS[2]	Volume	LOS	Volume	LOS	Volume	LOS
72	73	3	1750	B	2550	C	1600	A	2500	B
73	77	3	2050	B	2800	C	1750	B	2800	C
77	80	3	1950	B	2650	B	1750	B	2800	C
80	81	3	1900	B	2650	B	1800	B	2750	C

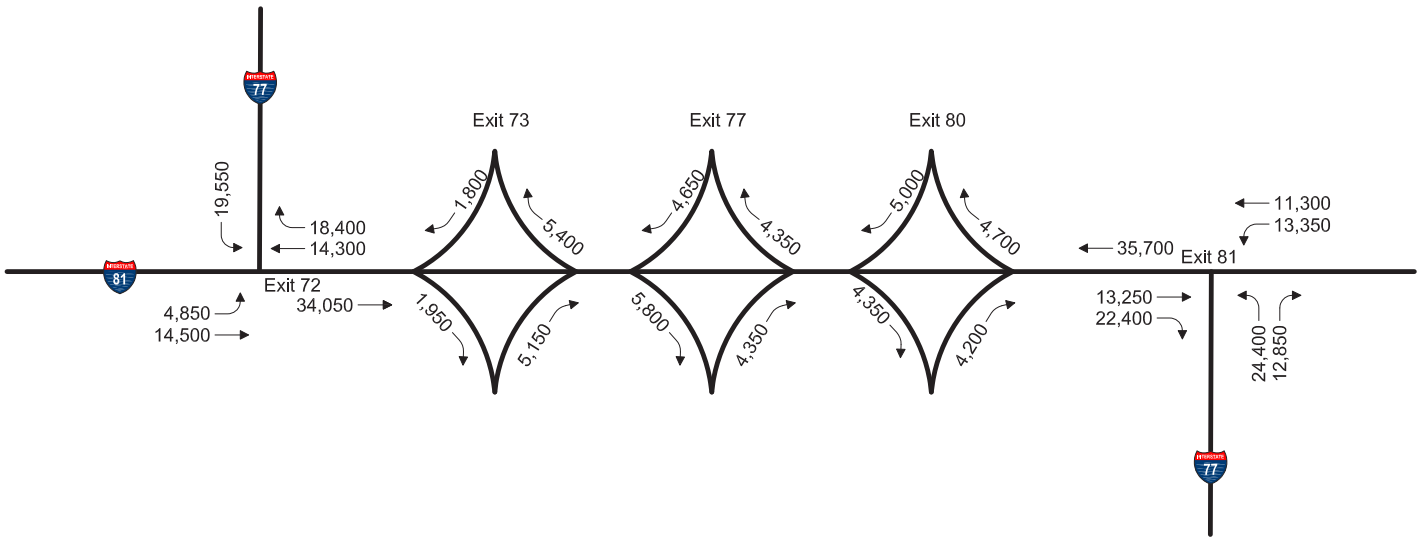
Note: Shaded sections are locations where substandard LOS is indicated.
1 Vehicles per hour
2 Level of Service

Compared to existing levels of service, traffic operating conditions decline along the mainline during the 2035 design peak hour. Based on projected 2035 No-Build volumes:

2015 Peak Hour



2015 Daily



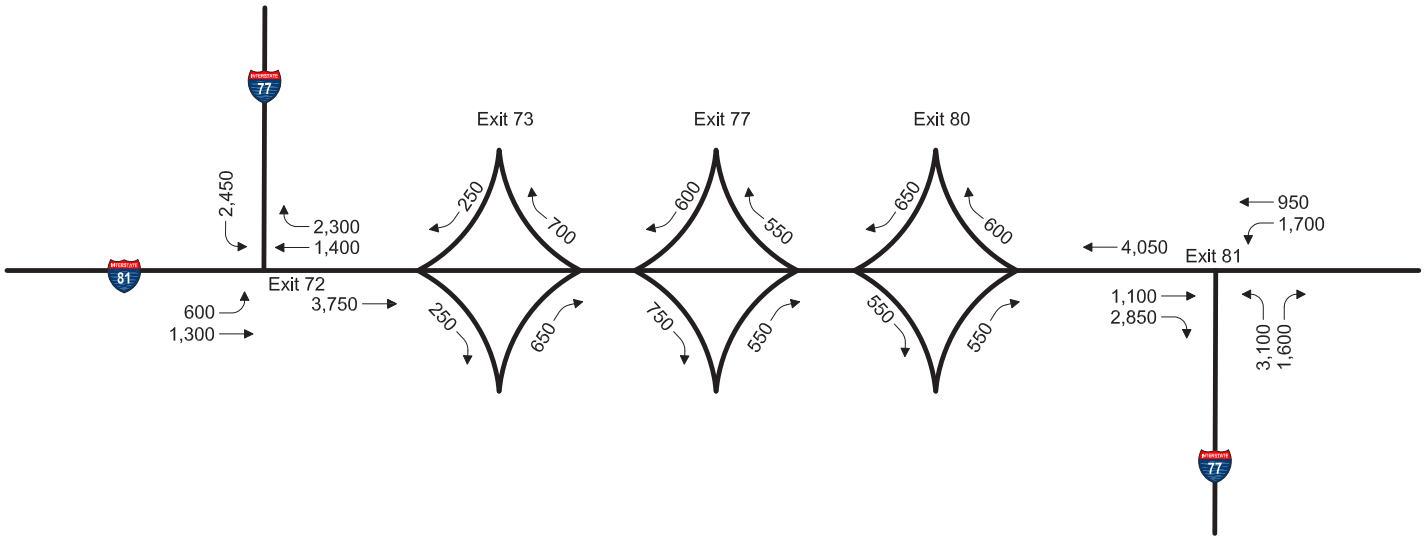
I-77/I-81 **I-81 Corridor Improvement Study**
Tier 2 I-77/I-81 Overlap

