ARTERIAL
PRESERVATION PROGRAM

Arterial Preservation Plan: Route 460 Corridor

VDOT Salem and Lynchburg Districts

Prepared for:

VDOT

1401 East Broad Street, Richmond, VA 23219

Prepared by:

Kimley»Horn

1700 Willow Lawn Drive, Suite 200, Richmond, VA 23230

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April 2020 | Final Report

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List of Acronyms

APN - Arterial Preservation Network

APP - Arterial Preservation Program

AADT - Annual Average Daily Traffic

CoSS - Corridor of Statewide Significance

EDTT - Extra Distance Travel Time

ETT - Experienced Travel Time

HCM - Highway Capacity Manual

LOS - Level of Service

MOE - Measure of Effectiveness

MUT - Median U-Turn

MUTCD - Manual of Uniform Traffic Control Devices

PDO - Property Damage Only

PHF - Peak Hour Factor

PSAP - Pedestrian Safety Action Plan

PSI - Potential for Safety Improvement

RCUT - Restricted Crossing U-Turn

RNS - Roadway Network System

SPS - Statewide Planning System

TMC - Turning Movement Count

TOSAM - Traffic Operations and Safety Analysis Manual

TRB - Transportation Research Board

TSN - Targeted Safety Need

v/c – Volume-to-Capacity Ratio

VDOT - Virginia Department of Transportation

VJuST - VDOT Junction Screening Tool

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1 Arterial Preservation Program Overview

1.1 Program Goals and Strategies

The Virginia Department of Transportation (VDOT) initiated the development of the **Arterial Preservation Program** in the spring of 2017. The purpose of the **Arterial Preservation Program** is to preserve and enhance the operational capacity and safety of the critical transportation highways included in the **Arterial Preservation Network**, while ensuring that:

- Increased safety for all users
- Local economic development goals are integrated into each plan
- Mainline through traffic is served with priority

The **Arterial Preservation Program** utilizes a toolbox of preservation and enhancement strategies to improve the current state of the corridor as well as progress future planning efforts. These strategies promote innovative transportation solutions to minimize delays for through traffic and improve safety while incorporating local economic development goals.

Arterial Preservation Plans are developed in partnership with localities for **Arterial Preservation Network** corridors to implement the following preservation and enhancement strategies:

- Integrate program priorities with local economic development goals
- Improve access management
- Educate community on the benefits of improved mobility
- Inspire comprehensive, transportation, and zoning planning efforts
- Eliminate unjustified traffic signals
- Implement innovative intersection configurations

1.2 Arterial Preservation Network

The **Arterial Preservation Network** is the state-maintained portion of the National Highway System in Virginia including some additional highways that facilitate connectivity. Over time, additional facilities may be added to further enhance connectivity should the need arise. More information on the **Arterial Preservation Program**, including an interactive map of the **Arterial Preservation Network**, can be found at http://www.virginiadot.org/programs/vdot_arterial_preservation_program.asp

2 Route 460 Corridor

The purpose of the Route 460 Arterial Preservation Plan is to develop strategies to ensure the safety and preserve the capacity of the Commonwealth's arterial highway network without wide-scale roadway widenings or increased signal proliferation. The goal of this plan is to identify recommendations to preserve and enhance this key transportation corridor. These recommendations are primarily focused on short-term, lower cost improvements aimed at preserving capacity and improving safety, but do not necessarily address all current or future needs along the corridor.

The study corridor includes of Route 460 from Route 220 ALT (Cloverdale Road) to Nottoway County limits and Route 220 ALT from Route 460 (Challenger Avenue) to Route 11. The limited access portions of the corridor were not included (i.e., Town of Bedford, City of Lynchburg, Town of Appomattox, and Town of Farmville). The Route 460 corridor a Corridor of Statewide Significance (CoSS) that connects major centers of activity and accommodates both inter-city travel and inter-state traffic. A map of the study corridor is shown in **Figure 1**.

2.1 Study Team

A Study Team was formed to provide local input and feedback to help guide the development of preferred alternatives throughout the planning process. The Study Team comprised of:

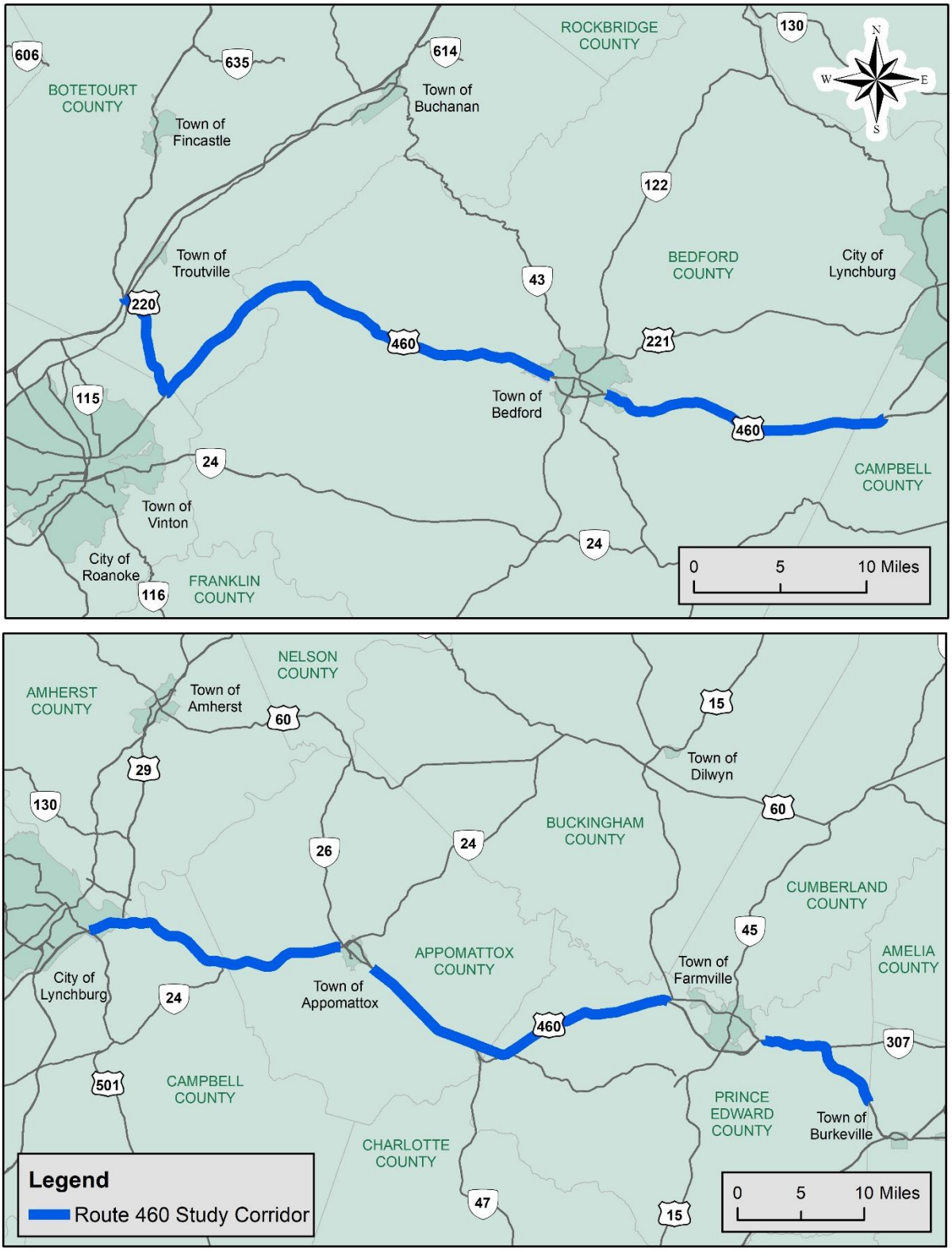
- VDOT District Land Use
- VDOT District Planning
- VDOT District Location and Design
- VDOT District Traffic Engineering
- VDOT Residency Offices
- VDOT Transportation and Mobility Planning Division
- Appomattox County
- Bedford County
- Botetourt County
- Campbell County
- Prince Edward County
- Roanoke County
  - City of Lynchburg
- Town of Bedford
- Roanoke Valley – Alleghany Regional Commission
- West Piedmont Planning District Commission
- Commonwealth Regional Council
- Kimley Horn

A framework document was developed prior to commencing this study that documented the methods and assumptions for the Route 460 Arterial Preservation Plan. The framework document is provided in **Appendix A**.

2.2 Public Outreach

One corridor-wide citizen information meeting was held during the study. The meeting was held on October 29, 2019 at the VDOT Ramey Memorial Auditorium in Lynchburg, VA. The purpose of the meeting was to receive comments on the preliminary recommendations along the study corridor. Members of the public were invited to provide comments on the preliminary recommendations of the corridor. Feedback received from the public was further reviewed with the stakeholders and revisions were made to the corridor recommendations where possible to address comments received. VDOT Salem District is expected to conduct an additional citizen information meeting in early 2020.

FIGURE 1: ROUTE 460 STUDY CORRIDOR



2.3 Previous Studies

Relevant studies and plans that have been completed in the study area were collected and reviewed to identify previous recommendations along the study corridor. These studies and plans are listed in **Table 1**.

