Arterial Preservation Plan: US 29 Corridor

VDOT Lynchburg District

December 2019 | Final Report

Prepared for

1401 East Broad Street, Richmond, VA 23219

Prepared by

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

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

Table of Contents

1 Arterial Preservation Program Overview 1
1.1 Program Goals and Strategies 1
1.2 Arterial Preservation Network 1
2 US 29 Corridor 2
2.1 Study Team 2
2.2 Public Outreach 2
2.3 Previous Studies 2
2.4 VTrans2040 Tier 1 Recommendations 4
2.5 Park and Ride Locations 5
3 Existing and Future Land Use 8
4 Corridor Segmentation and Emerging Intersections 8
4.1 Corridor Segmentation 8
4.2 Emerging Intersections 12
5 Data Collection and Inventory 14
6 Safety Analysis 14
6.1 Summary of Study Area Crashes 14
6.2 Roadway Departure Crashes 16
6.3 Emerging Intersection Crashes 17
6.4 Bicycle and Pedestrian Crashes 19
7 Access Management Spacing 19
8 Signal Justification Review 20
8.1 MUTCD Signal Warrant Results 21
9 Traffic Analysis 21
9.1 Existing Conditions 21
9.1.1 Traffic Analysis Assumptions 21
9.1.2 Traffic Analysis Results 22
9.2 Traffic Forecasting 24
9.2.1 Traffic Growth Rate Development 24
9.3 No-Build Conditions 24
9.3.1 Traffic Analysis Assumptions 26
9.3.2 Traffic Analysis Results 26
10 Alternatives Development and Screening 28

11 Recommendations 29
11.1 Build Conditions Traffic Analysis 32
11.1.1 Traffic Analysis Assumptions 32
11.1.2 Traffic Analysis Results 33

List of Figures

Figure 1: US 29 Study Corridor 3
Figure 2: Park and Ride Investment Strategy Locations Along the US 29 Corridor 7
Figure 3: US 29 Segmentation Map 10
Figure 4: US 29 Emerging Intersections 13
Figure 5: Heat Map of Roadway Departure Crashes 18
Figure 6: Traffic Growth Rates 25
Figure 7: Concept Development Considerations 28

List of Tables

Table 1: Previous Studies and Comprehensive Plans 4
Table 2: Park and Ride Investment Strategy Locations along the US 29 Corridor 6
Table 3: US 29 Segmentation Limits 11
Table 4: 2012 – 2016 US 29 Crashes by Year and Severity 14
Table 5: PSI Intersections And Segments 15
Table 6: TSN Intersections and Segments 16
Table 7: Roadway Departure Crashes by Year and Severity 17
Table 8: Emerging Intersection Crashes By Severity (2012 – 2016) 17
Table 9: Minimum Spacing Standards For Commercial Entrances, Intersections, and Median Crossovers 20
Table 10: Access Point Type and Spacing 20
Table 11: Signal Warrant Analysis Results 21
Table 12: Level of Service Criteria 22
Table 13: Existing (2018) Signalized Delay and LOS 23
Table 14: Existing (2018) Unsignalized Delay and LOS 23
Table 15: Existing (2018) Lane Groups where 95th Percentile Volumes Exceed Capacity 24
Table 16: No-Build (2040) Signalized Delay and LOS 26
Table 17: No-Build (2040) Unsignalized Delay and LOS 27
Table 18: No-Build (2040) Lane Groups where 95th Percentile Volumes Exceed Capacity 27
Table 19: Emerging Intersection Alternatives 30
Table 20: ETT LOS Criteria 33
Table 21: Build (2040) Signalized Delay and LOS 33
Table 22: Build (2040) Unsignalized Delay and LOS 34

Appendices

Appendix A - Framework Document

Appendix B - Existing and Future Land Use

Appendix C - Traffic Data

Appendix D - Safety Analysis

Appendix E - Traffic Signal Warrants

Appendix F - Existing Operational Analysis

Appendix G - No-Build Operational Analysis

Appendix H - Alternatives Evaluation

Appendix I - Preferred Intersection Alternative Concepts

Appendix J - Corridor Recommendations

Appendix K - Build Operational Analysis

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 safety and capacity 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. As an alternative to traditional widening to provide increased capacity, preservation and enhancement 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 US 29 Corridor

The purpose of the US 29 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.

The study corridor extends 50 miles from the City of Danville to the City of Lynchburg and is comprised of US 29 Business from Route 719 (E. Witt Road/Lawless Creek Road) to US 29, and US 29 from US 29 Business to US 460.The limited access portions of the roadway were not included in the study corridor (i.e., Town of Chatham, Town of Gretna, Town of Hurt and Town of Altavista). The US 29 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
- Pittsylvania County
- Campbell County
- City of Danville
- City of Lynchburg
- Liberty University
- Region 2000 Local Government Council
- West Piedmont Planning District Commission
- Kimley-Horn

A framework document was developed prior to commencing this study that documented the methods and assumptions for the US 29 Arterial Preservation Plan. The agreed upon framework document is provided in **Appendix A**.

2.2 Public Outreach

Two corridor-wide citizen information meetings were held during the study. One meeting was held on October 29, 2019 at the VDOT Ramey Memorial Auditorium in Lynchburg, VA, and one was held on November 14, 2019 at the VDOT Chatham Residency in Chatham, VA. The purpose of the meetings 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. Public feedback was considered in the final recommendations.