VDOT Virginia Department of Transportation

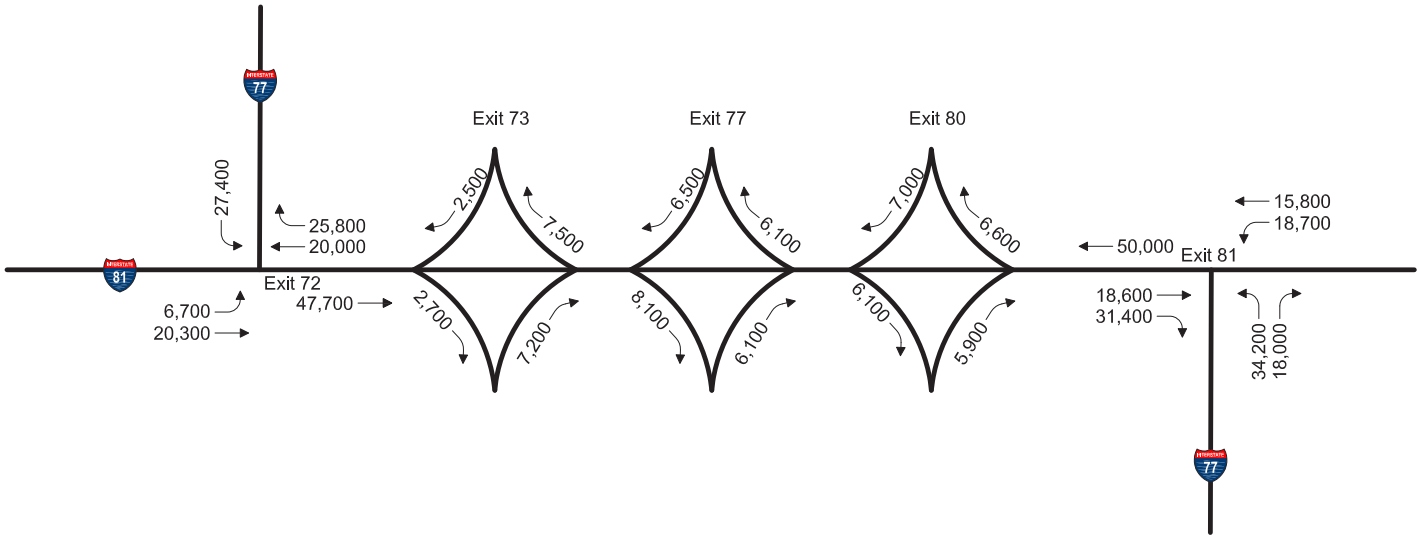
2015 No Build Volumes

Figure **4-2**

2035 Peak Hour



2035 Daily

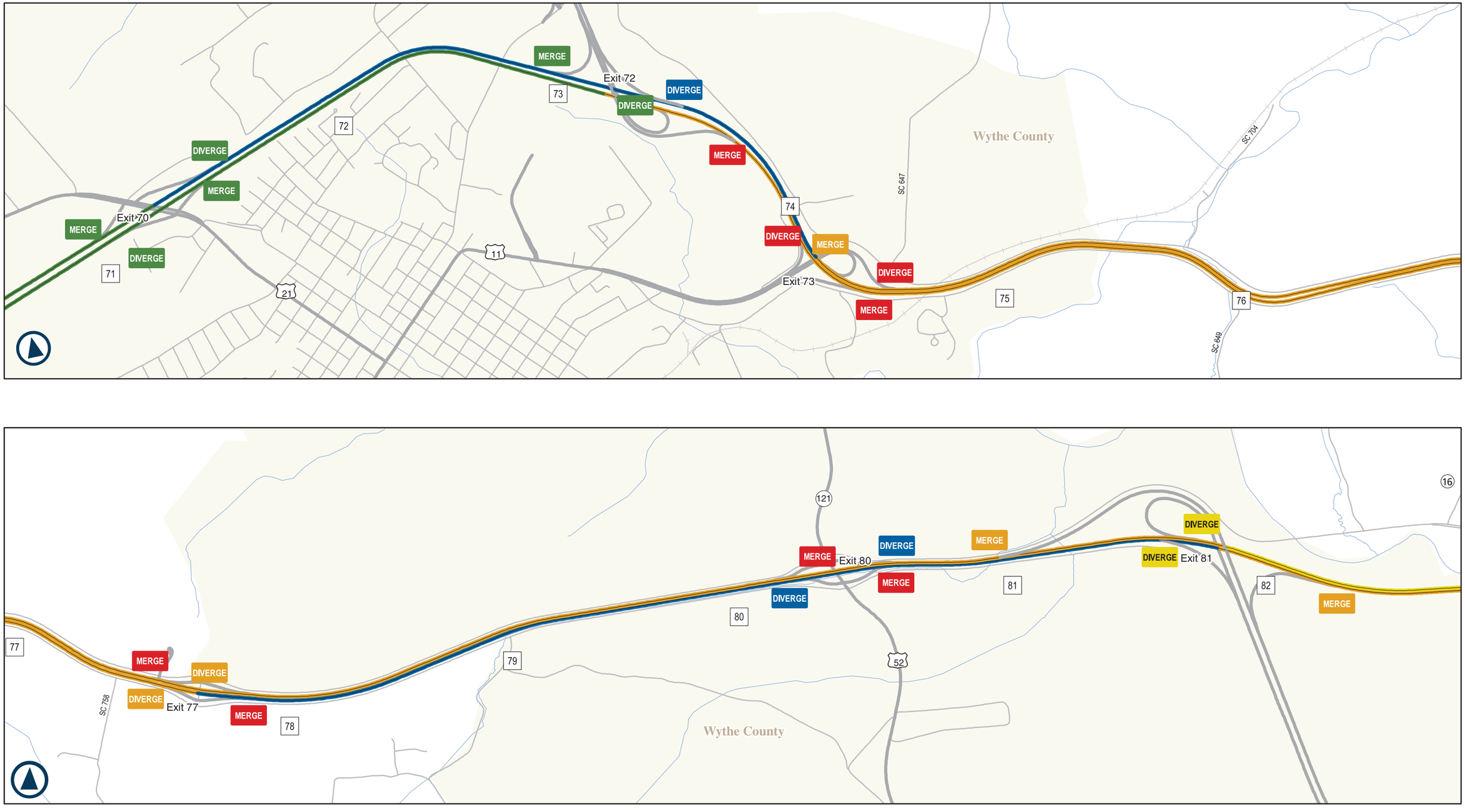


I-77/I-81 **I-81 Corridor Improvement Study**
Tier 2 I-77/I-81 Overlap

VDOT Virginia Department of Transportation

2035 No Build Volumes

Figure **4-3**



0 2,000 feet

I-77/I-81 I-81 Corridor Improvement Study
Tier 2 I-77/I-81 Overlap

VDOT

Future Corridor Conditions

Figure 4-4

- In the northbound direction, 5 miles (56 percent) of the I-77/I-81 overlap section are projected to operate worse than the level of service standard.
- In the southbound direction, 8 miles (89 percent) of the I-77/I-81 overlap section are projected to operate worse than the level of service standard.

Table 4-2 2035 I-77/I-81 Freeway Operations Summary

Segment			Northbound				Southbound			
			2008 Peak Hour		2035 Peak Hour		2008 Peak Hour		2035 Peak Hour	
From Interchange	To Interchange	Number of Lanes	Volume[1]	LOS[2]	Volume	LOS	Volume	LOS	Volume	LOS
72	73	3	1750	B	3750	D	1600	A	3700	C
73	77	3	2050	B	4150	D	1750	B	4150	E
77	80	3	1950	B	3950	C	1750	B	4100	D
80	81	3	1900	B	3950	C	1800	B	4050	D

Note: Shaded sections are locations where substandard LOS is indicated.
1 Vehicles per hour
2 Level of Service

Merge and Diverge Operations

The results of the merge and diverge analyses are presented in Table 4-3, along with the existing conditions analysis results. The results are also shown on Figure 4-4. The shaded segments in the tables indicate those areas that do not meet the level of service standard.

The results indicate that during the 2015 design peak hour:

- In the northbound direction, 1 of the 10 ramps (10 percent) serving the I-77/I-81 overlap section operate worse than the level of service standard.
- In the southbound direction, 2 of the 10 ramps (20 percent) operate worse than the level of service standard.

In both directions, the ramps operating worse than the level of service standard are ramps connecting I-81 to I-77 or are immediately downstream of the system interchanges. This indicates that, as early as 2015, the combined volumes of the co-located interstates would not only affect summer weekend and holiday traffic but would begin to affect daily traffic operations as well. Again, in both 2015 and 2030 it can be noted that low volume ramps at interchanges immediately downstream from major system ramps are operating at poorer levels of service than higher volume ramps elsewhere along the freeway.