TABLE 1: PREVIOUS STUDIES AND COMPREHENSIVE PLANS

Previous Studies and Comprehensive Plans	Year
Previous Studies	
Route 460 Corridor Access Management Plan: Bedford/Campbell County	2003
Route 460 Corridor Study: Bedford County East	2004
Route 460 Corridor Study: Bedford County West	2004
Town of Farmville Transportation Plan	2008
Region 2000 Local Government Council 2035 Rural Long-Range Transportation Plan	2011
Route 220 VISSIM Planning Study	2012
VTrans 2040 2040 Multimodal Transportation Plan: Heartland Corridor	2016
Comprehensive Plans	
Botetourt County	2010
City of Lynchburg	2013
Campbell County	2014
Bedford County	2015
Appomattox County	2016

2.4 VTrans2040 Tier 1 Recommendations

On January 10, 2010, the Commonwealth Transportation Board passed a resolution that states funds from VDOT and the Department of Rail and Public Transit (DRPT) should be limited to needs identified in the Statewide Transportation Plan (VTrans) Tier 1 recommendations. VTrans Tier 1 recommendations focus on critical needs for Virginia's CoSS, Regional Networks, and Urban Development Areas. In January 2020, VTrans published Mid-term Needs to identify the most pressing transportation issues in each district. For the purpose of this study, only Tier 1 recommendations were considered since the Mid-term needs were published after study recommendations were identified. The Tier 1 recommendations for the Route 460 study corridor were reviewed and incorporated into the final solution set for the corridor. The recommendations include:

- LY05: Improvements at the Route 460 and Colonial Highway (Route 24) intersection, Campbell County
    - *Install improvements on Route 460 and VA24/VA 608 in Campbell County to improve safety and reliability. Short-term: install Do Not Enter sign in median east of intersection on Route 460 and remove concrete island and Keep Right sign on northbound approach.*
- LY26: Access management and safety improvements along Route 460, multi-jurisdictional

- *Develop and implement access management and safety projects along Route 460 from the Lynchburg City/Campbell County line to the Prince Edward/Nottoway County line (55 miles). This is to improve safety and maintain the capacity and reliability of the corridor. Safety projects to address concerns on Route 460 between Cherry Street and Rocks Church Road, the intersection of Route 460 and Prospect Road, and the intersection Route 460 and Route 307.*

- SA12: Access management improvements on Route 460, multi-jurisdictional
  - *Develop and implement access management projects along Route 460 from the Roanoke City/County line to the Bedford/Campbell County line (38 miles). This is to improve safety and maintain the capacity and reliability of the corridor.*
- SA30: Second Amtrak service from Lynchburg to Roanoke, multi-jurisdictional
  - *Include a second Amtrak train from Lynchburg to Roanoke to improve accessibility*
- SA37: Regional greenway continual development and improvements, multi-jurisdictional
  - *Continue developing and improving the regional greenways in the Salem District. This includes connecting greenways, multimodal improvements, extending greenways, and construction of new greenways.*

2.5 Park and Ride Locations

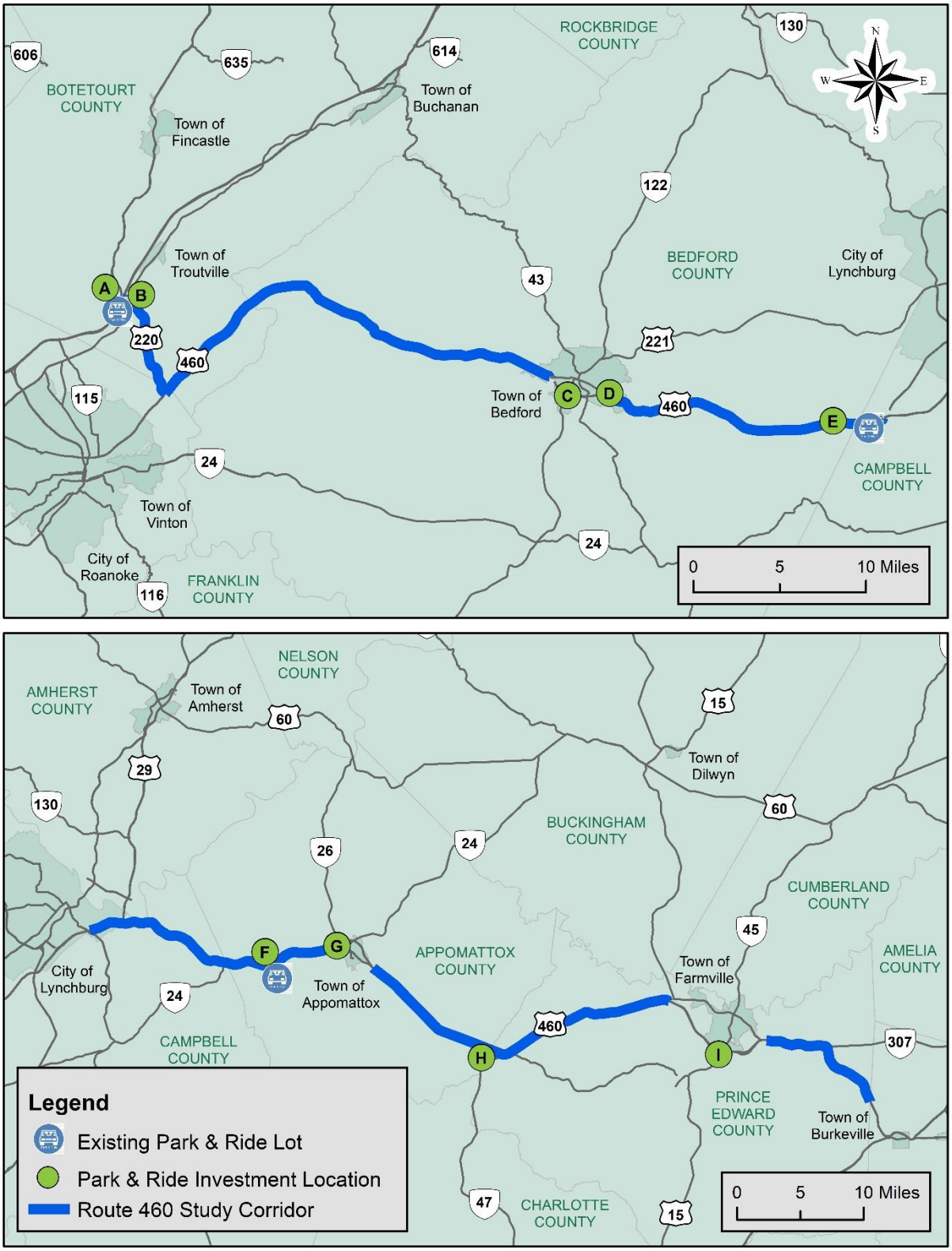
In 2014, VDOT completed a Park and Ride investment strategy study to determine where investments in Park and Ride lots are needed across the Commonwealth of Virginia. The recommendations include new Park and Ride lots, lot expansions, and safety improvements at existing Park and Ride lots. The Park and Ride lot investment strategy locations along the Route 460 corridor are summarized in **Table 2** and presented in **Figure 2.**

TABLE 2: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE ROUTE 460 CORRIDOR

ID	Site	Jurisdiction	Description
A	SAL-10	Botetourt County	Expand lot near Route 220 and Route 653 (Commons Pkwy)
B	SAL-11	Botetourt County	New lot near Route 220 and Appalachian Trail
C	SAL-13	Town of Bedford	New lot near Route 460 Bypass and Route 122 (Burkes Hill Rd)
D	LYN-1C	Town of Bedford	Obtain an agreement to use spaces at Wal-Mart
E	LYN-1D	Bedford County	Obtain an agreement to use spaces at Food Lion Store #1537
F	LYN-5	Appomattox County	Expand lot at Route 460 and Tonawanda Lake Rd
G	LYN-6	Appomattox County	Enhance lot near Route 460 and Route 26 (Oakville Rd)
H	LYN-22	Appomattox County	New 25-space lot along Route 460 Business and Route 47 (Thomas Jefferson Hwy)
I	LYN-20	Prince Edward County	New 25-space lot near Route 460 and US 15 (Farmville Rd)

Source: VDOT Park & Ride Program Investment Strategy

FIGURE 2: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE ROUTE 460 CORRIDOR



3 Existing and Future Land Use

The future and existing land use maps for Appomattox County, Bedford County, Botetourt County, Campbell County, Prince Edward County, and Roanoke County can be found in **Appendix B**.

The *Appomattox County Comprehensive Plan* published in 2016 stated that 95 percent of the land in Appomattox County is currently zoned for agricultural use, with only four percent for residential use, and one percent for commercial and industrial uses. The future land use map shows the areas directly surrounding the Route 460 corridor as commercial or neighborhood commercial. Areas beyond that are primarily rural transition areas. Appomattox County classifies rural transition areas as low-density single-family residential areas.

Bedford County is currently primarily zoned for agricultural rural preserve and agricultural residential land use. The Bedford County future land use map published in 2015 shows growing areas of residential and rural residential land use along the Route 460 corridor to the west of the Town of Bedford and outside the City of Lynchburg.

The *2010 Comprehensive Plan* published by Botetourt County shows the county is currently heavily used as agricultural forest conservation with some areas of industrial and low-density residential use. The future land use map for Botetourt County shows a large increase in medium density residential use and a small increase in commercial land use in the areas between the Route 460 corridor and the I-81 corridor.

The *Campbell County Comprehensive Plan* future land use map shows that the northern section of the corridor heading into the City of Lynchburg designated as medium to high density commercial area next to medium to high density residential areas.

The Prince Edward County future land use map shows the areas surrounding the Route 460 corridor are primarily designated as agricultural/forestall land use.

4 Corridor Segmentation and Emerging Intersections

4.1 Corridor Segmentation

The corridor was divided into segments to develop recommendation strategies for areas with similar safety, traffic operations, and land use characteristics. The segmentation was based on the existing and future land uses, previous studies, traffic data, crash data, LandTrack data, Land Use Permitting System (LUPS) data, and input from the VDOT Lynchburg District. Corridor segments for Route 460 were categorized into the following potential segment types:

- **Developed Segments:** have an existing concentration of residential, commercial, manufacturing, and industrial land development. These segments have a higher density of existing access points and often include a series of signalized intersections. The goals for developed segments are to improve the efficiency and safety of the segment through a retrofit strategy by eliminating unwarranted traffic signals, improving access management spacing, and exploring innovative intersection configurations.
- **Emerging Segments:** are stretches of roadway that have active development or high potential for increased development within 10 years. These segments are often

adjacent to developed segments or are adjacent to segments where limited access designations terminate. The goals for emerging segments are to develop a corridor management strategy to maintain and protect the efficiency of the segment while promoting and facilitating local economic development goals.

