US 460/US 19 Corridor Study

Final Report

STARS VDOT

US 460/US 19 Corridor Study

US 460 from US 460 BUS to US 19;

US 460/US 19 from US 460 to Route 637

Final Report

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Table of Contents

Figures

Tables

1 INTRODUCTION

1.1 Background

The Virginia Department of Transportation (VDOT) Bristol District, VDOT Transportation Mobility and Planning Division (TMPD) and Tazewell County, Virginia identified the need to evaluate existing and future conditions for the US 460 / US 19 corridor. This STARS corridor study focuses on evaluating US 460 from US 460 BUS to US 19 and US 460/US 19 from US 460 to Route 637, assessing measures to reduce congestion, and recommending possible spot improvements to address congestion, access management and safety issues.

US 460 is considered a north-south route while US 19 a east-west in this study. Both corridors are four-lane divided highways and are major arteries in the State of Virginia. These corridors function as important routes connecting Interstate 77, Tazewell County and numerous towns and localities. A high number of crashes and several access management issues are noted on the US 460 / US 19 corridors. Both corridors experience moderate congestion during peak hours. Access management and crash reduction/safety improvement are noted as key concerns along the corridors. With new development being planned and proposed along these corridors, it is important to establish guidance to address the long-term goals for the corridor.

1.2 Purpose of Study

The primary goal of this study is to determine and assess measures to reduce congestion, recommend possible adjustments to signal phasing and/or spot improvements to alleviate congestion and address safety as well as access management issues.

The ***operational*** issues intended to be addressed by this study include existing and future projected congestion within the corridor. This congestion is centered at the major intersections within the corridor, which are currently heavily utilized by passenger cars and truck traffic. Reduction in intersection delays would mitigate congestion, improve mobility and reduce travel time.

This study also intends to address existing and future ***safety*** concerns within the study corridor.

US 460 / US 19 serves a mix of commercial, retail and residential uses. This study also intends to address numerous potential ***access*** improvements within the limits of the study corridor by identifying and documenting driveway locations and their spacing, with the objective of recommending access management improvements in the context of *VDOT Access Management Standards for Entrances and Intersections.*

1.3 Study Work Group

The Study Work Group (SWG) was formed to include local stakeholders, who provide local and institutional knowledge of the corridor, review study goals and methodologies, provide input on key assumptions and review and approve proposed improvement concepts developed through the study process. The key members included in the SWG represent the following Agencies:

- VDOT Bristol District Office
- Tazewell County
- Town of Richlands
- WSP Team

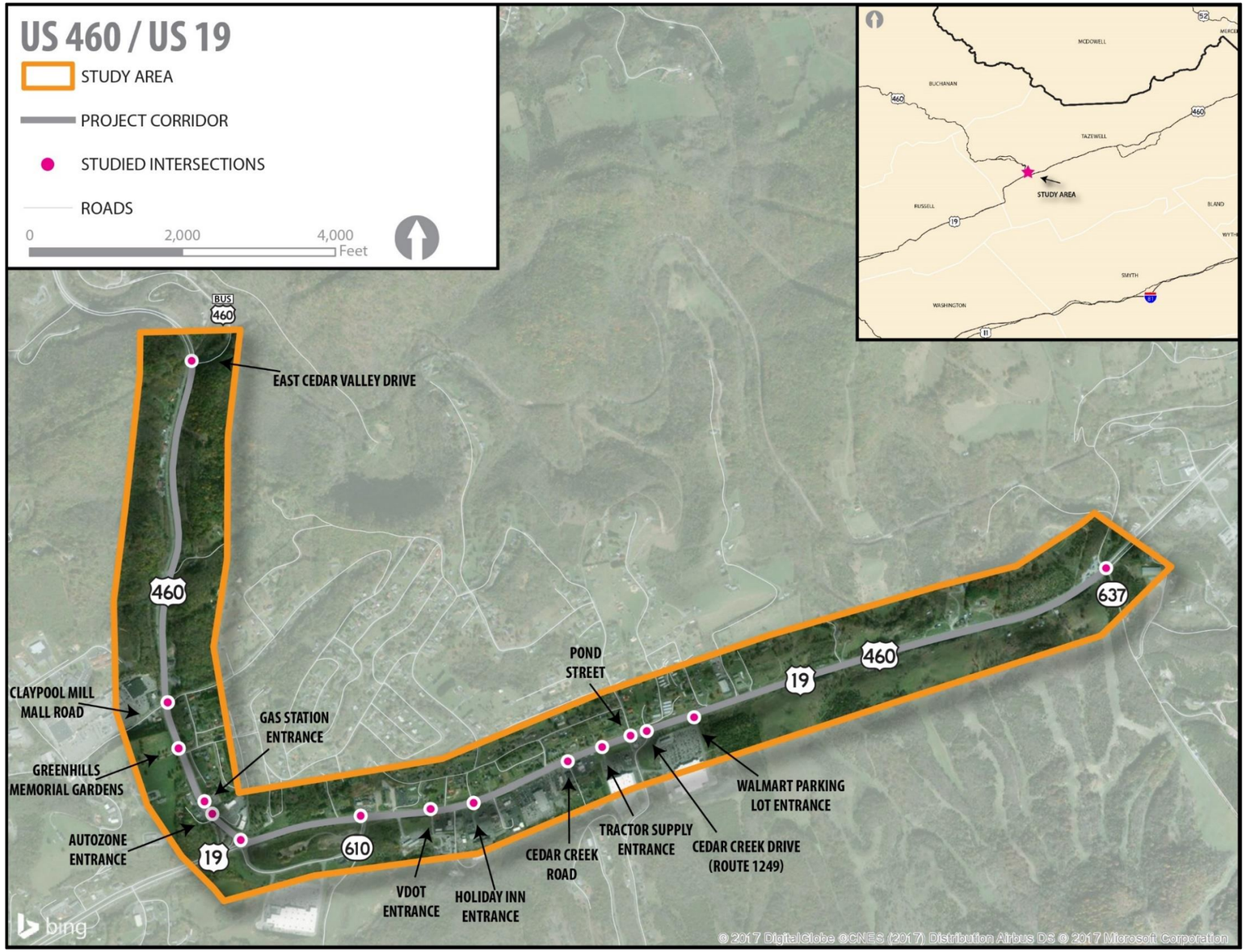
1.4 Study Area

The corridors to be studied are approximately 4.4 miles in total length that include fifteen (15) study intersections. These study intersections are listed below and shown in **Figure 1**.

Study Area Intersections

1. US 460 and Cedar Valley Drive
2. US 460 and Claypool Hill Mall Road
3. US 460 and Greenhills Memorial Garden Entrance
4. US 460 and Gas Station Entrance
5. US 460 and Autozone Entrance
6. US 460 and US 460/US 19
7. US 460/US 19 and Route 610
8. US 460/US 19 and VDOT AHQ
9. US 460/US 19 and Holiday Inn Entrance (VFW Road)
10. US 460/US 19 and Pond Street
11. US 460/US 19 and Cedar Creek Road
12. US 460/US 19 and Tractor Supply Entrance
13. US 460/US 19 and Route 1249
14. US 460/US 19 and Walmart Parking Lot
15. US 460/US 19 and Pounding Mill Branch Road

Figure 1. Study Area Map



2 Existing Conditions

2.1 Existing Land Use

Land use in the immediate vicinity of the study corridor of US 460 from US 460 BUS to US 19 and US 19 / US 460 from US 460 to Route 637 consists primarily of commercial and retail properties, light industrial uses, and to a lesser extent, residential properties. These parcels generate a mixture of trips involving passenger vehicles, heavy vehicles, and tractor trailers.