2.3 Previous Studies

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

FIGURE 1: US 29 STUDY CORRIDOR

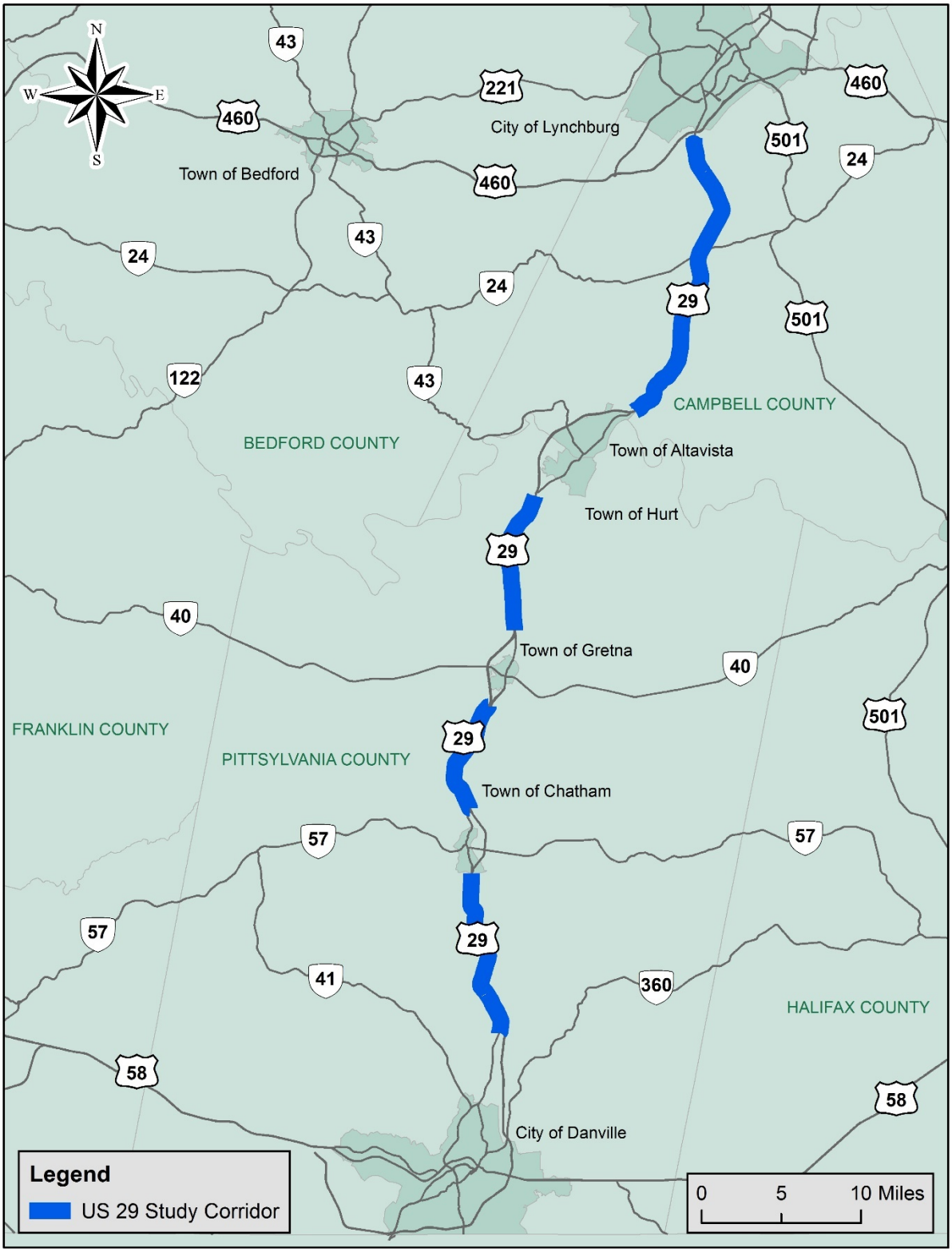


TABLE 1: PREVIOUS STUDIES AND COMPREHENSIVE PLANS

Previous Studies and Comprehensive Plans	Year
Previous Studies	
Central Virginia's Region 2000 Park and Ride Lot Location Study	2008
High Risk Rural Roads Study	2009
STARS I Wards Road - Route 29	2009
Blairs Access Management Plan	2010
Tightsqueeze Access Management Plan	2010
Region 2000 Local Government Council: 2035 Rural Long-Range Transportation Plan	2010
West Piedmont Planning District Commission: 2035 Rural Long-Range Transportation Plan	2011
Corridors of Statewide Significance Seminole Corridor – US 29	2013
Blairs Fire Station and Route 29 Study	2014
SHRP2 Route 29 Corridor Assessment	2016
VDOT's Park & Ride Investment Strategy	2016
VTrans2040 Multimodal Transportation Plan: Seminole Corridor	2016
Comprehensive Plans	
Pittsylvania County	2010
City of Danville	2010
City of Lynchburg	2013
Campbell County	2014
Town of Chatham	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. The recommendations for the US 29 study corridor were reviewed and incorporated into the final solution set for the corridor. The recommendations include:

- LY06: Construct regional bikeway that parallels US 29 corridor, multi-jurisdictional
    - *Construct Regional Bikeway along the US 29 corridor, running from Altavista north through Lynchburg and continues north of Amherst to improve mode choice and accessibility. Project to include the segments along US 29 identified within the CVMPO 2010 Region 2000 Bike Plan.*
- LY09: Construct new Park and Ride lot along US 29, Pittsylvania County
    - *Construct 50-space Park and Ride lot near intersection of US 29 Bypass and US 29 BUS just south of Chatham in Pittsylvania County to serve longer distance commuters bound for Lynchburg or Danville.*
- LY11: Improve safety of intersection of US 29 and Gladys Road (VA 699), Campbell County

    - *Improve intersection function and mitigate horizontal sight distance issues at US 29 and VA 699 to improve operations for trucks and safety for all users. Clearing sight triangles, installing acceleration lanes and/or possible RCUT solution.*
- LY19: US 29 (Wards Road) SHRP blended solution improvements, Campbell County
    - *Implementation of the SHRP blended solution improvements from the Lynchburg City/Campbell County line to the intersection of US 29 and Route 24 to improve safety and reliability. The improvements include access management strategies such as turn lane improvements, crossover closures/modifications and R-Cuts. Safety improvements would include speed limit reductions and traffic signal improvements. A shared use path and sidewalks from Calohan Road to US 460 are included as well. A safer and more efficient Wards Road will improve movement to various markets including retail, public services, and employment hubs along the corridor and beyond.*
- LY24: US 29 access management studies, multi-jurisdictional
    - *Procure Arterial Management Plan Studies along US 29 and in Pittsylvania, Campbell, Amherst and the City of Lynchburg to plan for the future and ensure reliability for commuters and freight. Study is eligible for prescoping funds. The recommendations of this project may be developed into various SMART SCALE eligible projects.*

2.5 Park and Ride Locations

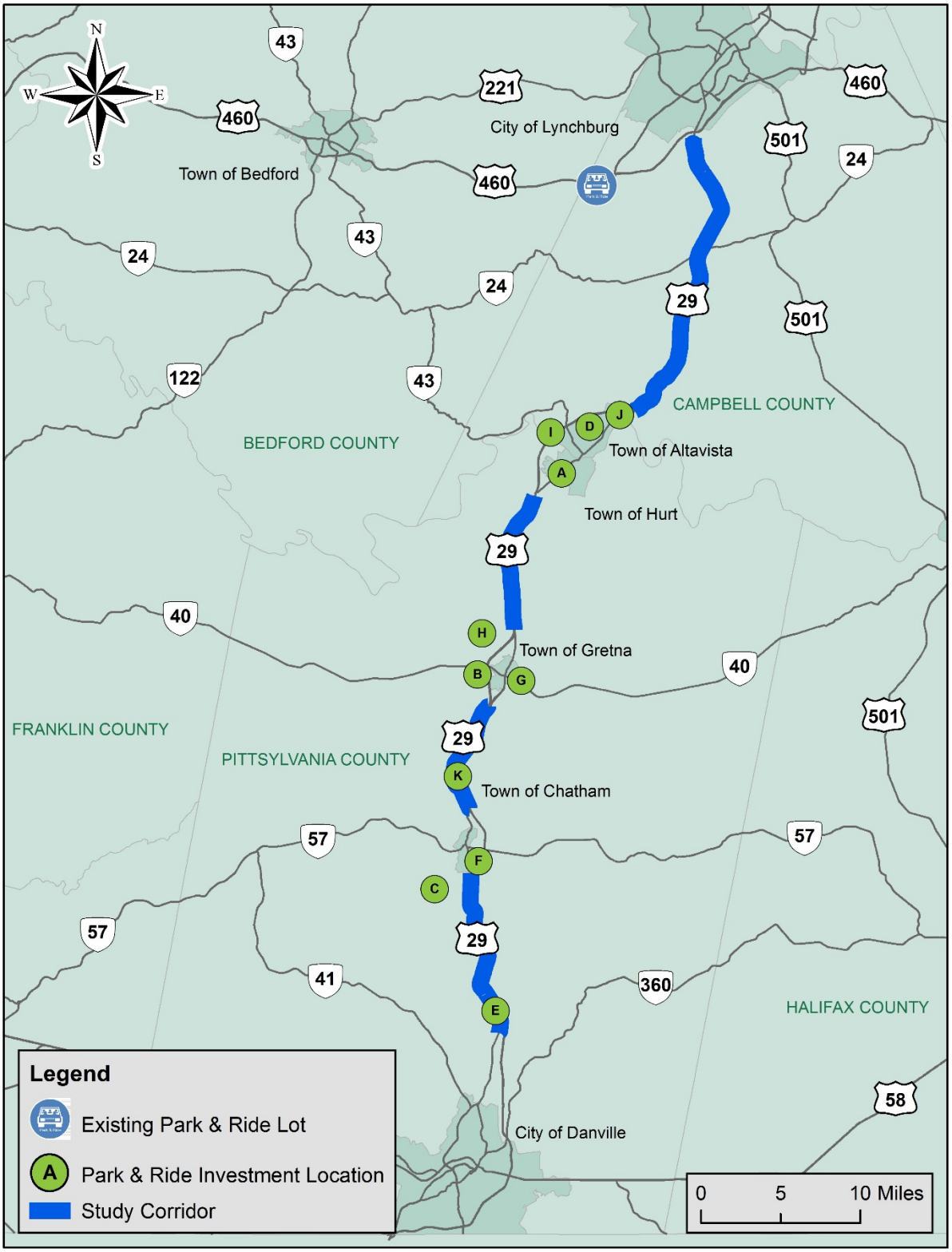
In 2014, VDOT completed a Park and Ride investment strategy study to determine where investments in Park and Ride lots are needed across the Commonwealth of Virginia. The recommendations include new Park and Ride lots, lot expansions, and safety improvements. The Park and Ride lot investment strategy locations along the US 29 corridor are summarized in **Table 2** and presented in **Figure 2**.