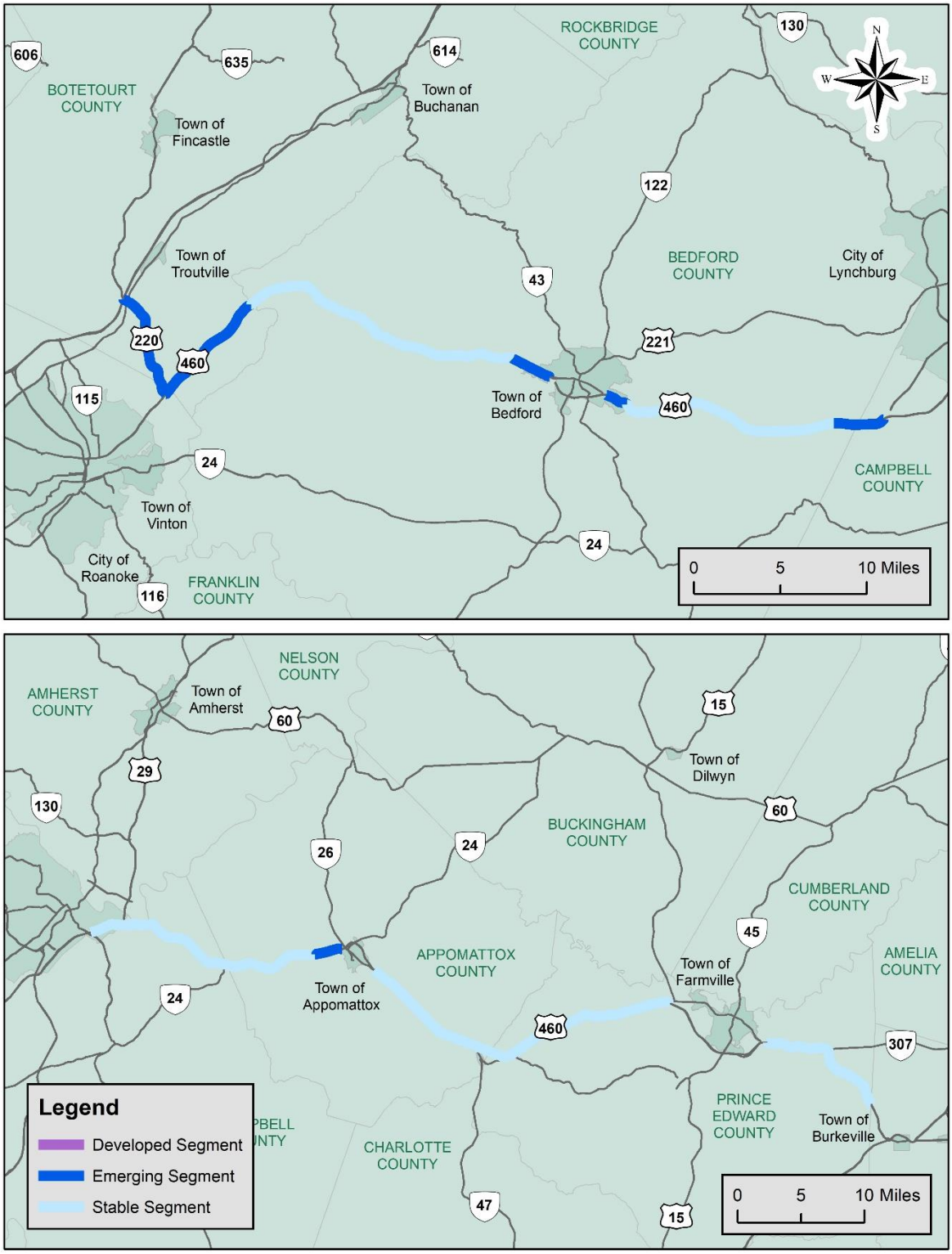
- **Stable Segments:** may experience sporadic development but the land use is expected to remain consistent over the long term. These segments often traverse between developed and emerging segments. The goals for stable segments are to preserve the efficiency of the segment by promoting increased access management spacing and identifying spot intersection improvements.

The corridor was divided into eight segments, four emerging segments totaling 27.4 miles and four stable segments totaling 86.7 miles. The segments are shown in **Figure 3** and the limits are described in **Table 3**.

TABLE 3: ROUTE 460 SEGMENTATION LIMITS

Segment ID	Category	Route	Limits
1	Emerging	220 ALT/Route 460	I-81 to Botetourt-Bedford County Line
2	Stable	Route 460	Botetourt-Bedford County Line to Haven Heights Drive
3	Emerging	Route 460	Haven Heights Drive to 500’ east of Shiloh Church Road
4	Stable	Route 460	500’ east of Shiloh Church Road to 500’ west of New London Drive/Hicks Road
5	Emerging	Route 460	500’ west of New London Drive to Timberlake Road Ramps
6	Stable	Route 460	Campbell Avenue to 500’ west of Police Tower Road
7	Emerging	Route 460	500’ west of Police Tower Road to Richmond Highway Ramps
8	Stable	Route 460	Richmond Highway Ramps to Campbell-Nottoway County Line

FIGURE 3: ROUTE 460 SEGMENTATION MAP



4.2 Emerging Intersections

Emerging intersections are existing intersections that experience safety, operational or congestion issues, or are expected to see an increase in demand due to planned or active development on the intersecting route. The goals for emerging intersections are to strategically target spot improvements and explore innovative intersection configurations to maintain or improve the safety and operations of the arterial. The following preliminary criteria were used to identify a draft list of emerging intersections along the Route 460 corridor:

- Signalized intersections
- Potential for Safety Improvement (PSI) intersections
- Targeted Safety Need (TSN) intersections
- Junction of two primary routes
- Minor Street ADT greater than or equal to 10% of major street ADT
- Crash data
- Intersections that will experience heavy increases in traffic due to future development
- Park & Ride investment strategy intersection
- District input

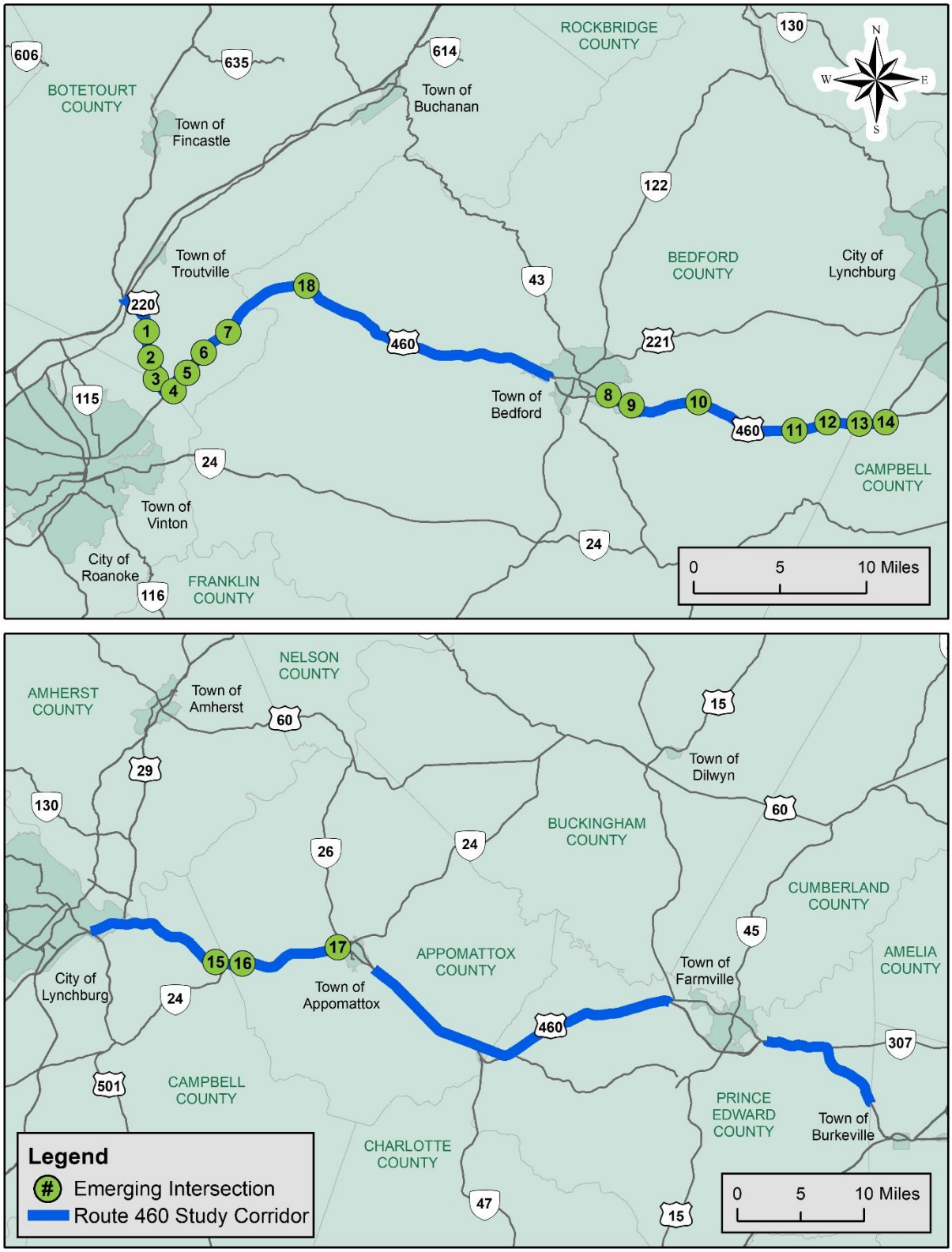
The preliminary list of emerging intersections was further narrowed based on these criteria:

- Signalized intersections
- Targeted Safety Need (TSN) intersections
- PSI intersection rank less than or equal to 50
- Intersections that will experience heavy increased in traffic due to future development

The emerging intersections identified along the Route 460 corridor are listed below and presented in **Figure 4**.

1. Route 220 ALT at Read Mountain Road
2. Route 220 ALT at Eastpark Drive
3. Route 220 ALT at Crumpacker Drive
4. Route 220 ALT at Route 460
5. Route 460 at Webster Road – West
6. Route 460 at Laymantown Road
7. Route 460 at Webster Road - East
8. Route 460 at Hull Street/Shopping Mall Entrance
9. Route 460 at Shiloh Church Road
10. Route 460 at Timber Ridge Road
11. Route 460 at Meade Road
12. Route 460 at New London Road/Thomas Jefferson Road
13. Route 460 at Turkey Foot Road
14. Route 460 at New London Drive/Hicks Road
15. Route 460 at Village Highway/Stonewall Road
16. Route 460 at Stage Road
17. Route 460 at The Shoppes of Appomattox Shopping Center/CVS Pharmacy

FIGURE 4: ROUTE 460 EMERGING INTERSECTIONS



5 Data Collection and Inventory

A preliminary field review of the study area was conducted March 2018 to observe existing geometric conditions, traffic control devices, peak hour traffic conditions, and driver behavior. Turning movement counts were collected on March 6-8, 2018. VDOT provided crash data, existing traffic signal timing plans, and traffic signal design plans. Traffic data is provided in **Appendix C**.