2.2 Existing Roadway Network

An inventory of the existing roadway condition was prepared along US 460 / US 19, based on field reviews. Traffic, crash and Geographic Information System (GIS) data was used to document existing conditions. During the field review, the following data was collected and documented:

- Digital photographs, videos, and observation to capture:
  - Roadway geometry to include lane configuration, lane/shoulder widths
  - Signs and pavement markings
  - Posted speed limits
  - Sight distance issues
  - Safety concerns
  - Existing driveway locations, their spacing and potential impact on crashes
  - Observation of traffic operations (traffic mix, congestion, driver behavior)
  - Inventory of existing roadway conditions to determine potential for safety improvements
  - Inventory of intersection operations (signal phasing, queuing)

The study corridor includes seven (7) signalized and seven (7) unsignalized intersections as discussed in **Sections 2.2.1** through **2.2.16** below:

2.2.1 US 460 / US 19 Corridor

US 460 from US 460 BUS to US 19 to US 460 / US 19 from US 460 to Route 637 is classified as Other Principal Arterial per *VDOT Functional Classification*. Within the study area, both corridors are 4-lane divided roadways. The posted speed limit is 45 miles per hour along the corridor until just east of the Walmart Entrance where the speed limit turns to 55 miles per hour. Pedestrian facilities and dedicated bike facilities are not present along the corridor.

2.2.2 Intersection A: US 460 at E Cedar Valley Drive (US 460 BUS)

E Cedar Valley Drive is classified as Minor Arterial per *VDOT Functional Classification.* The intersection of US 460 at E Cedar Valley Drive is a 3-leg T-signalized intersection. The posted speed limit for E Cedar Valley Drive is 35 miles per hour. The northbound approach of US 460 has two through lanes and one right-turn lane. The southbound approach has one left-turn lane and two through lanes. The westbound approach of E Cedar Valley Drive has one left-turn lane and one right-turn lane. The signal operations include protected left turns for the southbound approach. Pedestrian facilities (crosswalks, pedestrian signals) are not currently present at this intersection. **Figure 2** shows an aerial of the intersection.

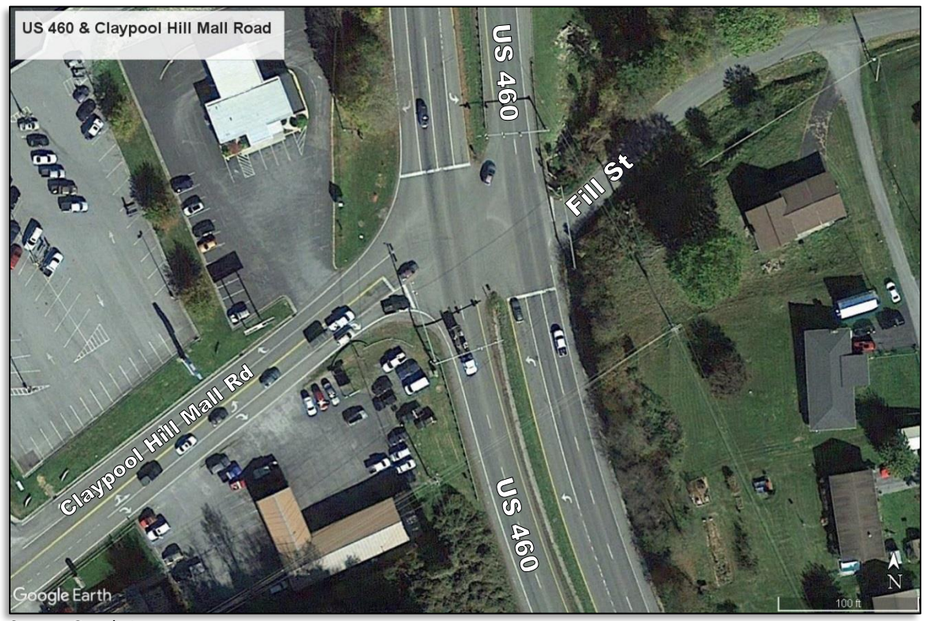
Figure 2: US 460 at E Cedar Valley Drive

Source: Google Imagery

2.2.3 Intersection B: US 460 at Claypool Hill Mall Road (Route 719)

Claypool Hill Mall Road is classified as a Minor Collector per *VDOT Functional Classification.* The intersection of US 460 at Claypool Hill Mall Road is a 4-leg signalized intersection. The posted speed limit along the west leg of Claypool Hill Mall Road is 35 miles per hour and 25 miles per hour along the east leg of Fill Street. The northbound approach of US 460 has one left-turn lane, one through lane, and one shared thru+right lane. The southbound approach has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Claypool Hill Mall Road has shared left-thru lane and one right-turn lane. The westbound approach of Fill Street has one shared left-thru-right lane. The signal operations include protected left-turns for the northbound and southbound approaches and split phase for the eastbound and westbound approaches. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 3** shows an aerial of the intersection.

Figure 3: US 460 at Claypool Hill Mall Road

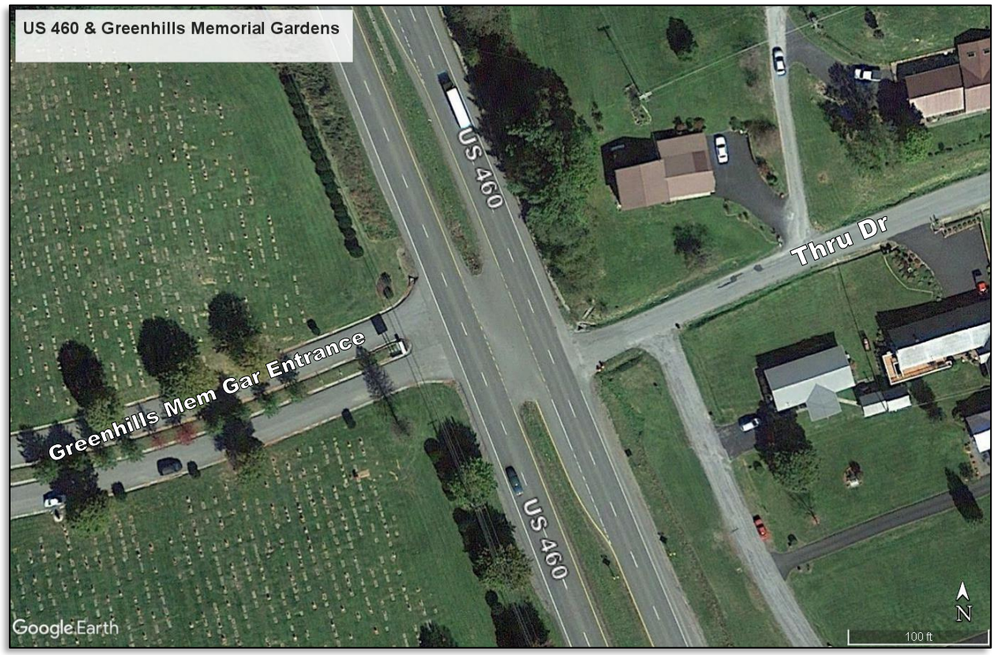


Source: Google Imagery

2.2.4 Intersection C: US 460 at Greenhills Memorial Gardens Entrance

The intersection of US 460 at Greenhills Memorial Gardens Entrance is currently a 4-leg unsignalized intersection. The northbound and southbound movements are free-flow. Posted speed limit was not observed along Thru Drive. The northbound approach of US 460 has one left-turn lane, one through lane, and one shared thru-right lane. The southbound approach has one shared left-thru lane and one shared thru-right lane. The westbound approach of Greenhills Memorial Gardens Entrance has one shared left-thru-right lane. The fourth leg eastbound approach of Thru Drive has one shared left-thru-right lane. No pedestrian facilities (crosswalks, pedestrian signals) are currently present at this intersection. **Figure 4** shows an aerial of the intersection.