Table 4-3 2015 I-77/I-81 Ramp Level of Service Analysis Summary

	Northbound Ramps						Southbound Ramps					
	2008 Peak Hour			2015 Peak Hour			2008 Peak Hour			2015 Peak Hour		
	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS	Volume	Density	LOS	Volume	Density	LOS
Interchange 72 Exit Ramp	400	7.1	A	400	7.5	A	1000	2.9	A	1550	--	F
Interchange 72 Entrance Ramp	900	13.7	B	1650	24.9	C	400	1.4	A	350	3.0	A
Interchange 73 Exit Ramp	100	18.0	B	200	--	F	350	15.0	B	500	23.7	C
Interchange 73 Entrance Ramp	400	12.1	B	450	16.9	B	200	4.6	A	200	10.9	B
Interchange 77 Exit Ramp	300	12.7	B	500	18.3	B	300	12.1	B	400	20.0	B
Interchange 77 Entrance Ramp	200	10.2	B	350	15.0	B	300	13.6	B	400	22.4	C
Interchange 80 Exit Ramp	250	11.1	B	350	15.8	B	350	15.1	B	400	30.7	D
Interchange 80 Entrance Ramp	200	9.2	A	350	15.2	B	300	11.9	B	450	19.6	C
Interchange 81 Exit Ramp	1100	5.9	A	1900	14.4	B	750	8.2	A	1150	12.3	B
Interchange 81 Entrance Ramp	650	10.1	B	1100	15.7	B	1150	9.8	A	2100	19.4	B

Note: Shaded sections are locations where substandard LOS is indicated.
1 Ramp volume expressed in vehicles per hour (vph)
2 Density expressed in passenger cars per mile per hour
3 LOS - Level of Service

Under 2035 No-Build Conditions:

- In the northbound direction, 3 of the 10 ramps (60 percent) serving the I-77/I-81 overlap section operate worse than the level of service standard.
- In the southbound direction, 8 of the 10 ramps (80 percent) operate worse than the level of service standard.

Table 4-4 2035 I-77/I-81 Ramp Level of Service Analysis Summary

	Northbound Ramps						Southbound Ramps					
	2008 Peak Hour			2035 Peak Hour			2008 Peak Hour			2035 Peak Hour		
	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS	Volume	Density	LOS	Volume	Density	LOS
Interchange 72 Exit Ramp	400	7.1	A	600	12.3	B	1000	2.9	A	2300	--	F
Interchange 72 Entrance Ramp	900	13.7	B	2450	--	F	400	1.4	A	500	8.3	A
Interchange 73 Exit Ramp	100	18.0	B	250	--	F	350	15.0	B	700	32.7	D
Interchange 73 Entrance Ramp	400	12.1	B	650	26.5	C	200	4.6	A	250	20.4	C
Interchange 77 Exit Ramp	300	12.7	B	750	27.4	C	300	12.1	B	550	28.6	D
Interchange 77 Entrance Ramp	200	10.2	B	550	23.5	C	300	13.6	B	600	--	F
Interchange 80 Exit Ramp	250	11.1	B	550	24.0	C	350	15.1	B	600	--	F
Interchange 80 Entrance Ramp	200	9.2	A	550	26.2	D	300	11.9	B	650	29.2	D
Interchange 81 Exit Ramp	1100	5.9	A	2850	26.3	C	750	8.2	A	1700	--	F
Interchange 81 Entrance Ramp	650	10.1	B	1600	24.9	C	1150	9.8	A	3100	--	F

Note: Shaded sections are locations where substandard LOS is indicated.
1 Ramp volume expressed in vehicles per hour (vph)
2 Density expressed in passenger cars per mile per hour
3 LOS - Level of Service

4.2.2 Intersection Level of Service

Capacity was analyzed for all of the signalized and unsignalized intersections in the study area based on the 2035 No-Build intersection volumes, and geometry/traffic control.

As shown in the table, by 2035 the improvements implemented in August 2009 as part of the Six-Year Transportation Plan would no longer be sufficient to mitigate poor levels of service.

Table 4-5 2035 Intersection Operations Summary

		Existing Conditions		2035 Conditions	
Intersection[1]	Critical Movement[2]	Delay[3]	LOS[4]	Delay	LOS
Interchange 77 NB Ramps @ U.S. Routes 11/52/Route 336	NB Exit Ramp LTR[5]	16	C	25	C
Interchange 77 SB Ramps @ U.S. Route 11/52/Route 336	SB Exit Ramp LTR[5]	35	E	32	D
Interchange 80 NB Ramps @ U.S. Routes 52/121	Intersection	8	A	25	C
Interchange 80 SB Ramps @ U.S. Routes 52/121	Intersection	21	C	37	D
Route 121 at E. Lee Highway	WB E. Lee Hwy LTR	14	B	38	E
Route 52 at Chapman Road	Intersection	17	B	19	B

Note: Shaded sections are locations where substandard LOS is indicated.
1 Signalized Intersections are displayed in bold print, and Delay and LOS data listed applies to the overall intersection.
2 Delay and LOS data listed for unsignalized intersections are for either the critical movement on the cross street or the minor (exit ramp) approach.
3 Delay - Average delay, expressed in seconds per vehicle. Delays in excess of two minutes are listed as '120+' seconds.
4 LOS – Level of Service.
5 Improvement includes widening exit ramp to provide two lanes at local street terminus. Future LOS reflects left-turn critical movement only.