6 Safety Analysis

Crash data for the study area was used to evaluate corridor safety and identify crash patterns. VDOT Roadway Network System (RNS) crash data was obtained for the latest available five years of crash data (January 1, 2012 to December 31, 2016). The following sections provide a summary of the crashes that occurred within the project study area during the five-year crash analysis period.

6.1 Summary of Study Area Crashes

Over the 5-year crash analysis period,188 crashes were reported in the study area. Of the reported crashes, there were 26 fatal crashes, 285 serious injury crashes, 698 minor/possible injury crashes, 134 no apparent injury crashes, and 2,045 crashes involving property damage only. A yearly summary of crashes, by crash severity is shown in **Table 4**.

TABLE 4: 2012 – 2016 ROUTE 460 CRASHES BY YEAR AND SEVERITY

Year	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
2012	10	72	137	40	347	606
2013	3	53	137	24	390	607
2014	5	46	142	20	423	636
2015	3	54	140	26	411	634
2016	5	60	142	24	474	705
Total	**26**	**285**	**698**	**134**	**2,045**	**3,188**

Annually, all intersections and roadway segments within the Virginia Department of Transportation (VDOT) linear referencing system (LRS) are evaluated for the potential for safety improvement (PSI) based on the Highway Safety Manual (HSM) methodology by VDOT. The crash frequency, severity of crashes, volume, and length of segment are contributing factors in the predictive analysis. Crash predictions based on the safety performance function (SPF) crash data files are made for intersections and segments. Within the study area, there were 6 intersections and 19 segments on Route 460 that were identified in VDOT Lynchburg and Salem District's list for PSI. The intersections and segments are shown in **Table 5.**

TABLE 5: PSI INTERSECTIONS AND SEGMENTS

Location	District	2016 PSI Rank
Intersections		
Route 220 ALT at Eastpark Drive	Salem	34
Route 220 ALT at Route 460	Salem	17
Route 460 at Laymantown Road	Salem	136
Route 460 at Timber Ridge Road	Salem	135
Route 460 at New London Road/Thomas Jefferson Road	Salem	126
Route 460 at Village Highway/Stonewall Road	Lynchburg	150
Segments		
Route 220 ALT from I-81 to Lee Highway	Salem	51
Route 460 from Welches Run Road to Laymantown Road	Salem	415
Route 460 from Irving Road/Batavia Road to Johnson School Road	Salem	211
Route 460 from Johnson School Road to Thaxton School Road	Salem	208
Route 460 from Haven Heights Drive to Wheatland Road	Salem	391
Route 460 from Patterson Mill Road/Wheatland Road to Turnpike Road	Salem	66
Route 460 from Baldwin Street to Harmony Crossing Drive/Turnpike Drive	Salem	308
Route 460 from Bells Mill Road to Dixie Lane	Salem	93
Route 460 from Meade Road to Thomas Jefferson Drive/New London Road	Salem	202
Route 460 from Poston Street to Concord Turnpike	Lynchburg	450
Route 460 from Concord Turnpike to US 29 Ramp	Lynchburg	22
Route 460 from Pleasant Valley Rd to Mt Athos Road	Lynchburg	222
Route 460 from Shoppes Corner to Route 460 BUS Ramp	Lynchburg	109
Route 460 from Peach Street to Heritage Trail	Lynchburg	316
Route 460 from Heritage Trail to Mountain Cut Road	Lynchburg	223
Route 460 from Morning Star Road to Paulette Lane	Lynchburg	253
Route 460 from Spruce Dr/Hixburg Rd to Old Bethany Rd/Rocks Church Rd	Lynchburg	260
Route 460 from Mountain View Road/Five Forks Road	Lynchburg	185
Route 460 from West of Creek House Lane to Creek House Lane	Lynchburg	364

VDOT also identifies Targeted Safety Need (TSN) locations, which are intersections or segments where the actual number of crashes is greater than expected for three or more years during the 2012 to 2016 analysis period. Within the study area, there were two intersections and five segments on Route 460 that were identified as TSN locations. The intersections and segments are shown in **Table 6**.

TABLE 6: TSN INTERSECTIONS AND SEGMENTS

Location	District	2016 PSI Rank
Intersections		
Route 220 ALT at Eastpark Drive	Salem	34
Route 460 at Timber Ridge Road	Salem	135
Segments		
Route 460 from Patterson Mill Road/Wheatland Road to Turnpike Road	Salem	66
Route 460 from Bells Mill Road to Dixie Lane	Salem	93
Route 460 from Meade Road from Thomas Jefferson Road/New London Road	Salem	202
Route 460 from Concord Turnpike to US 29 Ramp	Salem	22
Route 460 from Peach Street to Heritage Trail	Lynchburg	316

6.2 Roadway Departure Crashes

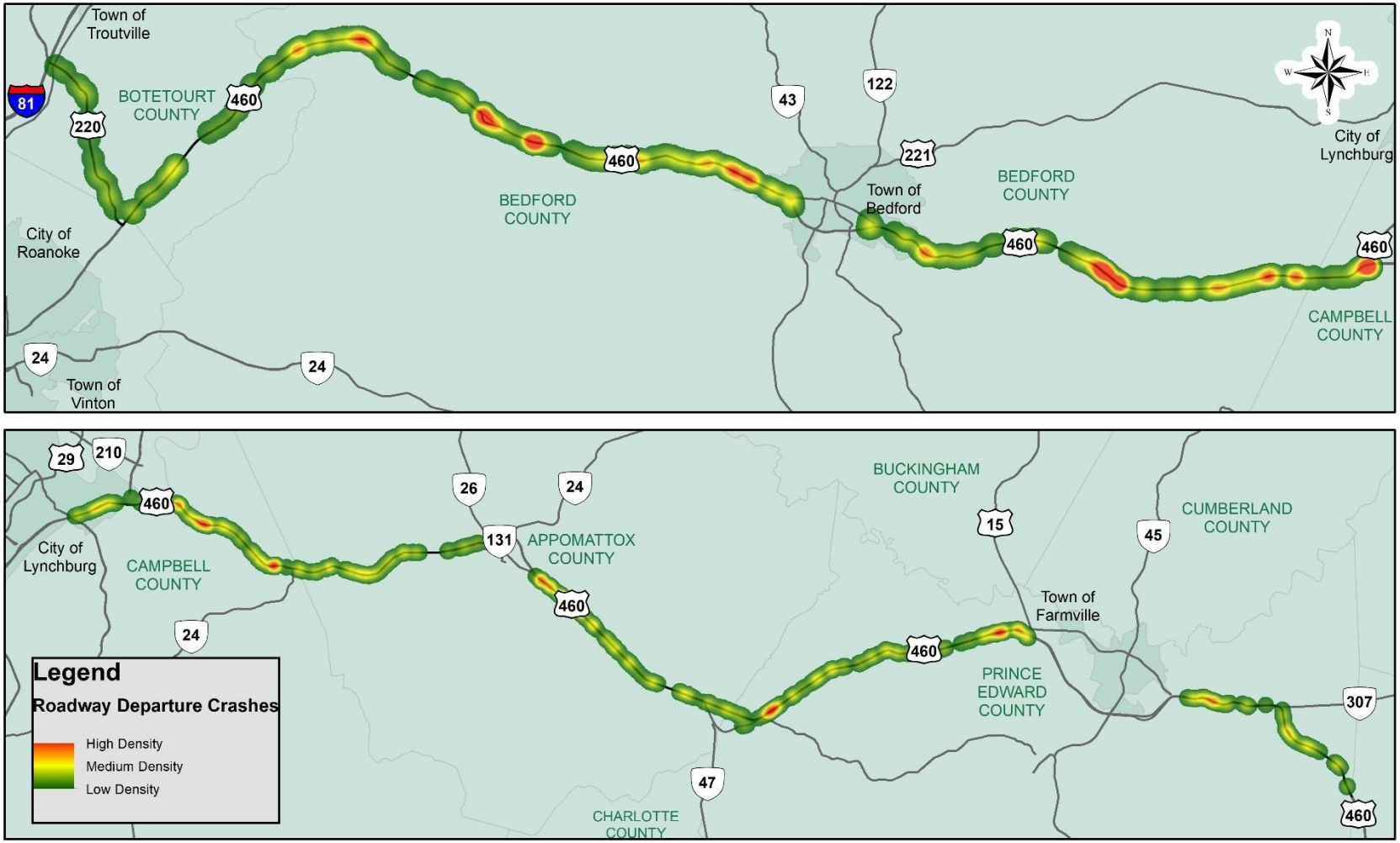
Roadway departure crashes involves a vehicle which crosses the edge line, center line, or leaves the traveled way in another manner. The roadway departure crashes by year and severity are shown in **Table 7**. A density heat map, shown in **Figure 5**, was created to identify the roadway departure hot spots along the corridor. The following locations were identified with the highest concentrations of roadway departure crashes:

- Route 460 near Camp Jaycee Road
- Route 460 east of Circle K Road
- Route 460 near Nester Road
- Route 460 near Patterson Mill Road
- Route 460 near Krantz Corner Road
- Route 460 from Bells Mill Road to Dixie Lane
- Route 460 west of Mt. Athos Road
- Route 460 from Peach Street to Wades Lane
- Route 460 from Five Forks Road to Price Lane
- Route 460 near Creek House Lane

TABLE 7: ROADWAY DEPARTURE CRASHES BY YEAR AND SEVERITY

Year	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
2012	4	28	32	10	54	128
2013	0	16	43	4	61	124
2014	2	19	32	1	68	122
2015	3	16	39	2	54	114
2016	2	14	28	2	76	122
Total	**11**	**93**	**174**	**19**	**313**	**610**

FIGURE 5: DENSITY HEAT MAP OF ROADWAY DEPARTURE CRASHES



6.3 Emerging Intersection Crashes

During the analysis period from 2012 to 2016, the crashes that occurred within the influence areas of the 17 emerging intersections ranged from three at Route 460 and Meade Road to 85 at Route 220 ALT and Route 460. The key crash statistics at each location are presented in **Appendix D**. **Table 8** provides a summary of the emerging intersection crashes.