Figure 4: US 460 at Greenhills Memorial Gardens Entrance

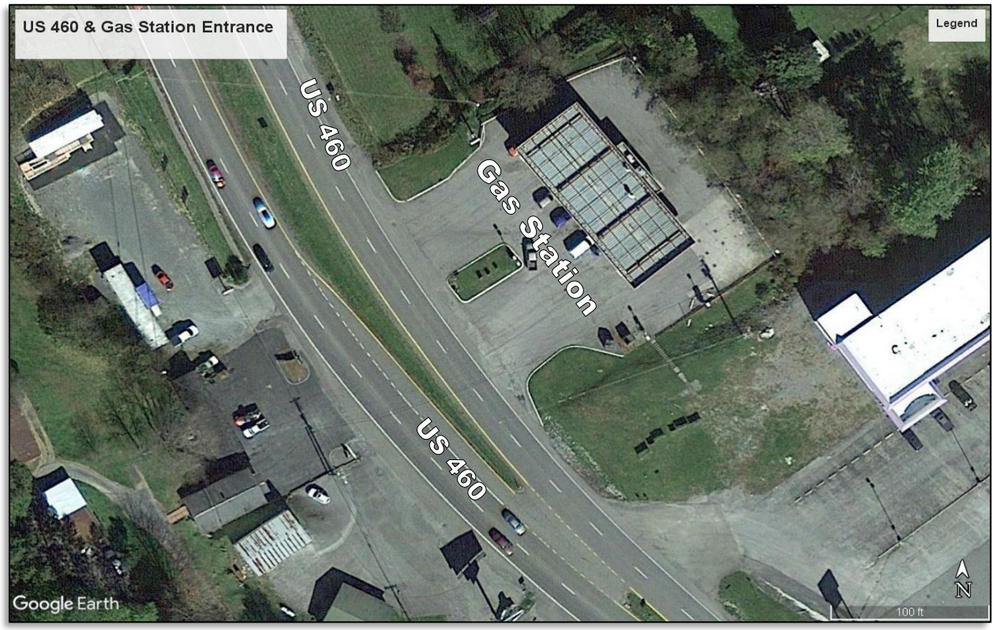


Source: Google Imagery

2.2.5 Intersection D: US 460 at Gas Station Entrance

The intersection of US 460 at Gas Station Entrance is currently a unsignalized right-in/right-out intersection, with the gas station having separate entrance and exit driveways. The northbound approach of US 460 has one through lane and one shared thru-right lane. The southbound approach does not have an entrance into the gas station due to the grass median. The westbound approach of the gas station entrance has one driveway for entrance and one for the exit. No pedestrian facilities (crosswalks, pedestrian signals) are currently present at this intersection. **Figure 5** shows an aerial of the intersection.

Figure 5: US 460 at Gas Station Entrance

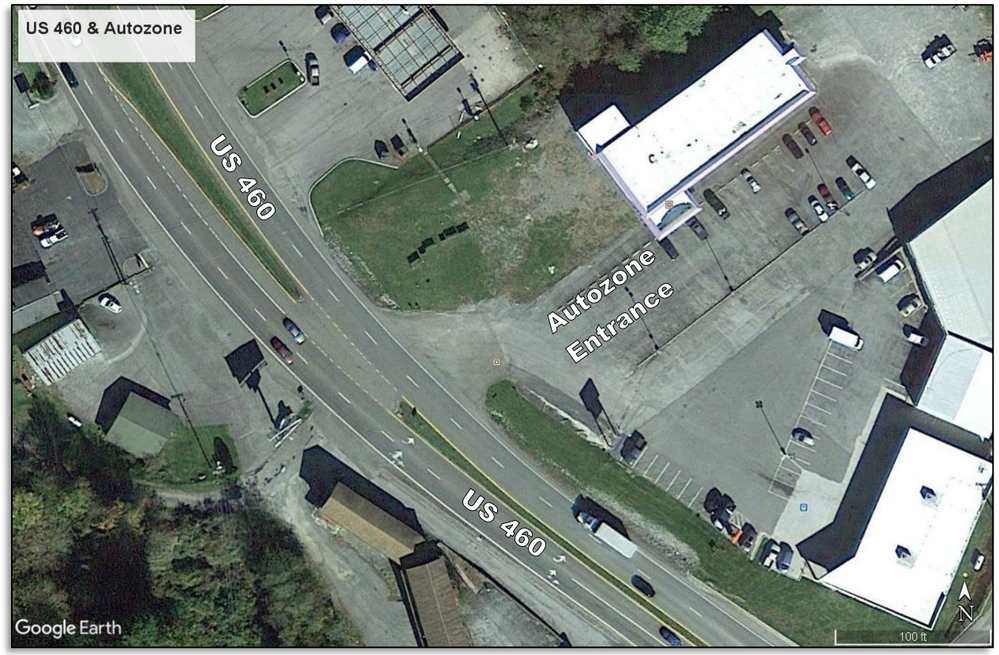


Source: Google Imagery

2.2.6 Intersection E: US 460 at Autozone Entrance

The intersection of US 460 at Autozone Entrance is currently a 3-leg unsignalized T-intersection at a median opening along US 460. The northbound and southbound approaches of US 460 are free-flow, while the westbound Autozone Entrance is stop-controlled. The northbound approach of US 460 has one through lane and one shared thru-right lane. The southbound approach has a shared U-turn-left-thru lane and two through lanes. The westbound approach of the Autozone Entrance has one shared left-right lane. No pedestrian facilities (crosswalks, pedestrian signals) are currently present at this intersection. **Figure 6** shows an aerial of the intersection.

Figure 6: US 460 at Autozone Entrance

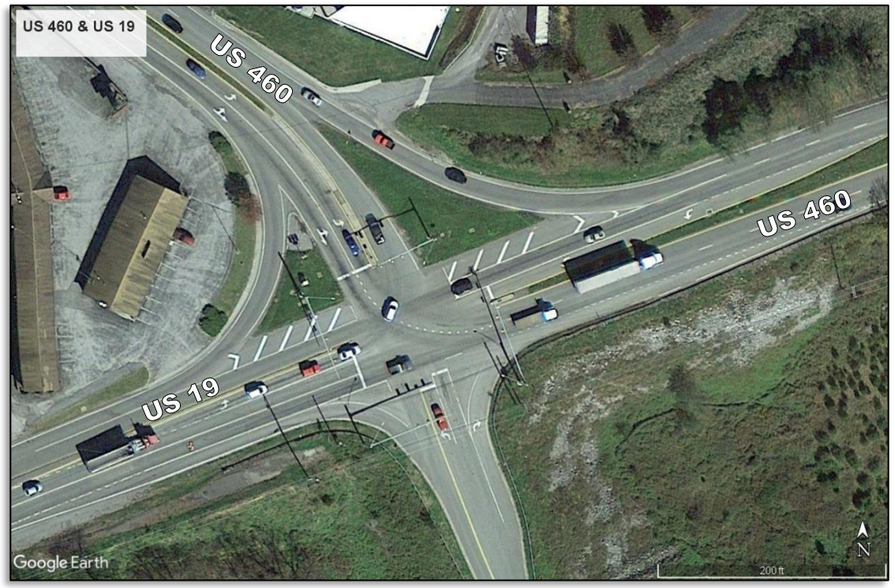


Source: Google Imagery

2.2.7 Intersection F: US 460 at US 460/US 19

US 19 is classified as Other Principal Arterial per *VDOT Functional Classification.* The intersection of US 460 at US 19 is currently a 4-leg signalized intersection. The posted speed limit for US 19 is 45 miles per hour. The northbound approach of US 460 has one left-turn lane, one through lane, and one right-turn lane. The southbound approach has one left-turn lane, one shared left-thru lane, and one channelized right-turn lane. The eastbound approach of US 19 has one left-turn lane, two through lanes, and one channelized right-turn lane. The westbound approach has one left-turn lane, one through lane, and one channelized right-turn lane. The signal operations include protected left turns for the eastbound and westbound approaches and split phasing for northbound and southbound. Pedestrian facilities (crosswalks, pedestrian signals) are not currently provided at this intersection. **Figure 7** shows an aerial of the intersection.