TABLE 2: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE US 29 CORRIDOR

ID	Site	Jurisdiction	Description
A	LYN-2	Pittsylvania County	New lot near US 29 and US 29 BUS (Main St), near Sycamore Creek
B	LYN-3	Pittsylvania County	New lot near US 29 & Route 40 (W Gretna Rd)
C	LYN-4	Pittsylvania County	New 25-space lot along US 29 near Route 703 (Tightsqueeze Rd)
D	LYN-13	Town of Altavista	Obtain an agreement to use spaces at the Shopping Center along US 29 BUS near 7th St
E	LYN-15	Pittsylvania County	New lot near US 29 BUS & Route 726 (Malmaison Rd)
F	LYN-16	Pittsylvania County	New lot near US 29 & S Main St, near Route 1443
G	LYN-17	Pittsylvania County	New lot near US 29 & Route 40 (W Gretna Rd), near Gretna High School
H	LYN-18	Pittsylvania County	New lot on Route 935 (Farmers Mountain Rd), near Route 40 (W Gretna Rd)
I	LYN-19	Pittsylvania County	New lot near US 29 & Route 924 (Pocket Rd)
J	LYN-1A	Town of Altavista	Town and Country Shopping Center, Altavista
K*	LYN-1O	Pittsylvania County	Along US 29 in the Chatham, Gretna, and Hurt areas of Pittsylvania County

Source: VDOT Park & Ride Program Investment Strategy
* VTrans Tier 1 Recommendation

FIGURE 2: PARK AND RIDE INVESTMENT STRATEGY LOCATIONS ALONG THE US 29 CORRIDOR



3 Existing and Future Land Use

The existing and future land use maps for the City of Danville, Pittsylvania County, the Town of Chatham, Campbell County, and the City of Lynchburg are presented in **Appendix B**.

The City of Danville existing land use map shows that much of the land is classified as single-family residential land use or vacant/forested land use, with pockets of retail and service land use in the downtown areas of Danville. The future land use map from the City of Danville's *2030 Comprehensive Plan* shows the City is expected to gain large areas of neighborhood commercial, community commercial, and mixed-use land areas. The US 29 study corridor begins outside of the City limits to the north, where the City is expected to grow into commercial, residential, and mixed-use land areas.

The *2010 Pittsylvania County Comprehensive Plan* shows the future land use for the areas surrounding the US 29 study corridor. The areas outside of the City of Danville, the Town of Chatham, the Town of Gretna, and the Town of Hurt are designated as medium to high density residential areas, with pockets of industrial areas. The majority of the land use along the study corridor between these areas of development is designated as agricultural and rural residential.

The Town of Chatham future land use map shows heavy areas of residential and industrial land use, with business and commercial use in the downtown area. The US 29 study corridor passes through a small section of the Town of Chatham, but the main route through the residential and downtown area is US 29 BUS, which is excluded from the study area.

The Campbell County *Comprehensive Plan* future land use map shows that the northern section of the corridor heading into the City of Lynchburg is designated as medium to high density commercial area next to medium to high density residential areas. In the town of Altavista, US 29 is shown as medium to high density mixed use.

The City of Lynchburg *Comprehensive Plan 2030* future land use map shows the areas surrounding US 29 north of the study corridor to be a variety of mixed use, medium density residential, high density residential, and community commercial 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 US 29 were categorized into the following 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 nine segments: one developed segment (2.3 total miles), four emerging segments (16.5 total miles), and four stable segments (27.7 total miles). The segments are shown in **Figure 3** and the limits are described in **Table 3**.