TABLE 8: EMERGING INTERSECTION CRASHES BY SEVERITY (2012-2016)

Intersection	Fatal Crashes	Serious Injury Crashes	Minor/ Possible Injury Crashes	No Apparent Injury Crashes	Property Damage Only Crashes	Total
Route 220 ALT at Read Mountain Road	1	0	6	2	21	30
Route 220 ALT at Eastpark Drive	0	4	9	1	12	26
Route 220 ALT at Crumpacker Drive	0	0	3	2	12	17
Route 220 ALT at Route 460	0	2	5	16	62	85
Route 460 at Webster Road – West	1	3	1	0	2	7
Route 460 at Laymantown Road	0	3	3	0	19	25
Route 460 at Webster Road - East	0	0	4	0	7	11
Route 460 at Hull Street/Shopping Mall Entrance	0	1	14	2	28	45
Route 460 at Shiloh Church Road	0	0	2	0	3	5
Route 460 at Timber Ridge Road	0	0	6	0	8	14
Route 460 at Meade Road	0	0	0	1	2	3
Route 460 at New London/Thomas Jefferson Road	0	1	17	4	25	47
Route 460 at Turkey Foot Road	0	0	4	0	10	14
Route 460 at New London Drive/Hicks Road	0	4	1	0	15	20
Route 460 at Village Highway/Stonewall Road	0	3	5	0	15	23
Route 460 at Stage Road	0	1	2	0	2	5
Route 460 at The Shoppes of Appomattox/CVS Pharmacy	0	2	8	1	14	25

The crash patterns identified at emerging intersections were considered during the concept development process. Innovative intersection improvements were considered to lower the

amount of conflict points in the intersection and help reduce the total number of crashes at each emerging intersection.

Additional crash analyses were conducted at the PSI intersections along the corridor to identify crash patterns and contributing factors. The results are summarized below.

Route 220 ALT at Eastpark Drive

The majority (54 percent) of the 26 total crashes at this intersection were injury crashes. Angle crashes accounted for 46 percent of all crashes. Seventy-five percent of angle crashes were due to vehicles disregarding the traffic signal or failing to yield to right of way.

Route 220 ALT at Route 460

Rear ends were the predominant (82 percent) crash type at Route 220 ALT and Route 460 which is a characteristic of signalized intersections. Out of the 85 crashes, 23 resulted in injury. A review of crash descriptions showed that a majority of rear ends occurred at the southbound Route 220 ALT right turn to westbound Route 460 and the westbound Route 460 right turn to northbound Route 220 ALT.

Route 460 at Laymantown Road

Rear ends comprised 60 percent of crashes at this signalized intersection. All the rear end crashes occurred on Route 460 and were due to congestion or the traffic signal. Three out of the six crashes that resulted in injury were angle crashes, all of which were failures to yield to right of way.

Route 460 at Timber Ridge Road

Fourteen total crashes occurred at Timber Ridge Road, of which 57 percent were angle crashes and 29 percent were fixed object off road crashes. Two of the four fixed object off road crashes involved failing to stop at a stop sign as a contributing factor.

Route 460 at New London Road/Thomas Jefferson Road

Crashes at New London Road/Thomas Jefferson Road primarily consisted of rear-ends (51 percent) and angle crashes (26 percent). Out of the 47 crashes, 22 resulted in injury. Of the 22, rear ends made up 50 percent. Seven of the nine angle crashes involved a vehicle running a red light.

Route 460 at Village Highway/Stonewall Road

Angle crashes comprised 52 percent of crashes at Village Highway/Stonewall Road. Most of the crashes occurred due to a vehicle failing to stop at a signal or failing to yield to oncoming traffic. Of the 15 crashes, eight resulted in injury.

6.4 Bicycle and Pedestrian Crashes

During the 2012 to 2016 analysis period, there were zero reported bicycle crashes and eleven reported pedestrian crashes along the Route 460 corridor. Of the eleven pedestrian crashes, there were two fatal crashes in 2013, five serious injury crashes, and four minor injury crashes.

One pedestrian crash occurred at the intersection of Route 460 and the Shoppes of Appomattox.

In 2017, VDOT completed the *2012 – 2016 Pedestrian Crash Assessment* which led to the development of a Pedestrian Safety Action Plan (PSAP). The PSAP identifies locations with high pedestrian crash potential and recommends policies and countermeasures to improve pedestrian safety. There were no PSAP locations identified within the study area.

7 Access Management Spacing

The *VDOT Road Design Manual* provides access management design standards for entrances and intersections along roadways, which aim to provide access to land uses while preserving the flow of traffic. The standards are based on the functional classification and posted speed limit of the roadway. The Route 460 Corridor is classified as an "other principal arterial", with speed limits ranging from 45 mph to 60 mph. The access management standards applicable to the roadway are listed in **Table 9**.

TABLE 9: MINIMUM SPACING STANDARDS FOR COMMERCIAL ENTRANCES, INTERSECTIONS, AND MEDIAN CROSSOVERS

Highway Functional Classification	Legal Speed Limit (mph)	Minimum Centerline to Centerline Spacing (Distance) in Feet			
		Spacing from Signalized Intersections to Other Signalized Intersections	Spacing from Unsignalized Intersections & Full Median Crossovers to Signalized or Unsignalized Intersections& Full Median Crossovers	Spacing from Full Access Entrances & Directional Median to Other Full Access Entrances and Any Intersection or Median Crossover	Spacing from Partial Access One or Two Way Entrances to Any Type of Entrance, Intersection or Median Crossover
Principal Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	1,050 1,320 2,640	880 1,050 1,320	440 565 750	250 305 495

Source: VDOT Road Design Manual (Appendix F, Table 2-2)

One of the goals of the Arterial Preservation Program is to improve access management so access points and traffic control do not degrade travel speed and safety. The access point types and spacings were reviewed to identify access management recommendations along the corridor based on existing deficiencies. **Table 10** shows a summary of the access points along the corridor.

TABLE 10: ACCESS POINT TYPE AND SPACING

Access Point Type	Access Management Spacing Met?		Total
	Yes	No	
Signalized Intersection	2	14	16
Full Median Crossover	42	189	231
Unsignalized Intersection	24	94	118
Grand Total	**68 (19%)**	**297 (81%)**	**365**

8 Signal Justification Review

An implementation strategy for the Arterial Preservation Program is to eliminate unjustified traffic signals. The purpose of the MUTCD and planning level warrant analyses was to identify the intersections that met the planning level warrants but also identify unsignalized improvements (e.g., innovative intersection configurations) to implement in place of installation of a traffic signal. Improving traffic operations and safety at intersections without the installation of a signal supports the main goals of the Arterial Preservation Program in preserving and enhancing capacity and safety. It should be noted that prior to installation of a signal, a Signal Justification Report should be completed which consists of a detailed warrant analysis and provides justification of a signal based on volumes, crash patterns, and operational analysis.

Signal warrant analyses were conducted at the emerging intersections to determine if they meet the volume warrants from the 2009 Edition of the Manual of Uniform Traffic Control Devices (MUTCD). The MUTCD volume warrants specify that a signal may be justified if the volume of intersecting traffic crosses a certain threshold, or that the volume of mainline traffic is so high that the minor street traffic cannot find an acceptable gap to cross or merge with the mainline traffic. The thresholds look at the peak eight-hours, four-hours, and one-hour of a typical day. Although the results of the planning level warrants show some volume warrants were met, unsignalized intersection alternatives were also considered during the concept development process.

8.1 MUTCD Signal Warrant Results

Table 11 shows the results of the traffic signal warrant analysis for the existing traffic volumes at the existing unsignalized emerging intersections. The signal warrant analysis worksheets are provided in **Appendix E**.

TABLE 11: SIGNAL WARRANT ANALYSIS RESULTS

Intersection	8-Hour Warrant Met?	4-Hour Warrant Met?	Peak Hour Warrant Met?
Route 460 at Webster Rd	**No**	Yes	Yes
Route 460 at Hilcrest St/Webster Rd	**No**	**No**	Yes
Route 460 at Timber Ridge Rd	**No**	Yes	Yes
Route 460 at Meade Rd	**No**	**No**	**No**
Route 460 at Stage Rd/Phoebe Pond Rd	**No**	**No**	**No**

8.2 Planning Level Signal Warrant Results

Planning level signal warrants were also conducted where 16-hour turning movement counts were not available. Four-hour turning movement counts and ADT projections were used to determine if the intersection met the volume warrants from the 2013 Virginia Supplement to the MUTCD. **Table 12** shows the results of the planning level traffic signal warrant analysis. Seven intersections do not meet Condition A of the planning level signal warrant and should be considered for removal during the alternatives development process.

TABLE 12: PLANNING LEVEL SIGNAL SIGNAL WARRANT ANALYSIS RESULTS

Intersection	Condition A Minimum Vehicular Volume				Condition B Interruption of Continuous Traffic			
	A	B	C	D	A	B	C	D
Route 220 ALT at Read Mountain Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 220 ALT at Eastpark Drive	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 220 ALT at Crumpacker Drive	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 220 ALT at Route 460	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at Laymantown Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at Hull Street[1]	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at Shiloh Church Road	**No**	**No**	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at New London Road/Thomas Jefferson Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at Turkey Foot Road	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at New London Drive/Hicks Road	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at Village Highway/Stonewall Road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Route 460 at The Shoppes of Appomattox[1]	**No**	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] – No count book ADT available. ADT estimated using PM peak hour volume and the k-factor from Route 460

9 Traffic Analysis

9.1 Existing Conditions

9.1.1 Traffic Analysis Assumptions

Traffic analyses for the emerging intersections was completed using Synchro 9.0, a computer-based intersection operations model, which implements procedures presented in the Transportation Research Board's (TRB) *Highway Capacity Manual* (HCM) 2010. Synchro is designed to evaluate the performance of arterials, signalized intersections, and unsignalized intersections (two-way stop, all-way stop, and roundabouts). The intersection level of service (LOS) reported by Synchro reflects the total intersection delay and delay by turning movement.