5
Build Alternatives

As discussed in the *Alternatives Technical Report*, the development of the alternatives was based on the Tier 1 Record of Decision, identified purpose and need, traffic and engineering considerations, environmental impacts, and the conditions and constraints of the study area. Sixteen candidate alternatives were screened to determine which, in addition to the No-Build Alternative, should be analyzed in detail as part of the EA. The screening process evaluated the potential transportation, environmental, and community impacts of each candidate Build Alternative and ranked them in order of severity of impacts. Two alternatives were carried forward for detailed analysis (the methodology and reasons for the selections of these alternatives is found in the *Alternatives Technical Report*.):

- Alternative A: This alternative is a highway on new location immediately north of the I-77/I-81 overlap section that would be designated as I-81. The I-77/I-81 overlap section would then be designated as I-77 and its roadway cross section would remain unchanged.
- Alternative B: This alternative would increase capacity on the I-77/I-81 overlap section by adding one travel lane (and additional left/right shoulder width) in each direction, thereby creating an eight-lane roadway cross section that meets interstate standards. No new interstate facility would be constructed.

Traffic for each alternative was evaluated based on the alternative's ability to meet the purpose and need for the project. Specifically, each alternative is evaluated based upon its potential to improve level of service along the interstate. The level of service application and designation are based on the methodologies outlined in the *Highway Capacity Manual*, as described in Chapter 3. The level of service standards to be achieved are in accordance with AASHTO guidelines (also described in Chapter 3).

Figures 5-1 through 5-6 present the 2015 and 2035 traffic volumes for each Build Alternative.

5.1 Operational Analysis Results and Findings

The following sections summarize the traffic operational results of the Build Alternatives as compared to the No-Build Alternative and address the alternative's ability to meet the project's Purpose and Need. Table 5-1 presents a summary of the traffic operational results of the 2015 No-Build and Build Alternatives and Table 5-2 presents the 2035 condition for the alternatives. Ramp levels of service are provided in Tables 5-3 and 5-4 for 2015 and 2035, respectively. Figures 5-7 through 5-12 present the level of service results graphically.

5.1.1 Alternative A

Alternative A involves building an interstate facility on a new alignment and separating I-77 from I-81. Other than the system-to-system interstate connections at Interchanges 72 and 81, no new interchanges are planned along the new alignment as part of this alternative. However, construction would not preclude additional interchanges from being added in the future, as separate initiatives if conditions warrant them. As discussed in the *Alternatives Technical Report*, the analysis assumes that I-81 traffic would be relocated to the new alignment because that shift would require the least number of lanes to be constructed (four as opposed to six). It is assumed that the major connecting ramps between I-77 and I-81 (at both Interchanges 72 and 81) would be constructed as two-lane ramps.

Under current (and projected future No-Build) conditions, congestion along the overlap section during peak times causes some vehicles to divert from the interstate to the local and regional roadway system in Wytheville. As discussed in the *Tier 1 EIS*, highway improvements have the potential to divert demand from the local and regional roadway infrastructure back to the improved interstate. For example, if large sections of I-81 were widened to provide additional travel lanes and reduce congestion, drivers traveling on the local and regional roadway system would likely use the interstate instead because it would give them the ability to complete their trip in a faster time. The potential to divert demand is based on a number of factors (see the *Tier I EIS Transportation Technical Report* for more information); a key factor is the proximity of local and regional roadways to the interstate facility and the congestion levels on these roadways.

Since existing traffic largely remains on the interstate during most times of the week and year, it is accounted for in the Existing and No-Build traffic volume networks. Therefore, while Alternative A would have the ability to divert traffic from the local and regional roadway system back to I-81, specific traffic volume adjustments were not needed to account for these vehicles. It is not anticipated that a substantial amount of additional traffic would divert to the interstate corridors because of the project under Alternative A. However, some excess capacity would exist with Alternative A and could accommodate any additional induced demand.

The analysis for Alternative A indicates that demand can be managed sufficiently as a result of the proposed improvement. As shown in Tables 5-1 and 5-2, Alternative A would provide LOS B or better results on the new interstate facility beyond 2035. On the existing alignment, LOS C or better would be achieved. These levels of service meet the operational standards defined by AASHTO. For ease of comparison, traffic results on the existing alignment (which would carry only I-77 traffic under this alternative) have been presented using the interchange numbers and directionality identified in Chapters 3 and 4. (Once construction is completed, this alignment would change interchange numbers and directionality to match the I-77 facility.) The five segments analyzed along the new alignment are depicted in Figure 5-13. These segments were determined based on the profile grade of the proposed alignment. Each segment contains one section where the grade of the roadway exceeds four percent. For a conservative analysis, it was assumed that the steep grade was sustained throughout the segment. For example, while a one-mile segment may experience a four percent grade for just 1,000 feet, the analysis assumes that there would be a four percent grade for the entire mile. In addition to accommodating the travel demand, the increased capacity of the dual facilities and the mitigation of some geometric deficiencies would address the safety concerns related to entering and exiting the overlap section at both ends.