Figure 7: US 460 at US 19

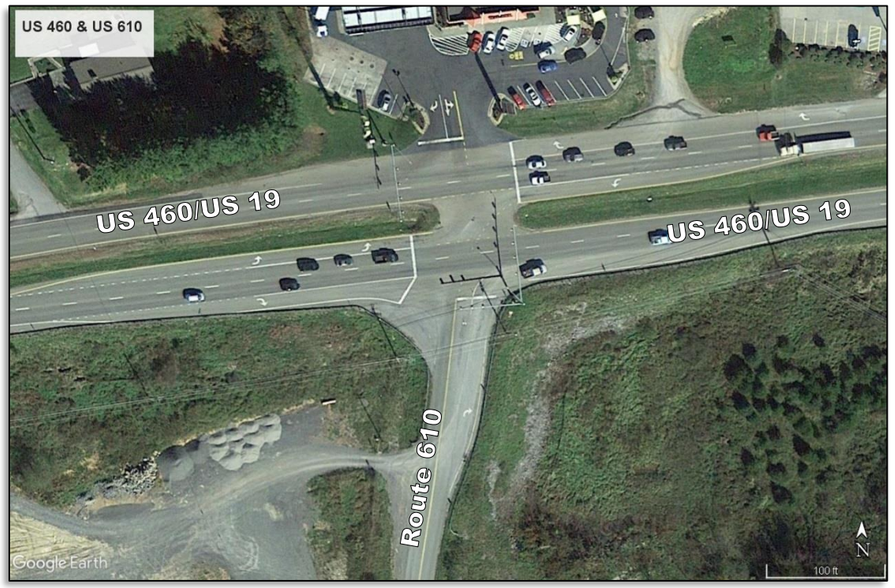


Source: Google Imagery

2.2.8 Intersection G: US 460/US 19 at Route 610

The intersection of US 460/US 19 at Route 610 is currently a 4-leg signalized intersection. The posted speed limit for Route 610 is 35 miles per hour. The northbound approach of Route 610 has one free-flowing right-turn lane with a receiving lane along east leg. The southbound approach, which primarily serves McDonald's restaurant has one shared left-thru lane and one right-turn lane. The eastbound approach of US 460/US 19 has one left-turn lane, two through lanes, and one right-turn lane. The westbound approach has one left-turn lane, two through lanes, and one right-turn lane. The signal operations include eastbound and westbound protected left-turn movements. Pedestrian facilities (crosswalks, pedestrian signals) are not provided for this intersection. **Figure 8** shows an aerial of the intersection.

Figure 8: US 460/US 19 at Route 610



Source: Google Imagery

2.2.9 Intersection H: US 460/US 19 at VDOT Area HQ Entrance

The intersection of US 460/US 19 at VDOT Area HQ Entrance is currently a 3-leg unsignalized intersection at a median opening along US 460/US 19. The eastbound and westbound directions are free-flow. The northbound approach of the VDOT Area HQ Entrance is a shared left-right lane. The eastbound approach of US 460/US 19 has a left-turn lane, a through lane, and a shared thru-right lane. The westbound approach has one left-turn lane and two through lanes. Pedestrian facilities (crosswalks, pedestrian signals) are not currently provided at this intersection. **Figure 9** shows an aerial of the intersection.

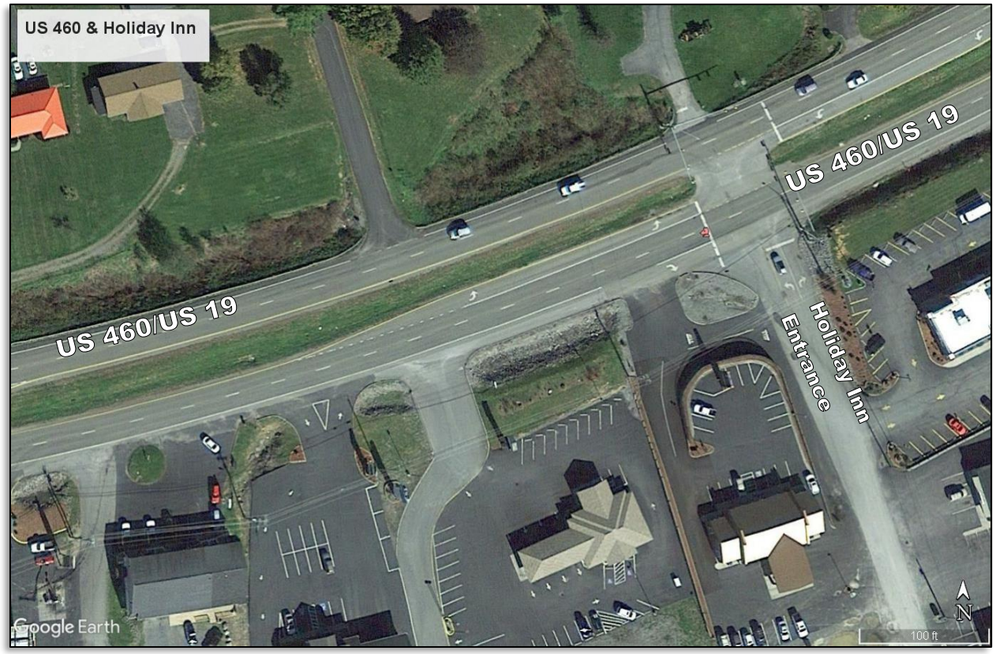
Figure 9: US 460/US 19 at VDOT Area HQ Entrance

Source: Google Imagery

2.2.10 Intersection I: US 460/US 19 at Holiday Inn Entrance (Clay Drive)

The intersection of US 460/US 19 at Holiday Inn Entrance is currently a 4-leg signalized intersection. The northbound approach of Holiday Inn Entrance (Clay Drive) has one left-turn lane and one right-turn lane. The southbound approach of the private driveway has one shared left-thru-right lane and is signalized. The eastbound approach of US 460/US 19 has one left-turn lane, two through lanes, and one right-turn lane. The westbound approach has one left-turn lane, one through lane, and one shared thru-right lane. The signal operations include protected lefts for the eastbound and westbound approaches. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided for this intersection. **Figure 10** shows an aerial of the intersection.

Figure 10: US 460/US 19 at Holiday Inn Entrance



Source: Google Imagery

2.2.11 Intersection J: US 460/US 19 at Cedar Creek Road

The intersection of US 460/US 19 at Cedar Creek Road is currently a 3-leg unsignalized intersection with a median opening along US 460/US 19. There is no posted speed limit along Cedar Creek Road. The northbound approach of Cedar Creek Road has one shared left-right lane. The eastbound approach of US 460/US 19 has one U-turn lane, one through lane, and one shared thru-right lane. The westbound approach has one left-turn lane and two through lanes. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided for this intersection. **Figure 11** shows an aerial of the intersection.