Synchro inputs and analysis methodologies were consistent with the VDOT Traffic Operations and Safety Analysis Manual (TOSAM), Version 1.0. The signal timing and phasing plans for all signalized intersections were provided by VDOT.

9.1.2 Traffic Analysis Results

The existing conditions traffic analysis results for the emerging intersections are summarized in the following section. Two measures of effectiveness were selected to measure the quantitative performance of these intersections:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle
- 95th percentile queue length by lane group – measured in feet

9.1.2.1 Delay and Level of Service

An intersection LOS is a qualitative measure of vehicular delay and considers several conditions related to intersection design and traffic volume, and the perception of those conditions by motorists. LOS ratings range from A to F, with LOS A indicating little or no average delay and LOS F indicating severe average delays, unstable traffic flow, and stop-and-go conditions. **Table 13** summarizes the LOS criteria as specified in the HCM.

TABLE 13: LEVEL OF SERVICE CRITERIA

LOS	Average Stopped Delay (seconds/vehicle)			Description of Traffic Conditions
	Signalized	Unsignalized	Roundabout	
A	≤ 10.0	≤ 10.0	≤ 10.0	Very low delay, progression is extremely favorable; most vehicles arrive during green phase.
B	> 10.0 to 20.0	> 10.0 to 15.0	> 10.0 to 15.0	Generally good progression, low delays, more vehicles must stop at intersection red phases.
C	> 20.0 to 35.0	> 15.0 to 25.0	> 15.0 to 25.0	Fair progression, increasing number of vehicles must stop; signal cycle fails to process all traffic.
D	> 35.0 to 55.0	> 25.0 to 35.0	> 25.0 to 35.0	Traffic congestion more noticeable, increasing cycle failures, unfavorable progression, and longer delays.
E	> 55.0 to 80.0	> 35.0 to 50.0	> 35.0 to 50.0	Poor progression, generally high v/c ratios, frequent cycle failures, intersection traffic approaching capacity.
F	≥ 80.0	≥ 50.0	≥ 50.0	Arrival flow exceeds intersection capacity, many cycle failures, poor progression, and high delays.

Source: 2000 Highway Capacity Manual (HCM)

LOS designation is reported differently for signalized and unsignalized intersections. Thus, the delay ranges differ slightly between unsignalized and signalized intersections due to driver expectations and behavior for each LOS. For signalized intersections, LOS is defined in terms of delay, which is a measure of driver discomfort and frustration, and lost travel time. For unsignalized intersections, the LOS analysis assumes that the traffic on the mainline is not affected by traffic on the side street. The LOS for each movement is calculated by determining the number of gaps that are available in the conflicting traffic stream.

HCM 2000 methodologies were used to analyze all signalized intersections and HCM 2010 methodologies were used to analyze all unsignalized intersections. The overall intersection delay and LOS for the 12 signalized intersections in the study area is summarized in **Table 14**. The delay and LOS for all locations, including individual movements, is included in **Appendix F.**

TABLE 14: EXISTING (2018) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1. Route 220 ALT and Read Mountain Road	24.5	C	30.5	C
2. Route 220 ALT and Eastpark Drive	18.6	B	19.1	B
3. Route 220 ALT and Crumpacker Drive	13.9	B	12.3	B
4. Route 220 ALT and Route 460	17.3	B	19.3	B
6. Route 460 at Laymantown Road	16.7	B	15.2	B
8. Route 460 at Hull Street/Shopping Mall Entrance	18.2	B	27.3	C
9. Route 460 Shiloh Church Road	9.1	A	9.4	A
12. Route 460 at New London Road/Thomas Jefferson Road	45.0	D	39.7	D
13. Route 460 at Turkey Foot Road	37.0	D	31.8	C
14. Route 460 at New London Drive/Hicks Road	23.5	C	20.5	C
15. Route 460 at Village Highway/Stonewall Road	31.8	C	28.6	C
17. Route 460 at The Shoppes of Appomattox/CVS Pharmacy	13.7	B	25.7	C

Approach delay and LOS, by movement, for the five unsignalized intersections in the study area are summarized in **Table 15**.

TABLE 15: EXISTING (2018) UNSIGNALIZED DELAY AND LOS

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
5. Route 460 at Webster Road – West	Northbound	37.8	E	46.6	E
	Southbound	-	-	-	-
7. Route 460 at Webster Road – East	Northbound	22.3	C	19.2	C
	Southbound	28.0	D	0.0	A
10. Route 460 at Timber Ridge Road	Northbound	-	-	-	-
	Southbound	17.3	C	20.4	C
11. Route 460 at Meade Road	Northbound	-	-	-	-
	Southbound	18.5	C	24.2	C
16. Route 460 at Stage Road	Northbound	12.8	B	19.3	C
	Southbound	23.8	C	41.6	E

9.1.2.2 Queuing

The results of the existing AM and PM peak hour queuing analysis is summarized in **Appendix D**. The corresponding Synchro output sheets are also provided in **Appendix D** for reference. A queue is the length of the line of cars that arrive at an intersection when the signal is red (or stop sign) combined with vehicles that did not clear the intersection during the previous green light, or able to be processed by a stop sign due to heavy cross street demand. The 95th percentile queue is the length, from the stop bar, that has only a 5-percent probability of being exceeded during the analysis period. Comparing the length of this line of vehicles to potential lane lengths available at each intersection provides another measure of how efficiently an intersection processes traffic and how long turn lanes should be to accommodate queuing.

For movements without conflicting traffic volumes, no queue length was reported by Synchro. Movements where the 95th percentile volume exceeds capacity or where the volume for the 95th percentile queue is metered by an upstream signal were identified and are shown in **Table 16**.

TABLE 16: EXISTING (2018) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection	Lane Group	Peak Hour
1. Route 220 ALT at Read Mountain Road	Eastbound right	PM
12. Route 460 New London Road/Thomas Jefferson Road	Southbound left	AM
	Westbound left	PM
13. Route 460 at Turkey Foot Road	Eastbound thru	AM and PM
	Westbound left	PM
14. Route 460 at New London Drive/Hicks Road	Eastbound thru	AM
	Westbound left	PM
15. Route 460 at Stonewall Road	Southbound left/thru/right	PM
17. Route 460 at Shoppes of Appomattox	Eastbound left	PM

9.2 Traffic Forecasting

To understand future traffic conditions for the emerging intersections in the study area and assess the long-term benefits of proposed improvements, traffic volumes were forecasted to 2040. The following sections describe the methodology for developing traffic growth rates and projecting future traffic volumes for the study area.

9.2.1 Traffic Growth Rate Development

The growth rate for the corridor was provided by VDOT Transportation and Mobility Division, using the Statewide Planning System (SPS) as a baseline, and verified by the VDOT Salem and Lynchburg Districts. SPS provides guidance to planners relative to using a consistent system for

traffic forecasting. The SPS data is generally derived through inspection of historical growth rates, and in areas that utilize a regional travel demand model, the SPS data considers the model output which corresponds to forecasted growth within the model area. The growth rates applied along the corridor are presented in **Figure 6**. Linear traffic growth rates were applied to existing (2018) turning movement traffic counts to develop future (2040) traffic projections for use in the analysis of future conditions at each emerging intersection.

9.3 No-Build Conditions

No-build traffic conditions were analyzed to evaluate the results of future (2040) traffic demand on the existing roadway network. The intent of the no-build conditions analysis is to provide a general understanding of the baseline future traffic conditions that may then be used to evaluate the effectiveness of potential future improvement strategies. Synchro modeling assumptions and analysis results for 2040 no-build conditions are described in the following sections.

9.3.1 Traffic Analysis Assumptions

The existing conditions Synchro model was used as a basis to develop the no-build model. Because this is a future model, planned and approved projects identified through previous efforts that are anticipated along the corridor have been included. No other geometric or traffic signal timing changes were made to the existing Synchro model, but the model was updated with projected 2040 no-build traffic volumes.

9.3.2 Traffic Analysis Results

The same measures of effectiveness used to evaluate existing conditions were used to measure the quantitative performance of the no-build Synchro model:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle
- 95th percentile queue length by lane group – measured in feet

9.3.2.1 Delay and Level of Service

Synchro was used to calculate the delay and associated LOS at each study area intersection under no-build conditions. The same methodologies used to analyze existing conditions were also used to analyze no-build conditions. HCM 2000 methodologies were used to analyze all signalized intersections and HCM 2010 methodologies were used to analyze all unsignalized intersections. The overall intersection delay and LOS for the 12 signalized intersections in the study area is summarized in **Table 17**.