Table 5-1 2015 Mainline Analysis[1]

	Segment		2008 Existing				No Build				Alternative A: New Alignment (I-81)				Alternative A: Existing Alignment (I-77)				Alternative B			
			Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound	
	From Interchange	To Interchange	Volume[2]	LOS[3]	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS
I-81	72	73	1750	B	1600	A	2550	C	2500	B					1450	B	1250	A	2550	B	2500	B
	73	77	2050	B	1750	B	2800	C	2800	C					1700	B	1550	B	2800	B	2800	B
	77	80	1950	B	1750	B	2650	B	2800	C					1600	A	1500	A	2650	B	2800	B
	80	81	1900	B	1800	B	2650	B	2750	C					1600	A	1500	A	2650	B	2750	B
	Segment 1										1000	A	1100	A								
	Segment 2										1000	A	1100	A								
	Segment 3										1000	A	1100	A								
	Segment 4										1000	A	1100	A								
	Segment 5										1000	A	1100	A								

Note: Shaded sections are locations where substandard LOS is indicated.

1 While no intermediate interchanges are assumed along the new A alignment, five segments of the approximate 9 mile interstate were selected for analysis. These segments (depicted in Figure 5-13) represent the five steepest grades along the corridor, each in excess of four percent. As such, these segments are considered the to be the segments with the worst operational conditions.

2 Vehicles per hour

3 Level of Service

Table 5-2 2035 Mainline Analysis[1]

	Segment		2008 Existing				No Build				Alternative A: New Alignment (I-81)				Alternative A: Existing Alignment (I-77)				Alternative B			
			Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound	
	From Interchange	To Interchange	Volume[2]	LOS[3]	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS	Volume	LOS
I-81	72	73	1750	B	1600	A	3750	D	3700	C					2250	C	2100	B	3750	C	3700	B
	73	77	2050	B	1750	B	4150	D	4150	E					2650	B	2550	C	4150	C	4150	C
	77	80	1950	B	1750	B	3950	C	4100	D					2450	B	2500	B	3950	B	4100	C
	80	81	1900	B	1800	B	3950	C	4050	D					2450	B	2450	B	3950	C	4050	C
	Segment 1										1500	B	1600	B								
	Segment 2										1500	B	1600	B								
	Segment 3										1500	B	1600	B								
	Segment 4										1500	B	1600	B								
	Segment 5										1500	B	1600	B								

Note: Shaded sections are locations where substandard LOS is indicated. For Existing, No-Build, and Widening Alternatives, both the I-77 and I-81 Milepost Systems are used for ease of comparison.

1 While no intermediate interchanges are assumed along the new A alignment, five segments of the approximate 9 mile interstate were selected for analysis. These segments (depicted in Figure 5-13) represent the five steepest grades along the corridor, each in excess of four percent. As such, these segments are considered the to be the segments with the worst operational conditions.

2 Vehicles per hour

3 Level of Service

Table 5-3 2015 Ramp Merge/Diverge Analysis

			2008 Existing			2015 No-Build			Alternative A: New Alignment (I-81)			Alternative B		
	Direction	Interchange	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS	Volume	Density	LOS	Volume	Density	LOS
Entrance Ramp	NB	72[4]	900	13.7	B	1650	24.9	C		SEE TABLE 5-5		1650	21.0	C
	NB	73	400	12.1	B	450	16.9	B	400	4.6	A	450	19.8	B
	NB	77	200	10.2	B	350	15.0	B	350	10.7	B	350	17.8	B
	NB	80	200	9.2	A	350	15.2	B	350	8.7	A	350	17.7	B
	NB	81[4]	650	10.1	B	1100	15.7	B	1100	11.7	B	1100	15.1	B
	SB	81[4]	1150	9.8	A	2100	19.4	B				2100	16.7	B
	SB	80	300	11.9	B	450	19.6	B	400	6.7	A	450	22.1	C
	SB	77	300	13.6	B	400	22.4	C	400	6.8	A	400	26.2	C
	SB	73	200	4.6	A	200	10.9	B	150	8.4	A	200	17.1	B
	SB	72[4]	400	1.4	A	350	3.0	A	350	2.7	A	350	6.5	A
	**[5]	72								SEE TABLE 5-5		1550	19.3	B
Exit Ramp														
	NB	72[4]	400	7.1	A	400	7.5	A		SEE TABLE 5-5		400	5.1	A
	NB	73	100	18.0	B	200	--	F	450	13.8	B	200	10.0	A
	NB	77	300	12.7	B	500	18.3	B	350	11.3	B	500	13.3	B
	NB	80	250	11.1	B	350	15.8	B	400	9.6	A	350	10.4	B
	NB	81[4]	1100	5.9	A	1900	14.4	B		SEE TABLE 5-5		1900	13.0	B
	SB	81[4]	750	8.2	A	1150	12.3	B	1150	19.5	B	1150	10.1	B
	SB	80	350	15.1	B	400	30.7	D	350	9.1	A	400	11.7	B
	SB	77	300	12.1	B	400	20.0	B	450	10.9	B	400	14.6	B
	SB	73	350	15.0	B	500	23.7	C	150	0.7	A	500	17.5	B
	SB	72[4]	1000	2.9	A	1550	--	F		SEE TABLE 5-5		1550	7.7	A

Note: Shaded sections are locations where substandard LOS is indicated.