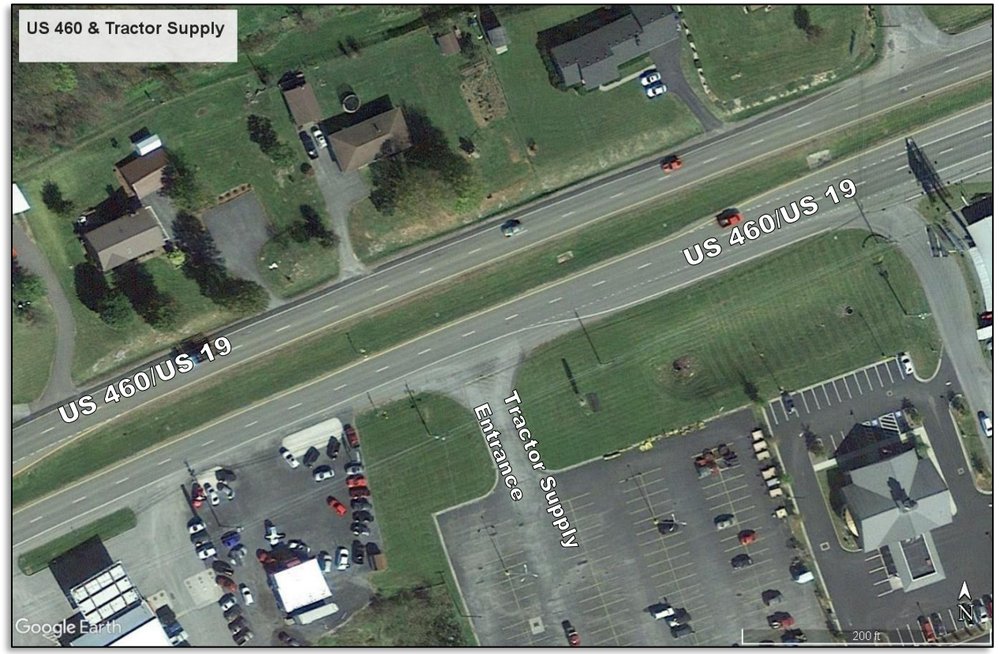
Figure 11: US 460/US 19 at Cedar Creek Road

Source: Google Imagery

2.2.12 Intersection K: US 460/US 19 at Tractor Supply Entrance

The intersection of US 460/US 19 at Tractor Supply Entrance is currently a 2-leg right -in/right-out unsignalized intersection. The northbound approach of Tractor Supply Entrance is a right-in/right-out stop controlled entrance, while the eastbound approach of US 460 is free-flow. The eastbound approach of US 460/US 19 has one through lane and one shared thru-right lane. Pedestrian facilities (crosswalks, pedestrian signals) are not currently provided at this intersection. **Figure 12** shows an aerial of the intersection.

Figure 12: US 460/US 19 at Tractor Supply Entrance

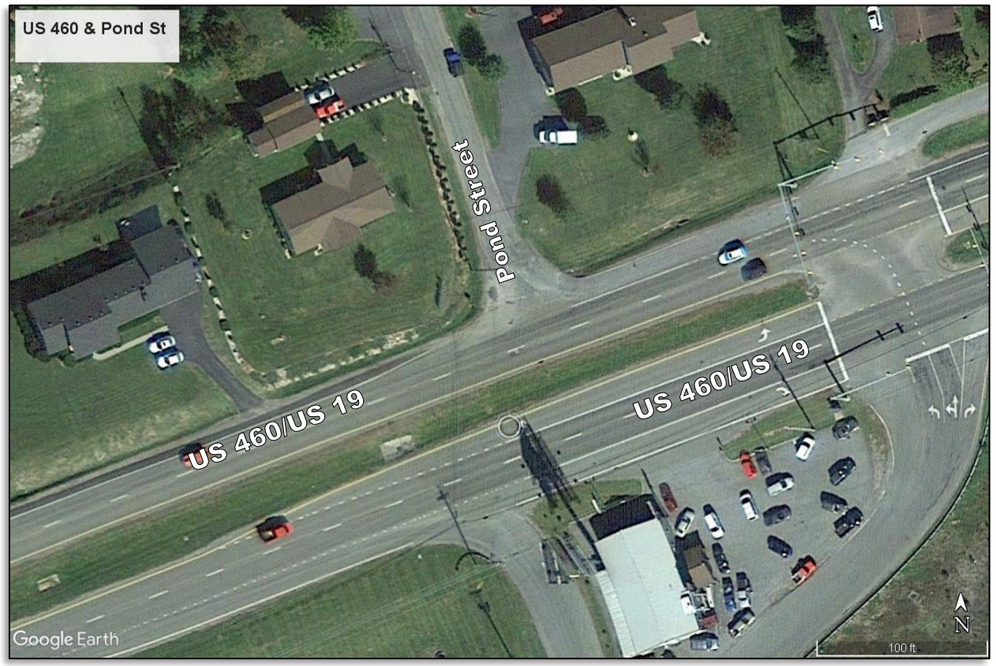


Source: Google Imagery

2.2.13 Intersection L: US 460/US 19 at Pond Street

The intersection of US 460/US 19 at Pond Street is currently a 2-leg right in/right out unsignalized intersection. There is no posted speed limit along Pond Street. The southbound approach of Pond Street is a right in/right out stop controlled entrance, while the westbound approach of US 460/US 19 is free-flow. The eastbound approach of US 460/US 19 has one shared thru-right lane and one through lane. Pedestrian facilities (crosswalks, pedestrian signals) are not currently provided at this intersection. **Figure 13** shows an aerial of the intersection.

Figure 13: US 460/US 19 at Pond Street

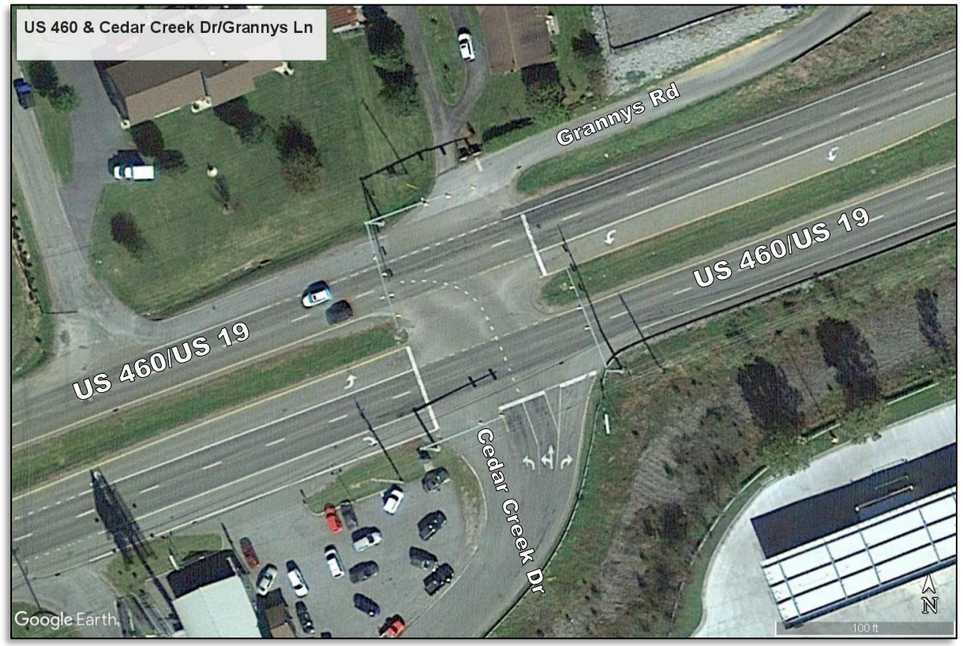


Source: Google Imagery

2.2.14 Intersection M: US 460/US 19 at Route 1249 (Cedar Creek Drive)/Granny's Road

The intersection of US 460/US 19 at Route 1249 (Cedar Creek Drive) is currently a 4-leg signalized intersection. There is no posted speed limit along Route 1249. The northbound approach of Route 1249 has one left-turn lane, one shared left-thru lane, and one right-turn lane. The southbound approach of Granny's Road has one shared left-thru-right lane. The eastbound approach of US 460/US 19 has one left-turn lane, two through lanes, and one right-turn lane. The westbound approach has one left-turn lane, one through lane, and one shared thru-right lane. The signal operations include protected left-turns for eastbound and westbound approaches and permitted lefts for northbound and southbound approaches. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 14** shows an aerial of the intersection.