FIGURE 3: US 29 SEGMENTATION MAP

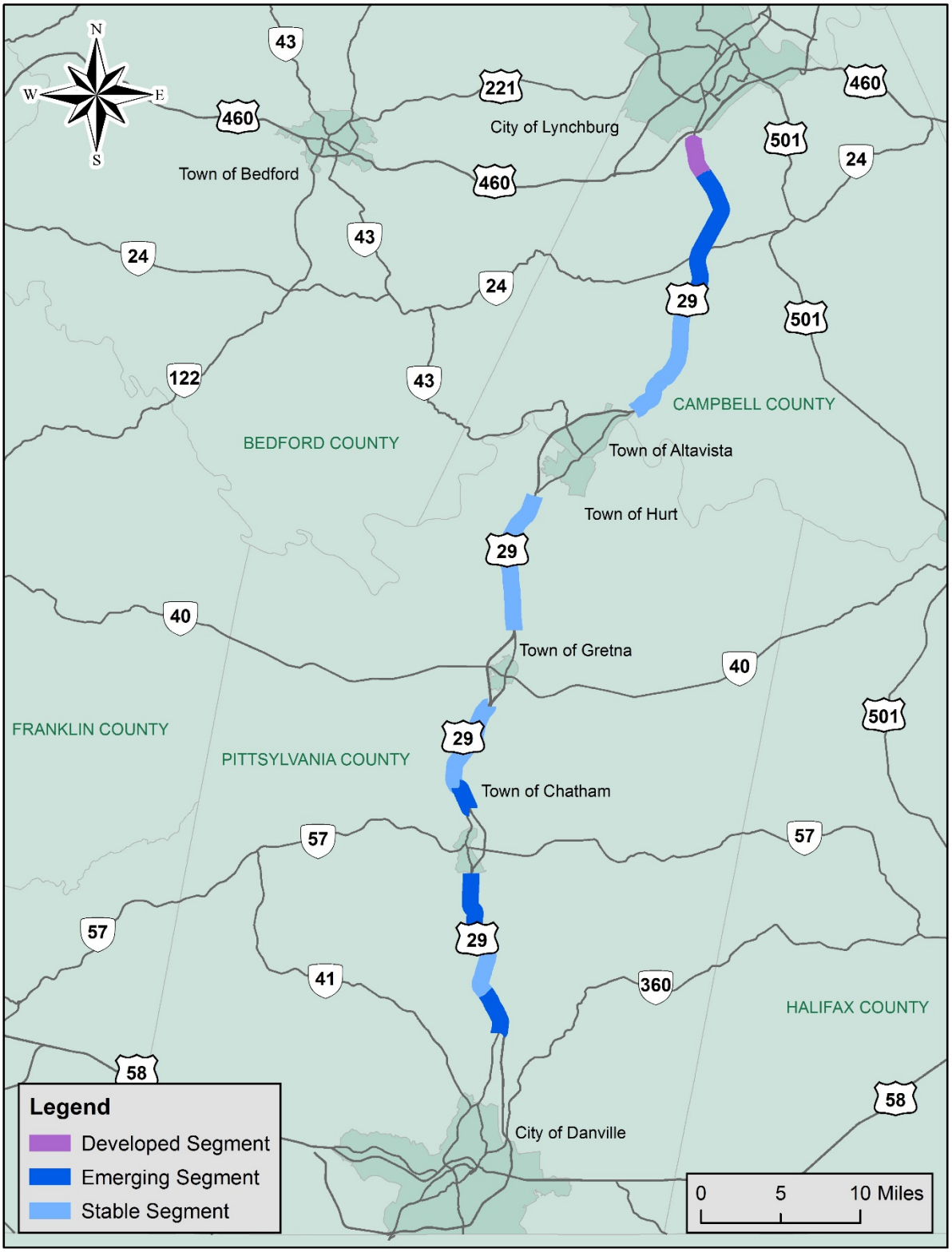


TABLE 3: US 29 SEGMENTATION LIMITS

Segment ID	Category	Route	Limits
1	Emerging	US 29/ US 29 BUS	500' south of Route 719 (E. Witt Road/Lawless Creek Road) to 500' north of Deerwood Drive
2	Stable	US 29	500' north of Deerwood Drive to 500' south of Route 718 (Dry Fork Road/Snakepath Road)
3	Emerging	US 29	500' south of Route 718 (Dry Fork Road/Snakepath Road) to US 29/US 29 BUS Junction south of Chatham
4	Emerging	US 29	US 29/US 29 BUS Junction north of Chatham to Railroad crossing north of Dual Tracks Road
5	Stable	US 29	Railroad crossing north of Dual Tracks Road to US 29/US 29 BUS Junction south of Gretna
6	Stable	US 29	US 29/US 29 BUS Junction north of Gretna to US 29/US 29 BUS Junction south of Hurt
7	Stable	US 29	US 29/US 29 BUS Junction north of Altavista to Phillips Lane
8	Emerging	US 29	Phillips Lane to 500' south of Route 738 (English Tavern Road)
9	Developed	US 29	500' south of Route 738 (English Tavern Road) to US 29/US 460 Interchange

4.2 Emerging Intersections

Emerging intersections are existing or future 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 draft list of emerging intersections along the US 29 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 increased in traffic due to future development
- Park & Ride investment strategy intersection
- District input

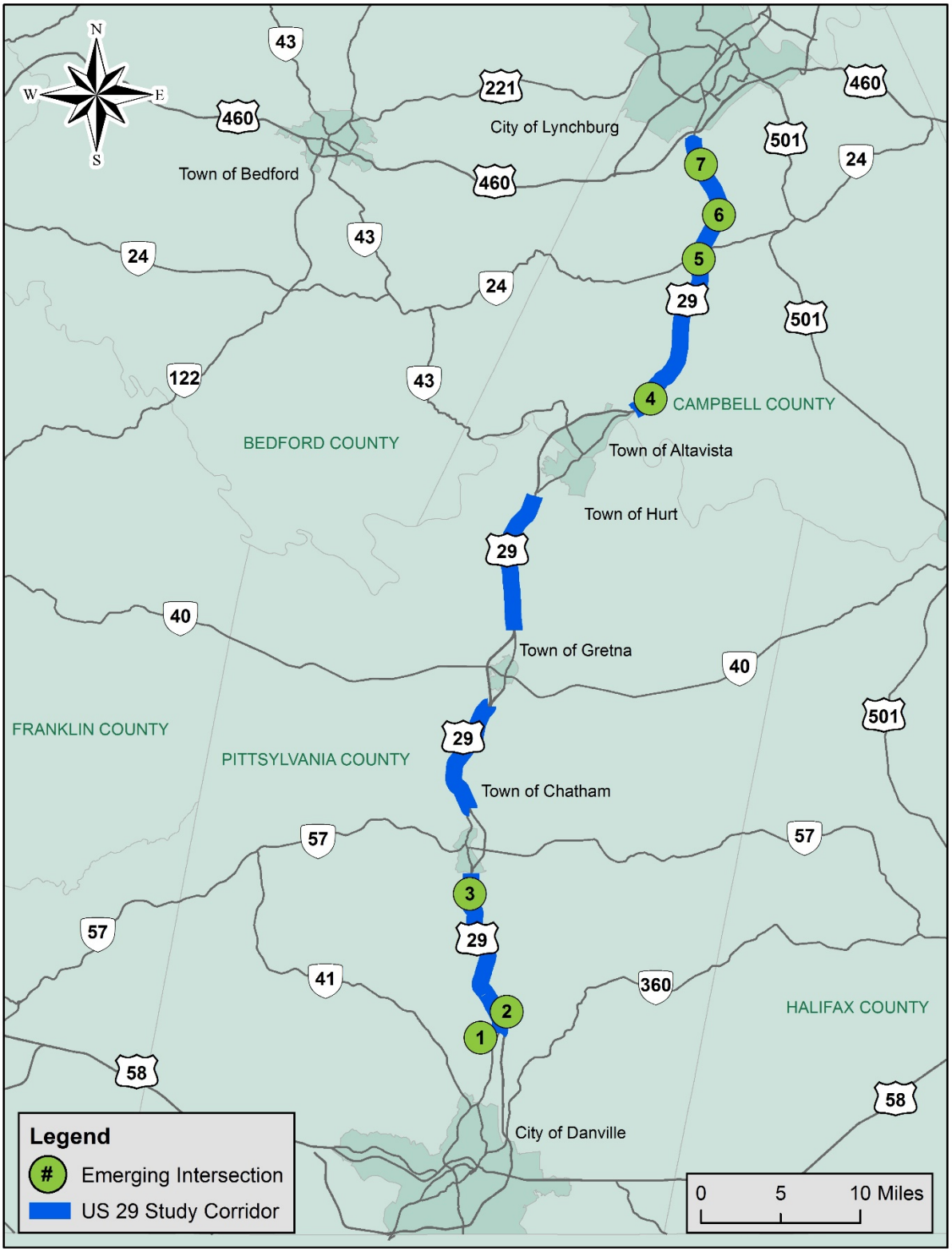
The preliminary list of emerging intersections was further narrowed based on the following criteria:

- Signalized intersection
- 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 US 29 corridor are listed below and presented in **Figure 4**.