FIGURE 6: TRAFFIC GROWTH RATES

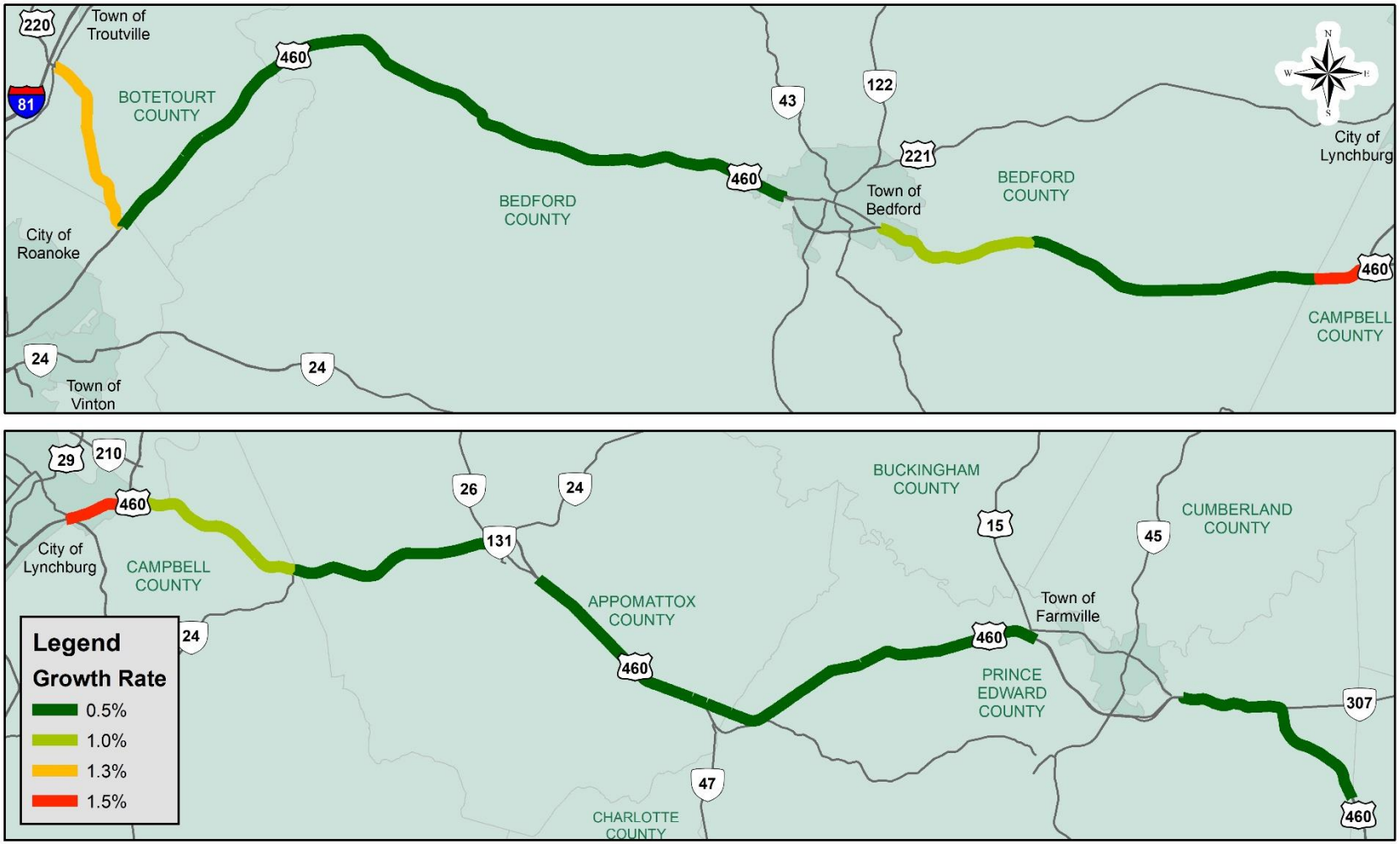


TABLE 17: NO-BUILD (2040) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1. Route 220 ALT and Read Mountain Road	33.2	C	67.6	E
2. Route 220 ALT and Eastpark Drive	29.1	C	21.3	C
3. Route 220 ALT and Crumpacker Drive	15.5	B	14.1	B
4. Route 220 ALT and Route 460	22.2	C	24.2	C
6. Route 460 at Laymantown Road	16.8	B	15.9	B
8. Route 460 at Hull Street/Shopping Mall Entrance	21.3	C	31.7	C
9. Route 460 Shiloh Church Road	9.7	A	9.7	A
12. Route 460 at New London Road/Thomas Jefferson Road	48.3	D	43.0	D
13. Route 460 at Turkey Foot Road	137.7	F	118.4	F
14. Route 460 at New London Drive/Hicks Road	96.3	F	42.3	D
15. Route 460 at Village Highway/Stonewall Road	33.8	C	33.3	C
17. Route 460 at The Shoppes of Appomattox/CVS Pharmacy	14.1	B	29.1	C

Approach delay by movement and LOS for the five unsignalized intersections in the study area is summarized in **Table 18**.

TABLE 18: NO-BUILD (2040) UNSIGNALIZED DELAY AND LOS

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
5. Route 460 at Webster Road – West	Northbound	60.8	F	69.4	F
	Southbound	-	-	-	-
7. Route 460 at Webster Road – East	Northbound	23.7	C	21.9	C
	Southbound	29.5	D	0.0	A
10. Route 460 at Timber Ridge Road	Northbound	-	-	-	-
	Southbound	21.0	C	27.0	D
11. Route 460 at Meade Road	Northbound	-	-	-	-
	Southbound	25.4	D	87.6	F
16. Route 460 at Stage Road	Northbound	13.3	B	22.1	C
	Southbound	28.2	D	60.3	F

9.3.2.2 Queuing

The results of the no-build AM and PM peak hour queuing analysis is summarized in **Appendix G**. The corresponding Synchro output sheets are also provided in **Appendix G** for reference. For movements without conflicting traffic volumes, no queue length was reported by Synchro. Movements where the 95th percentile volume exceeds capacity or where the volume for the 95th percentile queue is metered by an upstream signal were identified. The queuing results in **Table 19** show the following movements with 95th percentile volumes exceeding capacity in the study area:

TABLE 19: NO-BUILD (2040) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection	Lane Group	Peak Hour
1. Route 220 ALT at Read Mountain Road	Northbound left	AM
	Southbound thru	PM
	Eastbound right	PM
2. Route 220 ALT at Eastpark Drive	Northbound thru	AM
	Southbound thru/right	PM
8. Route 460 at Hull Street	Northbound left/thru	PM
	Eastbound left	PM
12. Route 460 New London Road/Thomas Jefferson Road	Southbound left	AM
	Westbound left	PM
13. Route 460 at Turkey Foot Road	Southbound left/thru/right	AM
	Eastbound thru	AM and PM
	Westbound thru	AM and PM
14. Route 460 at New London Drive/Hicks Road	Northbound right	AM
	Eastbound thru	AM and PM
	Westbound left/thru/right	PM
15. Route 460 at Stonewall Road	Southbound left/thru/right	AM and PM
17. Route 460 at Shoppes of Appomattox	Southbound left/thru	PM
	Eastbound left	PM

10 Alternatives Development and Screening

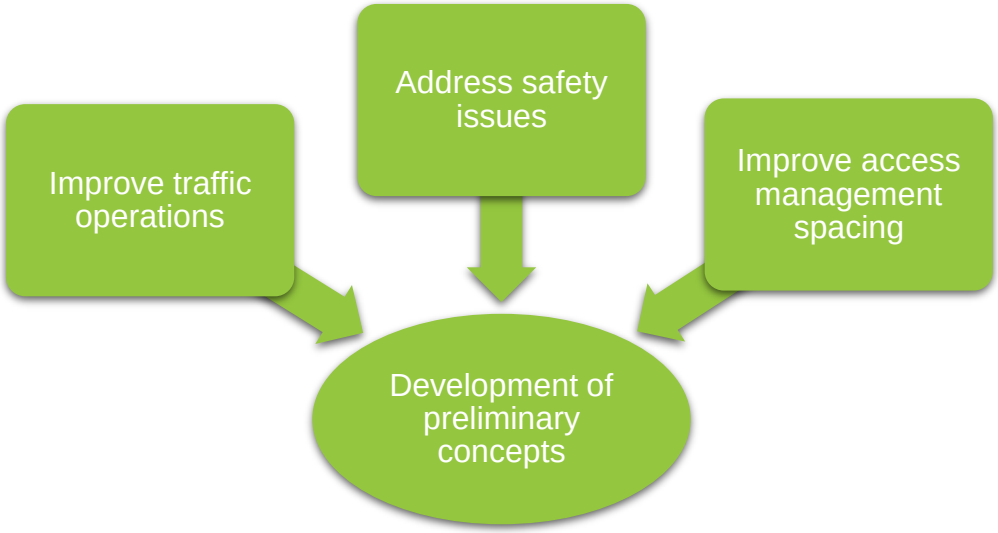
Alternatives for each emerging intersection were developed to address safety, geometric, and operational deficiencies along the study corridor identified in the existing and no-build analyses, as well as during the field review. The alternatives for each emerging intersection consisted of traditional capacity improvements (such as additional turn lanes) and innovative intersection improvements.

Innovative intersections modify the way vehicles, cyclists, and pedestrians navigate an intersection, compared to a traditional design, to improve traffic operations and safety. Examples of innovative intersections include roundabouts, Restricted Crossing U-Turns (RCUTs), Median U-Turns (MUTs), and Continuous Green-T intersections (CGTs).

Initial alternative screening was performed at the seven emerging intersections using the VDOT Junction Screening Tool (VJuST) and Synchro 9. VJuST is a screening tool that helps transportation engineers and planners consider innovative intersection and interchange configurations that address mobility and safety issues. VJuST can help identify configurations to be evaluated with further study, analysis, and design.

Once the initial screening process was complete, the study team participated in an alternatives development workshop on April 25, 2018. During the workshop, the preliminary developed concepts were shared and additional concepts were identified. The concepts discussed during the workshop focused on three key objectives: improve traffic operations, address safety issues, and improve access management spacing, as shown in **Figure 7**. The alternatives development workshop materials are provided in **Appendix H**. Additional conference calls were held following the initial alternatives development meeting to refine and select a preferred alternative at each intersection. Following the alternatives development workshop, VDOT Salem District initiated a separate study along Route 220 ALT to conduct further analysis and develop intersection and corridor solutions. Therefore, the recommendations and Build traffic analysis focus on the Route 460 corridor.

FIGURE 7: CONCEPT DEVELOPMENT CONSIDERATIONS



11 Recommendations

The emerging intersection alternatives considered are presented in **Table 20**, with the preferred alternative shown in bold text. Graphical displays of the preferred alternatives are provided in **Appendix I** along with the planning level cost ranges. The alternatives considered were modeled, analyzed, and discussed in order to select the preferred alternative at each emerging intersection. Preferred alternatives were reviewed, vetted, and agreed upon by the study team during the alternatives development workshop and subsequent conference calls.

In addition to intersection improvements, access management and selective roadway improvements were proposed along the 100-mile corridor. Recommendations were identified based on existing crash severity and frequency, roadway geometry (horizontal and vertical alignment, turn lane storage lengths, shoulder widths), and existing driveway and median opening spacing. Additional consideration was given to PSI segments and intersections. Recommendations include installing rumble strips, improving or installing curve warning signs and chevrons, converting full median openings to directional median openings, extending or constructing turn lanes, and other general access management improvements. The corridor recommendations are shown in **Appendix J**.