Figure 14: US 460/US 19 at Route 1249 (Cedar Creek Drive)

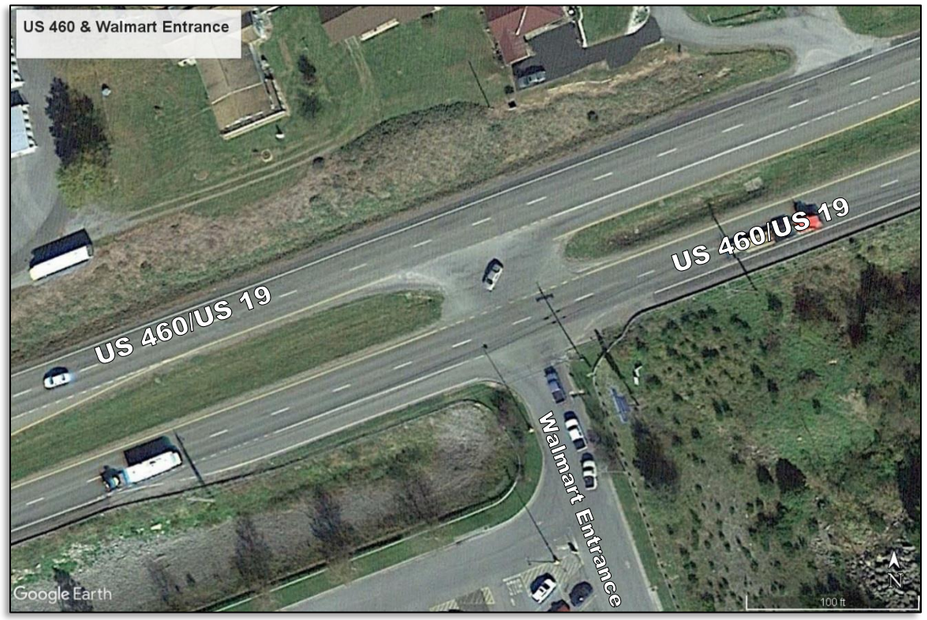


Source: Google Imagery

2.2.15 Intersection N: US 460/US 19 at Walmart Entrance

The intersection of US 460/US 19 at Walmart Entrance is currently an unsignalized T-intersection with a median opening along US 460/US 19. The northbound approach of Walmart Entrance has one shared left-right lane. The eastbound approach of US 460/US 19 has two through lanes and one right-turn lane. The westbound approach has one left-turn lane and two through lanes. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided for this intersection. **Figure 15** shows an aerial of the intersection.

Figure 15: US 460/US 19 at Walmart Entrance



Source: Google Imagery

2.2.16 Intersection O: US 460/US 19 at Route 637 (Pounding Mill Branch Rd)

Route 637 (Pounding Mill Branch Rd) is classified as a Minor Collector per the *VDOT Functional Classification.* The intersection of US 460/US 19 at Route 637 is currently a 4-leg unsignalized intersection. The eastbound and westbound movements are free-flow. Route 637 is referred to as Pounding Mill Branch Rd south of US 460/US 19 and Limestone Rd north of US 460/US 19. The posted speed limit for northbound Pounding Mill Branch Rd is 40 miles per hour and the speed limit for southbound Limestone Rd is 35 miles per hour. The northbound approach of Pounding Mill Branch Rd has one shared left-thru-right lane. The southbound approach has one shared left-thru-right lane. The eastbound approach of US 460/US 19 has one left-turn lane, two through lanes, and one right-turn lane. The westbound approach has one left-turn lane, one through lane, one shared thru-right lane. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 16** shows an aerial of the intersection.

Figure 16: US 460/US 19 at Route 637 (Pounding Mill Branch Rd)

Source: Google Imagery

2.3 Traffic Data

2.3.1 2017 Existing Traffic Volumes

Existing traffic volume data along the study corridor was collected in October, 2017 while schools were in session:

- 24-hour classification counts were collected on October 4, October 5, and October 11, 2017 at the following locations:
  - US 460 just north of Cedar Valley Drive intersection
  - US 19 just west of Cordelia Street
  - US 19 just east of Route 637 intersection

- AM and PM peak period turning movement counts were collected on October 4 and October 5, 2017 from 7:00 am – 9:00 am and 3:30 pm – 5:30 pm at the following intersections:
  - US 460 / E Cedar Valley Dr
  - US 460 / Claypool Hill Mall Rd (Route 719)
  - US 460 / Greenhills Memorial Gardens / Thru St
  - US 460 / US 19
  - US 460 / Route 610
  - US 460 / Route 1249
  - US 460 / Route 637 (Pounding Mill Branch Rd)
  - Holiday Inn – New Peoples Branch Entrance
  - Cedar Creek Rd / Taco Bell / Shoe Dept
  - Auto Zone / Cargo Gas
  - Walmart Entrance
  - Tractor Supply
  - VDOT Area HQ

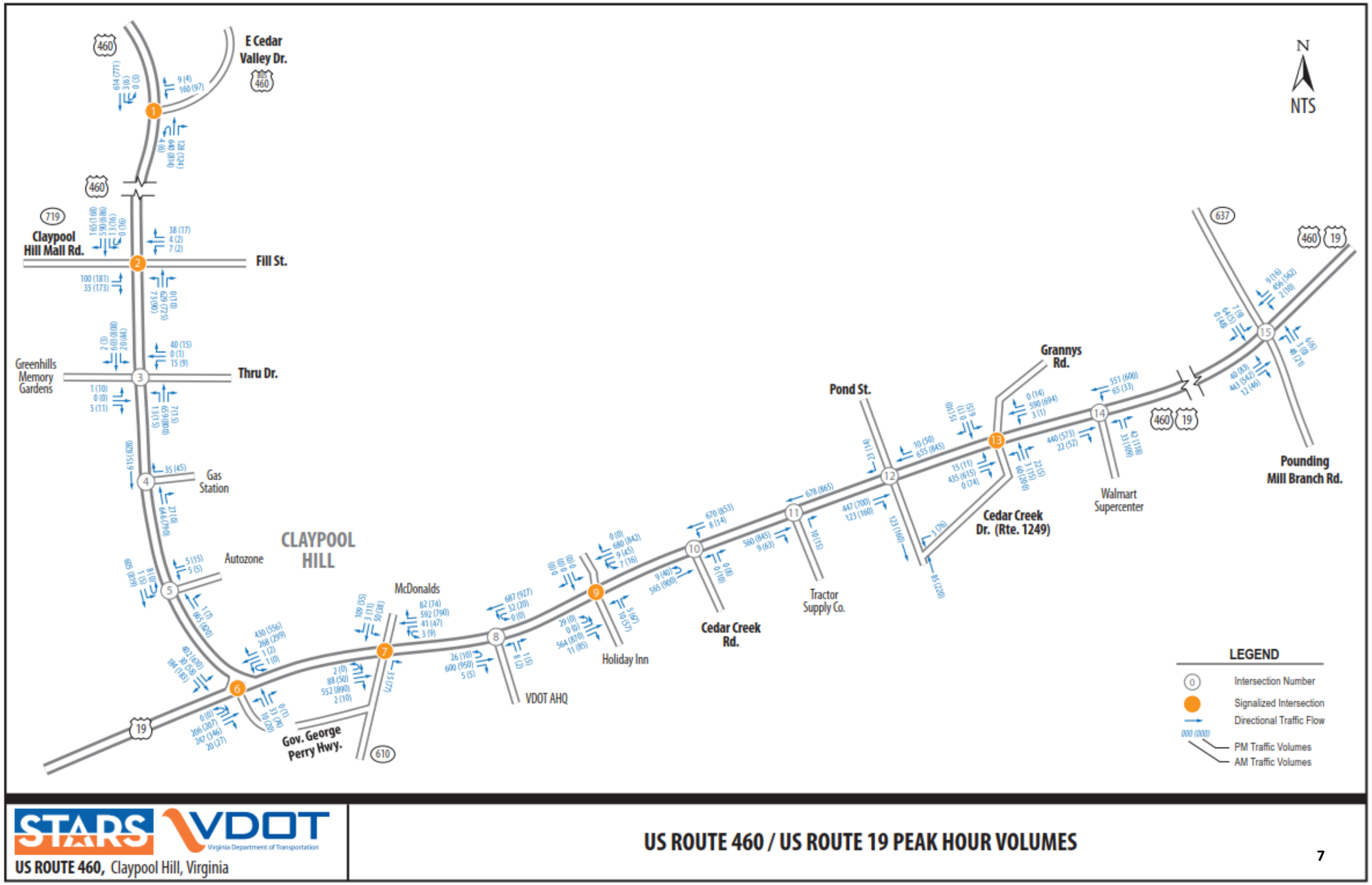
The field counts are enclosed with this report in **Appendix**. The existing (2017) peak hour volumes and Average Daily Traffic (ADT) volumes are summarized in **Figure 17**.