1. US 29 BUS at E. Witt Road/Lawless Creek Road
2. US 29 BUS at Malmaison Road
3. US 29 at Tightsqueeze Road
4. US 29 at Gladys Road
5. US 29 at Colonial Highway
6. US 29 at Calohan Road
7. US 29 at English Tavern Road (North)

FIGURE 4: US 29 EMERGING INTERSECTIONS



5 Data Collection and Inventory

A preliminary field review of the study area was conducted March 13-15, 2018 to observe existing geometric conditions, traffic control devices, peak hour traffic conditions, and driver behavior. Turning movement counts were collected on February 21, 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, 1,187 crashes were reported in the study area. Of the reported crashes, there were 13 fatal crashes, 88 serious injury crashes, 243 minor/possible injury crashes, 41 no apparent injury crashes, and 802 crashes involving property damage only. A yearly summary of crashes, by crash severity is shown in **Table 4**.

TABLE 4: 2012 – 2016 US 29 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	6	16	41	19	147	229
2013	0	19	55	8	141	223
2014	2	13	61	5	155	236
2015	3	20	41	1	174	239
2016	2	20	45	8	185	260
Total	**13**	**88**	**243**	**41**	**802**	**1187**

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 12 intersections and 13 segments on the US 29 study corridor that were identified in VDOT Lynchburg District's list for PSI. The intersections and segments are shown in **Table 5**.

TABLE 5: PSI INTERSECTIONS AND SEGMENTS

Location	2016 PSI Rank (Lynchburg District)	Intersection Studied?
Intersections		
US 29 at Gladys Road	20	Yes (Emerging Intersection)
US 29 at Russell Woods Drive	35	No (Addressed in SHRP 2 Study)
US 29 at Calohan Road	47	Yes (Emerging Intersection)
US 29 at Shula Drive	56	No (PSI rank greater than 50; addressed in VDOT study)
US 29 at Rangoon Street	82	No (Addressed in SHRP 2 Study)
US 29 at English Tavern Road (South)	84	No (PSI rank greater than 50; addressed in SHRP 2 Study)
US 29 at Hyland Drive	140	No (PSI rank greater than 50)
US 29 at Andrew Road	143	No (PSI rank greater than 50; right-in/right out configuration)
US 29 at Quartz Road	155	No (PSI rank greater than 50)
US 29 at Lyn Dan Drive	156	No (PSI rank greater than 50)
US 29 at Samuel Harris Lane	159	No (PSI rank greater than 50)
US 29 at Castle Craig Road	160	No (PSI rank greater than 50)
Segments		
US 29 from Preston Glenn Road to Liberty Mountain Drive	39	-
US 29 from Baker Road to Russell Woods Drive	77	-
US 29 from Lynbrook Road to Hyland Drive	147	-
US 29 from Liberty Mountain Drive to SpringHill Suites	160	-
US 29 from Calohan Road to English Tavern Road (South)	177	-
US 29 from SpringHill Suites to US 460 ramps	190	-
US 29 from Open Bible Baptist Church to Riddle Road	213	-
US 29 from Flat Creek to English Tavern Road (North)	214	-
US 29 from Elwood Lane to Brentwood Lane	321	-
US 29 from Wards Road to Rangoon Street	336	-
US 29 from Chatham Family Medical Center to Hawkins Road	372	-
US 29 from Pick-N-Save to Calohan Road	390	-
US 29 from Fenbrooke Drive to Peerman School Road	417	-

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 was one intersection and four segments on US 29 that were identified as TSN locations. The intersections and segments are listed in **Table 6**.

TABLE 6: TSN INTERSECTIONS AND SEGMENTS

Location	2016 PSI Rank (Lynchburg District)	Intersection Studied?
Intersections		
US 29 at Gladys Road	4	Yes (Emerging Intersection)
Segments		
US 29 from Preston Glenn Road to Liberty Mountain Drive	5	-
US 29 from Lynbrook Road to Hyland Drive	3	-
US 29 from Calohan Road to English Tavern Road (South)	4	-
US 29 from Flat Creek to English Tavern Road (North)	3	-

6.2 Roadway Departure Crashes

Roadway departure crashes are defined as when 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:

- US 29 near Gladys Road
- US 29 near Big Otter River
- US 29 south of the Sycamore community
- US 29 near Keesee Road
- US 29 near Riddle Road
- US 29 near Dual Track Road
- US 29 south of Banister River
- US 29 near Carter Lodge Road

Seventy-eight percent of the roadway departure crashes along the study corridor were collisions involving a vehicle and a fixed object. The heat map shows that these crashes most often occur in the rural areas with sharp curves. Thirty-two percent of the total roadway departure crashes along the corridor occurred in darkness in locations without roadway lighting.

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	3	5	12	5	23	48
2013	0	9	8	1	36	54
2014	1	3	12	1	25	42
2015	1	8	4	0	46	59
2016	1	8	7	3	27	46
Total	**6**	**33**	**43**	**10**	**157**	**249**