1 Vehicles per hour
2 Vehicles per mile per lane
3 Level of Service
4 Two-lane ramp
5 This ramp analysis represents the location where the Interchange 72 northbound exit ramp and Interchange 72 southbound exit ramp (both destined to I-77 northbound) meet before the merge onto I-77 north of the I-77/I-81 overlap section.

Table 5-4 2035 Ramp Merge/Diverge Analysis

			2008 Existing			No-Build			Alternative A: New Alignment (I-81)			Alternative B		
	Direction	Interchange	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS	Volume	Density	LOS	Volume	Density	LOS
Entrance Ramp	NB	72[4]	900	13.7	B	2450	--	F		SEE TABLE 5-5		2450	26.4	C
	NB	73	400	12.1	B	650	26.5	C	650	9.4	A	650	27.0	C
	NB	77	200	10.2	B	550	23.5	C	550	18.6	B	550	24.0	C
	NB	80	200	9.2	A	550	26.2	C	550	15.8	B	550	23.9	C
	NB	81[5]	650	10.1	B	1600	24.9	C	1600	12.5	B	1600	27.5	C
	SB	81[5]	1150	9.8	A	3100	--	F		SEE TABLE 5-5		3100	26.6	C
	SB	80	300	11.9	B	650	29.2	D	650	12.5	B	650	21.9	C
	SB	77	300	13.6	B	600	--	F	600	12.5	B	600	24.1	C
	SB	73	200	4.6	A	250	20.4	C	250	15.2	B	250	23.2	C
	SB	72	400	1.4	A	500	8.3	A	500	9.0	A	500	13.4	B
	**[6]	72								N/A		2300	27.9	C
Exit Ramp														
	NB	72	400	7.1	A	600	12.3	B		SEE TABLE 5-5		600	9.4	A
	NB	73	100	18.0	B	250	--	F	250	21.5	C	250	18.1	B
	NB	77	300	12.7	B	750	27.4	C	750	18.8	B	750	22.1	C
	NB	80	250	11.1	B	550	24.0	C	550	15.9	B	550	17.9	B
	NB	81[4]	1100	5.9	A	2850	26.3	C		SEE TABLE 5-5		2850	24.2	C
	SB	81[5]	750	8.2	A	1700	--	F	1700	24.6	C	1700	17.1	B
	SB	80	350	15.1	B	600	--	F	600	15.2	B	600	19.2	B
	SB	77	300	12.1	B	550	28.6	D	550	18.3	B	550	23.4	C
	SB	73	350	15.0	B	700	32.7	D	700	9.2	A	700	26.9	C
	SB	72[5]	1000	2.9	A	2300	--	F		SEE TABLE 5-5		2300	17.4	B

Note: Shaded sections are locations where substandard LOS is indicated.

1 Vehicles per hour
2 Vehicles per mile per lane
3 Level of Service
4 Two-lane ramp
5 Two-lane ramp in Build conditions only
6 This ramp analysis represents the location where the Interchange 72 northbound exit ramp and Interchange 72 southbound exit ramp (both destined to I-77 northbound) meet before the merge onto I-77 north of the I-77/I-81 overlap section.

Table 5-5 presents the new ramp systems that would be at each end of the new facility. These ramp systems would essentially be reconstructed Interchange 72 and reconstructed Interchange 81, as discussed in the *Alternatives Technical Report*. Figures 5-14 and 5-15 present the ramp analysis locations by the Ramp ID denoted in the table. As identified in Table 5-5, all ramps are expected to operate above the level of service standard.

Table 5-5 2015/2035 Ramp Merge/Diverge Analysis (New Interchanges)

					2015 Build New Alignment			2035 Build New Alignment		
	Exit	Ramp ID	From	To	Volume[1]	Density[2]	LOS[3]	Volume	Density	LOS
Entrance Ramp	72	72-5-M	I-81 NB	I-77/I-81 NB	150	15.9	B	250	23.6	C
	72	72-4-M	I-81 NB	I-77 NB	380	17.6	B	600	26.7	C
	72	72-2-M	I-77 SB	New I-81 NB	50	11.6	B	50	16.4	B
	72	72-9-M	New I-81 SB	I-77 NB	50	13.7	B	70	20.4	C
	72	72-10-M	I-77/I-81 NB	I-81 SB	150	13.4	B	200	18.6	B
	81	81-4-M	I-81 SB	I-77/I-81 SB	100	17.7	B	150	26.2	C
Exit Ramp	72	72-2-D	I-77 SB	New I-81 NB	50	15.7	B	50	22.7	C
	72	72-5-D	I-81 NB	I-77/I-81 NB	150	7.7	A	250	13.0	B
	72	72-7-D	New I-81 SB	I-77 NB	50	12.8	B	70	18.0	B
	72	72-6-D	I-77/I-81 SB	I-81 SB	150	14.0	B	200	21.5	C
	81	81-5-D	I-77/I-81 NB	I-81 NB	150	16.7	B	150	25.8	C
	81[4]	81-4-D	I-81 SB	I-77/I-81 SB	100	0	A	150	2.0	A