2.3.2 Additional Data

In addition to traffic volumes, following supplemental data was collected to support this study:

- Travel time runs along north-south US 460 and east-west US 460 / US 19 to be used in the calibration of the existing Synchro models were collected when counts were performed on October 4 and October 5, 2017 from 7:00 am – 9:00 am and 3:30 pm – 5:30 pm.
- Crash Data from the last five years to perform the crash analysis.
- Signal timing data from Tazewell County for input into the Synchro analysis models.

Figure 17. Existing (2017) Peak Hour Volumes



STARS VDOT Virginia Department of Transportation

US ROUTE 460, Claypool Hill, Virginia

US ROUTE 460 / US ROUTE 19 PEAK HOUR VOLUMES

7

2.3.3 Existing Access Management

An evaluation of the existing driveways and access points along the study area corridor was completed to assess compliance with *VDOT Access Management Design Standards for Entrances and Intersections,* which is included as *Appendix F* of the *VDOT Roadway Design Manual*. The assessment involved analysis of existing spacing of driveways and intersections and compliance with VDOT minimum spacing standards for commercial entrances, intersections and median crossovers. **Table 1** provides a summary of the minimum spacing requirements for a Principal Arterial for various speed limits.

Table 1. Minimum Spacing Standards for Commercial Entrances, Intersections, and Median Crossovers

Highway Functional Classification	Minimum Centerline to Centerline Spacing (Feet)				
	Legal Speed Limit (mph)	Spacing between Signalized Intersections	Spacing between Unsignalized Intersections and Full/Directional Median Crossovers and Other Intersections or Median Crossovers	Spacing between Full Access Entrances and Other Full Access Entrances, Intersections, or Median Crossovers	Spacing between Partial Access Entrances (one or two-way) and Other Entrances, Intersections, or Median Crossovers
Principal Arterial	35 to 45	1,320	1,050	565	305
	≥ 50	2,640	1,320	750	495

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

A total of 94 access points are located within the study corridor of US 460 from US 460 BUS and US 19 and US 19 / US 460 from US 460 to Route 637. The speed limit increases from 45 mph to 55 mph east of the Walmart Entrance. Most of these access points are closely spaced and serve commercial and retail parcels, with a large percentage serving residential parcels. Many businesses have multiple entrances serving their property, creating safety concerns around these areas. These access points are shown graphically in the **Appendix** and identified as **AP1** through **AP94**. The spacing of these points was analyzed to assess their compliance with the VDOT minimum spacing standards shown in **Table 1**. **Table 2** below identifies the access points that do not meet the minimum spacing standard; as well as those that are compliant with the spacing standard.

Table 2. Access Points Analysis for US 460/US 19

Roadway	Number of Access Points	Per VDOT Spacing Guidelines	
		Compliant	Non-Compliant
US 460/US 19	94	9 Total: AP1, AP2, AP11, AP12, AP 19, AP 20, AP 33, AP 37, AP78*	85 Total: AP3 through AP10, AP 13 through AP 18, AP21 through AP32, AP34 through AP36, AP38 though AP77*, AP79 through AP82, AP83*, AP84 through AP86, AP87*, AP88, AP89*, AP90, AP91, AP92*, AP93, AP94

Note: Refer to the Appendix for graphical presentation of access points.
Note: An asterisk (*) refers to an entrance that is already in existence but has no development currently utilizing the entrance.

Along US 460/US 19, the spacing standards are not satisfied for 85 out of the 94 access point locations involving full/partial access driveways, entrances, median crossovers and intersections. The area serves suburban land uses, with significant development along both sides of the roadway. Application of access management practices would benefit corridor operations by reducing conflict points along the corridor and several access management projects are currently in the process of being completed by the County.

3 Traffic Operational Analysis

3.1 Analysis Peak Periods

Weekday peak periods were identified from the count data for the arterial segments and for each study intersection. The overall AM and PM peak hours for the network were determined based on the highest volume of traffic in a one hour period, travel patterns along the study corridor and percentage of traffic during the highest hour. Based upon a review of the traffic count data at individual intersections and individual peak hours at these intersections, the following universal peak hours for the entire corridors were identified for this study:

- AM Peak: 7:30 AM – 8:30 AM
- PM Peak: 4:30 PM – 5:30 PM

3.2 Analysis Tools

Traffic operations analysis for the corridor was conducted using analysis tools *Synchro 9.0 (Version 9.1, build 907)* as well as *SimTraffic,* which is a companion microsimulation tool for Synchro. The operational analysis was based on guidance provided in *VDOT Traffic Operations and Safety Analysis Manual (TOSAM), Version 1.0, November 2015 update. Synchro* is based on methodologies presented in *2010 Highway Capacity Manual*. *SimTraffic* was used to assess the traffic operations at the signalized and unsignalized intersections within the study area, as well as to evaluate arterial segments between the intersections. **Section 3.3** below presents a summary of Measures of Effectiveness (MOE) that were evaluated for this study.

3.3 Measures of Effectiveness

The MOE in traffic operations analysis is a factor that quantifies operational and safety objectives and provides a basis for evaluating the performance of a transportation network. Several MOEs for a corridor can be reported from *Synchro* and *SimTraffic*. For the purposes of this study, guidance for reporting MOEs for a corridor involving intersections and arterial segments as provided in *VDOT TOSAM, Chapter 4* was utilized. A summary of the MOEs evaluated for the study corridor is presented below:

- SimTraffic:
  - Maximum Queue Lengths (feet)
  - Microsimulation Delay for each movement at intersections
  - Total Delay (hours), Delay/Vehicle (seconds), Travel Time (hours), Average Speed (miles/hour)

Per the *TOSAM* guidance under *Section 8.6*, Level of service (LOS) is not reported for intersections with *SimTraffic* as an analysis tool. Instead, the microsimulation delay is reported for intersection movements and then the overall delay for the intersection. The overall intersection delay can be presented graphically by assigning color coding for ranges of microsimulation delay. This color coding as shown in **Table 3** is based on *2010 Highway Capacity Manual (HCM)* delay thresholds and the associated LOS. Green, yellow and red colors were assigned to delay thresholds for each study intersection.