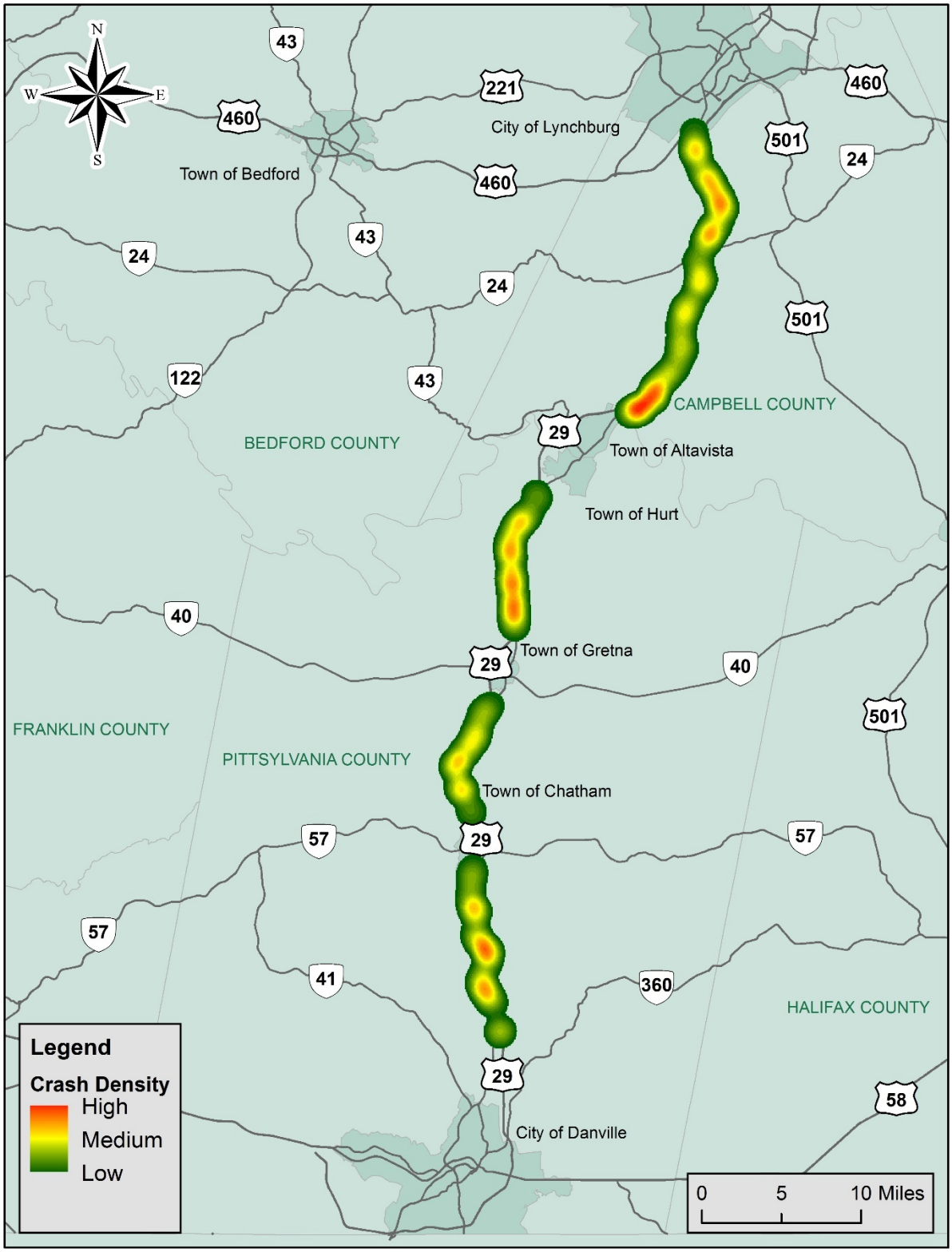
6.3 Emerging Intersection Crashes

During the analysis period from 2012 to 2016, the crashes that occurred within the influence areas of the seven emerging intersections ranged from three at US 29 and E. Witt Road/Lawless Creek Road to 39 at US 29 and English Tavern Road (North). 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
US 29 BUS at E. Witt Road/Lawless Creek Road	0	0	1	1	1	3
US 29 BUS at Malmaison Road	0	0	2	0	5	7
US 29 at Fairview Road/Tightsqueeze Road	0	1	5	1	15	22
US 29 at Gladys Road	1	0	7	0	16	24
US 29 at Colonial Highway	0	2	6	0	12	20
US 29 at Calohan Road	0	2	8	1	23	34
US 29 at English Tavern Road (North)	0	1	10	1	27	39

FIGURE 5: HEAT MAP OF ROADWAY DEPARTURE CRASHES



Rear-end crashes totaled 48 percent of the total crashes at the seven emerging intersections. No-rear end crashes resulted in a fatality, 32 percent resulted in an injury, and 68 percent resulted in property damage only. 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 ranked higher than 50 along the corridor to identify crash patterns and contributing factors. The results are summarized below.

US 460 at Gladys Road

Angle crashes, which typically correlate with high crash severities, comprised 54 percent of crashes at Gladys Road, the only unsignalized emerging intersection along the study corridor. Over 80 percent of angle crashes occurred when left turning vehicles from Gladys Road to southbound US 29 pulled into the path of northbound US 29 vehicles or failed to yield to right of way. One fatality also occurred at Gladys Road, when a northbound vehicle approaching the intersection struck a log protruding from a right-turning vehicle.

US 460 at Calohan Road

Rear-end crashes, which are typical at signalized intersections, comprised 59 percent of crashes at Calohan Road. During the field review, queues were observed in the PM peak hour on northbound US 29 upstream of the signal ahead warning signs. Seven out of the 11 crashes that resulted in an injury were rear-ends. Angle crashes comprised nearly 30 percent of crashes, which is not typical at signalized intersections with protected left turn phasing. Three of the nine angle crashes involved red-light running as a contributing factor.

6.4 Bicycle and Pedestrian Crashes

During the 2012 to 2016 analysis period, there were no reported bicycle crashes and four reported pedestrian crashes along the US 29 study corridor. Of the four pedestrian crashes, there was one fatal crash in 2012, one serious injury crash in 2015, and two minor injury crashes in 2013 and 2016. No pedestrian crashes occurred at an intersection.

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 US 29 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	0	9	9
Full Median Crossover	17	52	69
Unsignalized Intersection	15	45	60
Grand Total	**32 (23%)**	**106 (77%)**	**138**

8 Signal Justification Review

An implementation strategy for the Arterial Preservation Program is to eliminate unjustified traffic signals. Signal warrant analyses were conducted at the seven 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.

8.1 MUTCD Signal Warrant Results

Table 11 shows the results of the traffic signal warrant analysis for the existing traffic volumes at the seven emerging intersections. The signal warrant analysis worksheets are provided in **Appendix E**. Based on these results, the existing traffic signal at US 29 BUS at E. Witt Road/Lawless Creek Road should be considered for removal during the alternatives development process.

TABLE 11: SIGNAL WARRANT ANALYSIS RESULTS

Intersection	8-Hour Warrant Met?	4-Hour Warrant Met?	Peak Hour Warrant Met?
US 29 BUS at E. Witt Road/Lawless Creek	**No**	**No**	Yes
US 29 at Malmaison Road	Yes	Yes	Yes
US 29 at Tightsqueeze Road	Yes	Yes	Yes
US 29 at Gladys Rd	Yes	Yes	Yes
US 29 at Colonial Highway	Yes	Yes	Yes
US 29 at Calohan Road	Yes	Yes	Yes
US 29 at English Tavern Road (North)	Yes	Yes	Yes

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. SIDRA Intersection 8.0 was used to analyze roundabout alternatives.

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. SIDRA Intersection 8.0 inputs and analysis methodologies were consistent with the VDOT TOSAM, Version 1.0.

9.1.2 Traffic Analysis Results

The existing conditions traffic analysis results are summarized in the following section. Two measures of effectiveness were selected to measure the quantitative performance of the emerging 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 12** summarizes the LOS criteria as specified in the HCM.

TABLE 12: 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 six signalized intersections in the study area is summarized in **Table 13**. The delay and LOS for all locations, including individual movements, is included in **Appendix F.**

TABLE 13: EXISTING (2018) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1. US 29 BUS at E. Witt Road/Lawless Creek Road	25.5	C	19.2	B
2. US 29 BUS at Malmaison Road	19.8	B	20.6	C
3. US 29 at Tightsqueeze Road	29.0	C	42.3	D
5. US 29 at Colonial Highway	26.1	C	23.8	C
6. US 29 at Calohan Road	25.1	C	24.2	C
7. US 29 at English Tavern Road (North)	24.7	C	22.9	C

Approach delay and LOS, by movement, for the US 29 at Gladys Road unsignalized intersection is summarized in **Table 14**.

TABLE 14: EXISTING (2018) UNSIGNALIZED DELAY AND LOS

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
5. US 29 at Gladys Road	Eastbound	10.1	B	19.2	C
	Westbound	17.9	C	23.9	C

9.1.2.2 Queuing

The results of the existing AM and PM peak hour queuing analysis is summarized in **Appendix F**. The corresponding Synchro output sheets are also provided in **Appendix F** 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 15**.