TABLE 20: EMERGING INTERSECTION ALTERNATIVES

Description	Alternatives Considered
Route 460 at Webster Road – West	RCUT
	Seagull (Unsignalized Green-T)
	Modified unsignalized seagull
Route 460 at Laymantown Road	Continuous Green-T
	RCUT
Route 460 at Webster Road - East	Realignment of northbound right turns
	RCUT
	Close crossover
Route 460 at Hull Street/Shopping Mall Entrance	Add crosswalk
	Add channelization to right-in/right-out locations
	Additional southbound left turn lanes
	MUT (restrict side street throughs)
	RCUT
	RCUT – unsignalized upstream ramps
Route 460 at Shiloh Church Road	Continuous Green-T
	Seagull
	RCUT (unsignalized)
	RCUT (signalized)
Route 460 at Timber Ridge Road	Add southbound right turn lane
	Close crossover
	RCUT
	Seagull

Description	Alternatives Considered
Route 460 at Meade Road	**Unsignalized RCUT (short-intermediate term)**
	Signalized RCUT (long term)
	Continuous Green-T
	Conventional signal
Route 460 at New London/Thomas Jefferson Road	Consolidate entrances at Exxon gas station
	Additional eastbound left turn lane
	Additional southbound left turn lane
	Additional eastbound and southbound left turn lanes
	Bowtie
	MUT
	RCUT
Route 460 at Turkey Foot Road	Add northbound right turn lane
	Add southbound right turn lane
	Add northbound and southbound right turn lanes
	MUT
	RCUT
	Bowtie
Route 460 at New London Drive/Hicks Road	Add westbound right turn lane
	Add additional westbound left turn lane
	Permissive minor street phasing
	RCUT
	Jughandle
Route 460 at Village Highway/Stonewall Road	Add southbound right turn lane
	Add northbound right turn lane
	Add southbound and northbound right turn lanes
	RCUT
	MUT
Route 460 at Stage Road	Add westbound left turn lane
	Add eastbound left turn lane
	Add westbound and eastbound left turn lanes
	Close crossover
	RCUT
Route 460 at The Shoppes of Appomattox/CVS Pharmacy	Consolidate entrances at Exxon gas station
	Lengthen southbound left-turn lane
	Add additional southbound left-turn lane
	Restricted thru-cut
	RCUT
	RCUT – unsignalized upstream ramps

Route 460 at Webster Road – West

The preferred alternative at this intersection converts the existing unsignalized intersection to a modified unsignalized seagull. A dedicated acceleration lane would be provided for left turning vehicles from Webster Road (West) to merge onto westbound Route 460. Additionally, the number of conflict points will be reduced because westbound Route 460 left turns onto Webster Road (West) would make the left turn to the east of the existing intersection where the northbound right turn slip lane currently is positioned. This improvement is expected to reduce delays and improve safety at the intersection.

Route 460 at Laymantown Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to a signalized RCUT intersection. The western median crossover will operate with two phase signals which control the U-turn and opposing through movements. The eastbound Route 460 through movement at Laymantown Road would operate free-flow. Removing the left movements from Laymantown Road is expected to reduce delays and improve safety at the intersection.

Route 460 at Webster Road – East

The preferred alternative at this intersection converts the existing unsignalized intersection to an RCUT. All three intersections in the RCUT would operate as unsignalized. In addition, Hillcrest Street would be converted to right-in/right-out. Removing minor approach left turn and through movements and eastbound Route 460 left turns at the main intersection and reduces conflict points to improve safety.

Route 460 at Hull Street/Shopping Mall Entrance

The preferred alternative at this intersection converts the existing conventional signalized intersection to a MUT that restricts side street through movements. The eastern median crossover location will operate with two phase signals which control the U-turn and opposing through movements. Removing the side street through movements at the main intersection is expected to reduce delays and improve safety at the intersection.

Route 460 at Shiloh Church Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. The existing traffic signal is recommended to be removed; thus, all intersections in the RCUT would operate as unsignalized. Removing the minor street left and through movements and rerouting vehicles to downstream U-turn locations reduces the number of conflict points and improves safety.

Route 460 at Timber Ridge Road

The preferred alternative at this intersection closes the existing unsignalized intersection. The crossover closure would reroute vehicles to downstream U-turn locations. Removing all minor approach movements and through movements on the main approach reduces conflict points to improve safety.

Route 460 at Meade Road

The preferred short-term alternative at this intersection converts the existing unsignalized intersection to an RCUT intersection. Both intersections in the RCUT would operate as unsignalized. Removing minor approach left-turn and through movements at the main intersection reduces conflict points to improve safety. As development occurs, it is recommended to evaluate signalizing the two RCUT intersections.

Route 460 at New London/Thomas Jefferson Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. The eastern and western median crossover locations will operate with two-phase signals which control the U-turn and opposing through movements. Removing minor approach left-turn and through movements at the main intersection improves traffic operations and reduces conflict points to improve safety.

Route 460 at Turkey Foot Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to a MUT intersection. The eastern and western median crossover locations will operate with two-phase signals, which control the U-turn and opposing through movements. Removing mainline left movements at the main intersection decreases the number of phases at the signal which reduces delay and deceases the number of conflict points which increases safety. Left turns would be permitted from the side street, whereas through movements would be restricted.

Route 460 at New London Drive/Hicks Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. Side street through and left turning vehicles would utilize the adjacent unsignalized intersections for U-turns. Removing the minor street left and through movements reduces the number of conflict points and improves safety.

Route 460 at Village Highway/Stonewall Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. The existing intersection will remain signalized while the eastern and western median crossover locations will be unsignalized. Removing the minor street left and through movements and rerouting vehicles to downstream U-turn locations reduces the number of conflict points and improves traffic operations and safety.

Route 460 at Stage Road

The preferred alternative at this intersection closes the existing unsignalized intersection. The crossover closure would reroute vehicles to downstream U-turn locations. Removing all minor approach movements and through movements on the main intersection reduces conflict points to improve safety.

Route 460 at The Shoppes of Appomattox/CVS Pharmacy

The preferred alternative at this intersection converts the existing conventional signalized intersection to a restricted thru-cut which removes through movements from the side street at the main intersection. The main intersection will remain signalized while the western median crossover location will be unsignalized. Removing the side street through movements at the main intersection is expected to reduce delays and improve safety.

11.1 Build Conditions Traffic Analysis

Build traffic conditions were analyzed to evaluate the results of future (2040) traffic demand under the preferred intersection alternative geometry. The intent of the 2040 build conditions analysis is to compare it to the 2040 no-build conditions analysis to determine the operational impacts. Synchro modeling assumptions and analysis results for 2040 build conditions are described in the following sections.

11.1.1 Traffic Analysis Assumptions

The no-build conditions Synchro model was used as a basis to develop the build model. The Synchro model was updated with the recommended intersection alternatives which involved geometric and traffic signal changes. Additionally, 2040 no-build traffic volumes were rerouted for innovative intersection concepts.

Since some improvement concepts involve innovative intersection designs that involve diverting some traffic movements, the experienced travel time (ETT) was calculated for movements that are diverted by the intersection design. ETT combines control delay from signalized and unsignalized intersections, crossovers, and the time for extra distance traveled. ETT was calculated using the methodologies provided by the *Highway Capacity Manual, 6th Edition.* The LOS criteria for ETT is defined in **Table 21**.

TABLE 21: ETT LOS CRITERIA

ETT LOS	ETT (seconds/vehicle)
A	≤ 10.0
B	> 10.0 to 20.0
C	> 20.0 to 35.0
D	> 35.0 to 55.0
E	> 55.0 to 80.0
F	≥ 80.0
Source: Highway Capacity Manual 6th Edition (HCM)	

11.1.2 Traffic Analysis Results

The same measures of effectiveness used in existing and no-build conditions were used to measure the quantitative performance of the build Synchro model with the addition of ETT:

- Average vehicle delay by movement, approach, and intersection – measured in seconds per vehicle

- 95th percentile queue length by lane group – measured in feet
- ETT for innovative intersections – measured in seconds per vehicle

11.1.2.1 Delay and Level of Service

Synchro was used to calculate the delay and associated LOS at each study area intersection under build conditions. HCM 2000 methodologies were used to analyze all signalized intersections and HCM 2010 methodologies were used to analyze all unsignalized intersections. For intersections with proposed innovative intersection concepts, the delay results from Synchro were used to calculate the ETT. The overall intersection delay and LOS for the signalized intersections in the study area is summarized in **Table 22**. The delay and LOS for all locations, including individual movements, is included in **Appendix K**.

TABLE 22: BUILD (2040) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
6. Route 460 at Laymantown Road (RCUT)	16.1	B	15.4	B
8. Route 460 at Hull Street/Shopping Mall Entrance (MUT restricted side street throughs)	19.1	B	25.7	C
12. Route 460 at New London Road/Thomas Jefferson Road (RCUT)	26.2	C	26.9	C
13. Route 460 at Turkey Foot Road (MUT)	29.1	C	39.2	D
14. Route 460 at New London Drive/Hicks Road (RCUT)	32.1	C	17.3	B
15. Route 460 at Village Highway/Stonewall Road (RCUT)	15.2	B	14.3	B
17. Route 460 at The Shoppes of Appomattox Shopping Center/CVS Pharmacy (Restricted Thru-Cut)	9.9	A	19.8	B

Approach delay by movement and LOS for the unsignalized intersections is summarized in **Table 23**.

TABLE 23: BUILD (2040) UNSIGNALIZED DELAY AND LOS

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
5. Route 460 at Webster Road – West (Modified Seagull)	Northbound	20.8	C	56.5	E
	Southbound	-	-	-	-
7. Route 460 at Webster Road – East (RCUT)	Northbound	50.7	D	28.3	C
	Southbound	33.4	C	28.3	C
9. Route 460 at Shiloh Church Road (RCUT)	Northbound	-	-	-	-
	Southbound	21.7	C	25.5	C
10. Route 460 at Timber Ridge Road (Closed Crossover)	Northbound	-	-	-	-
	Southbound	34.6	C	35.3	D
11. Route 460 at Meade Road (RCUT)	Northbound	-	-	-	-
	Southbound	47.7	D	55.2	E
16. Route 460 at Stage Road (Closed Crossover)	Northbound	19.9	B	18.6	B
	Southbound	44.2	D	47.3	D

The intersections of Route 460 at Webster Road West and Route 460 at Meade Road experience LOS E during the PM peak. This is an improvement from LOS F under No-Build conditions.

11.1.2.2 Queuing

The results of the build AM and PM peak hour queuing analysis is summarized in **Appendix K**. The corresponding Synchro output sheets are also provided in **Appendix K** for reference. For movements without conflicting traffic volumes, no queue length was reported by Synchro.