Note: Shaded sections are locations where substandard LOS is indicated.
1 Vehicles per hour
2 Vehicles per mile per lane
3 Level of Service
4 Left exit

5.1.2 Alternative B

Alternative B consists of widening the I-77/I-81 overlap section to eight lanes (four lanes per direction). The two interstate facilities would remain co-located and all interchanges would remain.

Similar to Alternative A, Alternative B has the potential to divert demand from the local and regional roadway infrastructure back to the improved interstate. Since existing traffic largely remains on the interstate during most times of the week and year, it is accounted for in the Existing and No-Build traffic volume networks. Therefore, while Alternative B has the ability

to divert traffic from the local and regional roadway system back to I-81, specific traffic volume adjustments were not needed to account for these vehicles. It is not anticipated that a substantial amount of additional traffic would divert to the interstate corridor because of the project under Alternative B. However, some excess capacity would exist under Alternative B and could accommodate any additional induced demand.

The analysis for Alternative B indicates that demand can be managed sufficiently with the proposed improvement. As shown in Tables 5-1 and 5-2, Alternative B would provide LOS C or better results beyond 2035. As shown in Table 5-3, all ramps are expected to operate above the level of service standard in 2015 and 2035. In addition to accommodating the travel demand, safety concerns would be partially addressed by the additional capacity and the improvements to geometric deficiencies.

5.1.3 Weave Segments

As part of Alternatives A and B, Interchange 72 would be reconstructed. Since the spacing between Interchanges 72 and 73 on the I-77/I-81 overlap section are only one mile apart and the distance between Interchanges 72 and 41 on I-77 north of the overlap section are less than one-half mile apart, weaving areas may be created by the proposed project as ramp spacing changes. A preliminary weave analysis was conducted to determine the impact reconstruction may have on traffic operations The results of this analysis are presented in Table 5-6.

Table 5-6 Weave Analysis

					2015 Condition			2035 Condition		
Alternative	From Interchange	To Interchange	Mainline	Direction	Demand[1]	Density[2]	LOS[3]	Demand[1]	Density[2]	LOS[3]
A	72	73	I-81	NB	1850	16.6	B	3500	29.8	D
A	72	41[4]	I-77	NB	660	12.5	B	1060	23.6	C
B	72	73	I-77	NB	240	21.0	C	400	35.1	E

Note: Shaded sections are locations where substandard LOS is indicated.

1 Vehicles per hour – weaving vehicles only
2 Vehicles per mile per lane
3 Level of Service
4 This weave occurs on I-77 north of the overlap section; between Exit 72 on the overlap section and Exit 41 on I-77.

As shown, by 2035, the northbound weave between Interchanges 72 and 73 begins to operate below the level of service standard. With Alternative A, this is due to a high volume of weaving traffic. With Alternative B, this condition would occur because there is an additional travel lane through which vehicles would weave. The analysis indicates that, in addition to the distance of the weave, the overall grade of the new ramp would have a substantive impact on the level of service of the weave. To the extent practicable, ramp grades would be minimized and the gore-to-gore distances would be greater than 2,500 feet. Reducing the ramp grade to a maximum of 2 percent would allow traffic operations above the level of service standard for

both alternatives. The feasibility of modifying ramp grades would be determined during final design.

5.2 Local Roadways

The proximity of the frontage roads to the I-77/I-81 overlap section make these roads an attractive alternate route during periods of high congestion. Diversion from the interstate to the frontage roads occurs during long holiday weekends and was discussed by many Wytheville residents during the Scoping process for the EA.

Alternative A would be the most effective at reducing the likelihood of vehicles diverting. This alternative diverts sufficient traffic to the new alignment (I-81) such that the existing interstate (I-77) would have adequate excess capacity to handle atypical traffic volumes demands, as well as those of a typical travel day. The new alignment of I-81 could also be used as an alternate route to make certain connections should I-77 be closed for emergency reasons. This would help alleviate impacts to the frontage roads if an vehicle crash or other incident were to occur.

Alternative B would also be somewhat effective at reducing the likelihood of vehicles diverting. The additional capacity created would handle above peak demands on some holiday weekends. However, the frontage roads would still be needed as alternate routes should the interstate be closed for emergency reasons.

5.3 Transportation Findings

The findings of the Transportation Technical Report are that both Alternative A and Alternative B are appropriate alternatives to address the transportation deficiencies on the I-77/I-81 overlap section.