TABLE 15: EXISTING (2018) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection	Lane Group	Peak Hour
2. US 29 BUS at Malmaison Road	Southbound left	PM
3. US 29 at Tightsqueeze Road	Northbound left	AM
	Southbound left	PM
	Eastbound left/thru/right	AM and PM
5. US 29 at Colonial Highway	Eastbound left/thru	AM
	Westbound left/thru/right	AM and PM
6. US 29 at Calohan Road	Southbound left	PM
7. US 29 at English Tavern Road (North)	Southbound left	PM

9.2 Traffic Forecasting

To understand future traffic conditions 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.

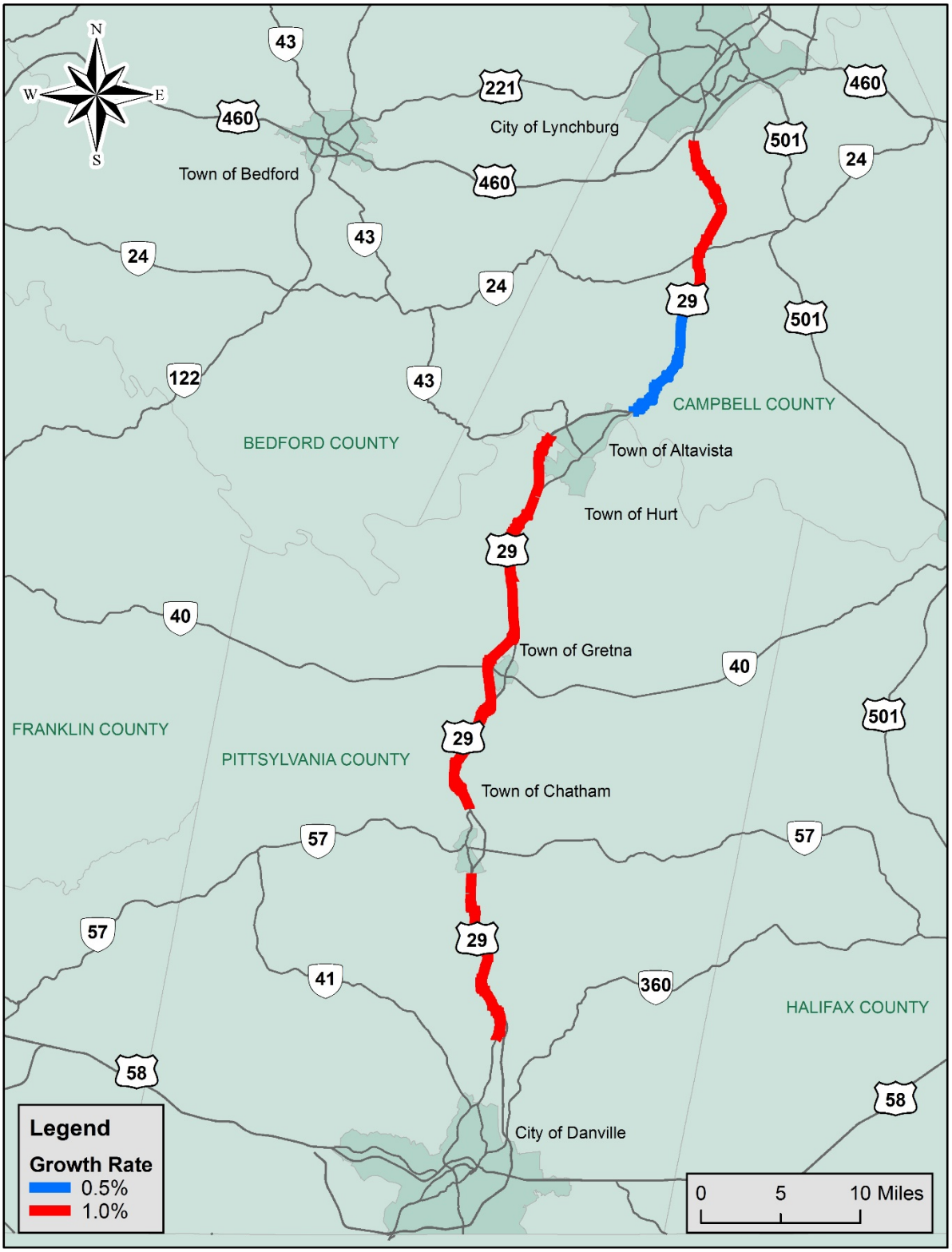
9.2.1 Traffic Growth Rate Development

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 Lynchburg District. 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 rate 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.

FIGURE 6: TRAFFIC GROWTH RATES



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 six signalized intersections in the study area is summarized in **Table 16**.

TABLE 16: NO-BUILD (2040) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1. US 29 BUS at E. Witt Road/Lawless Creek Road	26.4	C	21.3	C
2. US 29 BUS at Malmaison Road	21.6	C	23.5	C
3. US 29 at Tightsqueeze Road	38.3	D	73.1	E
5. US 29 at Colonial Highway	30.3	C	27.6	C
6. US 29 at Calohan Road	33.5	C	31.9	C
7. US 29 at English Tavern Road (North)	44.0	C	32.6	C

Approach delay by movement and LOS for the US 29 at Gladys Road unsignalized intersection is summarized in **Table 17**.

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

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
4. US 29 at Gladys Road	Eastbound	10.4	B	21.5	C
	Westbound	21.2	C	30.2	D

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 18** show the movements where the 95th percentile volumes exceed capacity in the study area.

TABLE 18: NO-BUILD (2040) LANE GROUPS WHERE 95TH PERCENTILE VOLUMES EXCEED CAPACITY

Intersection	Lane Group	Peak Hour
2. US 29 BUS at Malmaison Road	Southbound left	PM
	Westbound left/thru	AM
3. US 29 at Tightsqueeze Road	Northbound left	AM and PM
	Southbound left	PM
	Eastbound left/thru/right	AM and PM
5. US 29 at Colonial Highway	Eastbound left/thru	AM
	Westbound left/thru/right	AM and PM
6. US 29 at Calohan Road	Southbound left	PM
	Westbound right	AM
7. US 29 at English Tavern Road (North)	Southbound left	PM

10 Alternatives Development and Screening

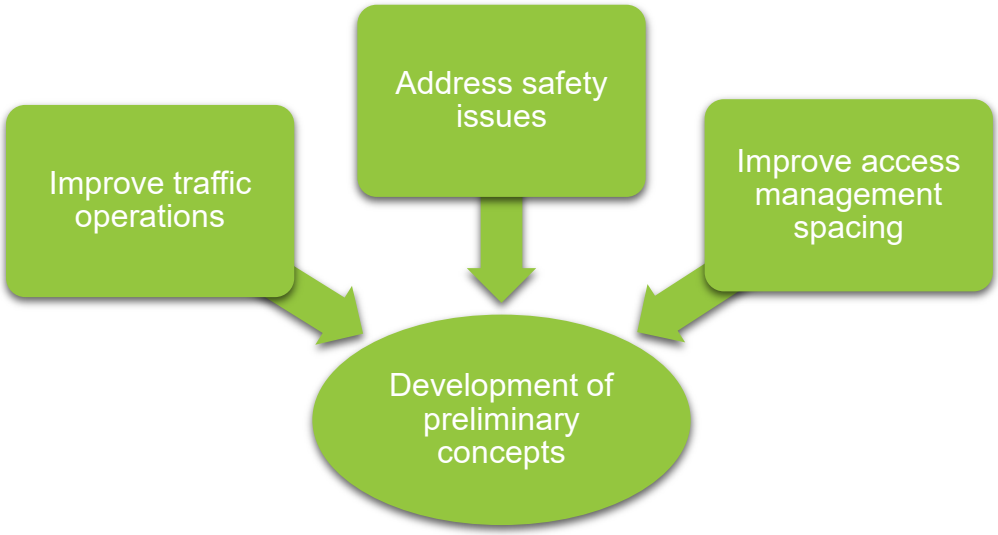
Alternatives for each emerging intersection were developed to address safety, geometric, and operational deficiencies along the study corridor identified in the existing and no-build analyses, as well as during the field review. The alternatives for each emerging intersection consisted of traditional 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 16, 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 **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.

FIGURE 7: CONCEPT DEVELOPMENT CONSIDERATIONS



11 Recommendations

The emerging intersection alternatives considered are presented in **Table 19**, with the preferred intersection alternative shown in bold text. Graphical displays of the preferred intersection alternatives are provided in **Appendix I** along with the planning level cost estimates. The alternatives considered were modeled, analyzed, and discussed in order to select the preferred intersection alternative at each emerging intersection.

In addition to intersection improvements, access management and roadway improvements were proposed along the 50-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**.

Recommendations were reviewed, vetted, and agreed upon by the study team during the alternatives development workshop and subsequent conference calls. Localities, MPOs, and VDOT should consider funding sources such as Revenue Sharing, Congestion Mitigation and Air Quality (CMAQ), Highway Safety Improvement Program (HSIP), and SMART SCALE to advance the recommendations identified in this study.

TABLE 19: EMERGING INTERSECTION ALTERNATIVES

Description	Alternatives Considered
US 29 BUS at E. Witt Road/Lawless Creek Road	Signalized eastbound right turn lane
	Two-way stop control
	RCUT (short-term)
	Hybrid roundabout (long-term)
	Single-lane roundabout
US 29 BUS at Malmaison Road	**Additional westbound left turn lane (short-term)**
	RCUT
	Single-lane roundabout
	Hybrid roundabout (long-term)
US 29 at Fairview Road/Tightsqueeze Road	Additional eastbound left turn lane
	Additional northbound left turn lane
	Additional eastbound left and northbound left turn lanes
	Partial MUT
	RCUT
US 29 at Gladys Road	Continuous Green-T
	RCUT
US 29 at Colonial Highway	Eastbound and westbound left turn lanes with permissive phasing
	Bowtie
	Partial MUT
	Signalized RCUT
US 29 at Calohan Road	Additional westbound right turn lane
	Additional southbound left turn lane
	Additional westbound right and southbound left turn lanes
	Continuous Green-T
	RCUT
US 29 at English Tavern Road (North)	Additional westbound right turn lane
	Additional southbound left turn lane
	Additional westbound right and southbound left turn lanes
	RCUT

US 29 BUS at E. Witt Road/Lawless Creek Road

The preferred short-term 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 three intersections in the RCUT would operate as unsignalized. Removing minor approach left-turn and through movements at the main intersection allows for both directions of US 29 BUS to operate free-flow and reduces conflict points to improve safety.

The preferred long-term alternative at this intersection is to reconfigure the intersection to a hybrid roundabout, which also improves traffic operations and safety. The roundabout option allows for a future road diet along US 29 with pedestrian and bicycle accommodations from E. Witt Road/Lawless Creek Road to Malmaison Road.

US 29 BUS at Malmaison Road

The preferred short-term alternative at this intersection constructs an additional westbound left turn lane on Malmaison Road and install a northbound right turn overlap to improve operations and increase the intersection capacity. The existing signal timings will be optimized to account for the new lane configuration on the minor approach.

The preferred long-term alternative at this intersection is to reconfigure the intersection to a hybrid roundabout, which also improves traffic operations and safety. The roundabout option allows for a future road diet along US 29 with pedestrian and bicycle accommodations from E. Witt Road/Lawless Creek Road to Malmaison Road.

US 29 at Tightsqueeze Road

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. The southern and northern median crossover locations will operate with two-phase signals, which control the U-turn and opposing through movements. Removing the left-turn and through movements from the side street at the main intersection is expected to reduce delays and improve safety at the intersection. Access is proposed to be consolidated at some existing driveway entrances to improve safety.

US 29 at Gladys Road

The preferred alternative at this intersection converts the existing unsignalized intersection to an RCUT intersection. 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. Further review is necessary to determine if lighting is warranted at this intersection.

US 29 and Colonial Highway

The preferred alternative at this intersection converts the existing conventional signalized intersection to a bowtie intersection. Left turns are restricted from all approaches at the main intersection and vehicles must instead use roundabouts on Colonial Highway to complete left-turn movements. Removing left-turns from the main intersection allows the intersection to operate with two-phase signal control, increasing green time on US 29 and reducing delay for mainline through vehicles. The roundabouts are designed to accommodate large trucks and are spaced to provide adequate queue storage.

US 29 at Calohan Road

The preferred alternative at this intersection converts the existing conventional intersection to an RCUT intersection. Removing the left-turn and through movements from the side street at the main intersection is expected to reduce delays and improve safety at the intersection. The norther median crossover location will be operated by a two-phase signal which controls the northbound U-turn and southbound through movements. The southern median crossover will remain unsignalized. Further study is needed to identify any access management improvements necessary on Calohan Road east of the intersection.

US 29 at English Tavern Road (North)

The preferred alternative at this intersection converts the existing conventional signalized intersection to an RCUT intersection. Removing left-turn and through movements from the side street is projected to reduce delays and improve safety. The northern median crossover location will be operated by a two-phase signal which controls the northbound U-turn and southbound through movements. The southern median crossover will remain unsignalized.

11.1 Build Conditions Traffic Analysis

Build traffic conditions were analyzed to evaluate the results of future (2040) traffic demand under the preferred 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 and help inform the conceptual design. 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 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 20**.

TABLE 20: 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 21**. The delay and LOS for all locations, including individual movements and long-term alternatives, is included in **Appendix K**.

TABLE 21: BUILD (2040) SIGNALIZED DELAY AND LOS

Signalized Intersection	AM Peak Hour		PM Peak Hour	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
2. US 29 BUS at Malmaison Road (Additional westbound left turn lane)	18.5	B	20.1	C
3. US 29 at Tightsqueeze Road (RCUT)	19.3	B	25.0	C
5. US 29 at Colonial Highway (Bowtie)	16.1	B	16.0	B
6. US 29 at Calohan Road (RCUT)	16.7	B	15.8	B
7. US 29 at English Tavern Road (North) (RCUT)	26.2	C	12.2	B

Approach delay by movement and LOS for the unsignalized intersections is summarized in **Table 22**.

TABLE 22: BUILD (2040) UNSIGNALIZED DELAY AND LOS

Unsignalized Intersection		AM Peak Hour		PM Peak Hour	
	Approach	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
1. US 29 BUS at E. Witt Road/Lawless Creek Road (Short Term - RCUT)	Eastbound	47.1	D	35.6	D
	Westbound	35.4	D	30.9	C
4. US 29 at Gladys Road (RCUT)	Eastbound	10.7	B	29.0	C
	Westbound	27.5	C	35.7	D

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.