Table 3: Intersection Color Coding based on Delay

Signalized Intersection Delay Thresholds (sec/veh)	Unsignalized Intersection Delay Thresholds (sec/veh)	Color
< 10	< 10	
> 10 – 20	> 10 – 15	
>20 – 35	>15 – 25	
>35 – 55	>25 – 35	
>55 – 80	>35 – 50	
>80	>50	

Source of Delay Thresholds: Highway Capacity Manual 2010

3.4 Base Model Development and Calibration

To provide a more accurate representation of field conditions, the existing conditions *SimTraffic* models were calibrated to reasonably replicate balanced field observed traffic volumes and travel times. This calibration process is an essential part of the model development process because it ensures that the simulation reasonably replicates existing field conditions and can be used as the base for the evaluation of future scenarios.

The *SimTraffic* input parameters were in accordance with *Section 7.6.1* of *VDOT TOSAM* and included 1-15-minute seed interval and 4-15-minute recording intervals. To account for simulation variance, 10 simulation runs were conducted and averaged together. Because there were no special conditions observed in the field, simulation settings generally remained at the default settings.

3.4.1 Microsimulation Sample Size

In addition to conducting proper model calibration, determining and applying an appropriate number of microsimulation runs is an important step in developing accurate microsimulation results. WSP followed the guidelines provided in *Section 5.4 of the VDOT TOSAM* and utilized the macro-enabled *VDOT Sample Size Determination Tool* to finalize the number of *SimTraffic* runs necessary for correctly reporting arterial and intersection MOEs. Ten *SimTraffic* microsimulation runs were initially recorded following the guidelines for *SimTraffic* Input Parameters found in *Section 7.6 of the VDOT TOSAM.* The MOE, Average Travel Speed obtained from each of these ten runs was then input into the VDOT Sample Size Determination Tool to verify that MOEs from ten runs meet the required tolerance error and confidence interval. **Appendix** shows a screen capture of the *VDOT Sample Size Determination Tool*.

3.4.2 Volume Calibration

The full *SimTraffic* volume calibration results table is shown in the **Appendix**. The volume calibration includes a comparison between simulated volumes (the average of 10 runs) and balanced field counts modeled in Synchro for the AM and PM Peak Hours. The tables show the difference and percentage difference between field counts and the average volumes from the simulation runs. *Section 5.3* of *VDOT TOSAM* requirements indicate that at least 85% the

selected locations should meet the designated criteria, which is based on the total volume for each movement. In the AM model, the simulated volumes meet the calibration criteria for 96% of identified locations. In the PM model, the simulated volumes meet the calibration criteria for 95% of identified locations.

3.4.3 Travel Time Calibration

The *SimTraffic* travel time calibration results table is show in the **Appendix.** The travel time calibration includes a comparison between theoretical (simulated) travel times with average of 10 runs and the field measured travel times during the AM and PM peak hours. *Section 5.3* of *TOSAM* requires calibration threshold of ± 30% for average observed travel times on arterials. The results indicate that field recorded travel times for both the corridors of US 460/US 19 and US 460 fall within the ± 30% of simulated travel times, except for the southbound US 460 travel time during PM Peak hour. Although the southbound PM travel rime run doesn't meet the threshold, the overall threshold is met for 87.5% of travel time routes which is acceptable per *TOSAM*.

3.5 Intersection Operations: 2017 Existing Conditions

Traffic operations analyses was conducted using *SimTraffic* to evaluate overall performance of the study intersections and arterial segments within the US 460/US 19 corridor for the Existing 2017 Conditions scenario. *SimTraffic* run outputs were also used to analyze the maximum queues formed for each intersection approach.

Microsimulation Delay were reported from *SimTraffic* for all the signalized and unsignalized intersections. **Table 4** summarizes the average AM and PM peak hour delay for each movement for the study intersections along the study corridors. **Figure 18** summarizes the overall intersection delay graphically. SimTraffic output sheets are provided in **Appendix**.

The results in **Table 4** suggest that, under Existing Conditions, the highest Microsimulation Delay (sec/veh) that was reported was at the intersection of US 460/US 19 during the PM peak hour. All other intersections and their movements operate under satisfactory traffic conditions of intersection delay of less than 55 seconds for a signalized intersection and 35 seconds for an unsignalized intersection. The typical reported delay ranges from 0 sec/veh indicating no delay to 10 sec/veh indicating minor delay.

Table 4. Existing (2017) SimTraffic AM(PM) Peak Hour Delay

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
1 US 460 and Cedar Valley Drive					Cedar Valley Dr		US 460		US 460			
	Signal	Left	†	†	14.3	16.5	14.2	12.5	27.4	27.3	Delay	Delay
		Through	†	†	†	†	8.6	7.6	6.0	4.7	7.9	6.7
		Right	†	†	1.8	1.7	4.9	5.2	†	†		
		Approach	†	†	13.7	15.9	8.0	7.3	6.1	4.9		
2 US 460 and Claypool Hill Mall Rd/ Fill St			Claypool Hill Mall Rd		Claypool Hill Mall Rd		US 460		US 460			
	Signal	Left	28.0	30.8	32.5	58.2	27.3	30.6	37.4	37.7	Delay	Delay
		Through	†	†	33.3	41.9	9.6	12.0	15.8	17.5	13.5	15.9
		Right	6.7	9.8	9.0	9.4	0.0	9.9	4.6	5.5		
		Approach	22.1	20.4	14.9	16.1	11.4	13.9	13.7	15.9		
3 US 460 and Thru Dr/ Greenhills Memorial Gardens Entrance			Greenhill Mem Gardens		Thru Dr		US 460		US 460			
	Two-Way Stop	Left	0.0	20.2	11.6	23.4	4.4	7.6	9.2	11.1	Delay	Delay
		Through	†	†	0.0	21.0	1.0	1.0	3.7	4.1	2.6	3.1
		Right	4.4	7.5	5.6	8.4	0.5	0.5	2.1	3.5		
		Approach	5.0	13.5	7.2	14.4	1.1	1.1	3.9	4.4		
4 US 460 and Gas Station Entrance					Gas Station Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	†	†	†	†	0.5	0.4	†	†	0.8	0.9
		Right	†	†	4.6	5.6	0.1	0.0	1.0	1.2		
		Approach	†	†	4.6	5.6	0.5	0.4	1.0	1.2		
5 US 460 and Autozone Entrance					Autozone Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	21.4	39.5	†	†	15.7	11.7	Delay	Delay
		Through	†	†	†	†	9.1	9.0	0.7	0.9	5.3	5.2
		Right	†	†	5.9	5.6	7.0	7.6	†	†		
		Approach	†	†	14.5	14.0	9.1	8.9	0.8	1.0		
6 US 460 and US 460/19			US 460/19		US 460/19		US 460		US 460			
	Signal	Left	31.2	41.5	43.3	49.8	32.2	42.2	25.2	34.4	Delay	Delay
		Through	11.4	17.0	23.5	36.2	34.9	42.1	20.5	43.9	17.3	24.8
		Right	2.1	2.5	4.3	4.7	0.0	2.9	9.8	20.5		
		Approach	19.8	25.0	11.7	15.8	35.1	41.3	20.7	32.0		

Existing (2017) SimTraffic AM and PM Peak Hour Delay (Continued)

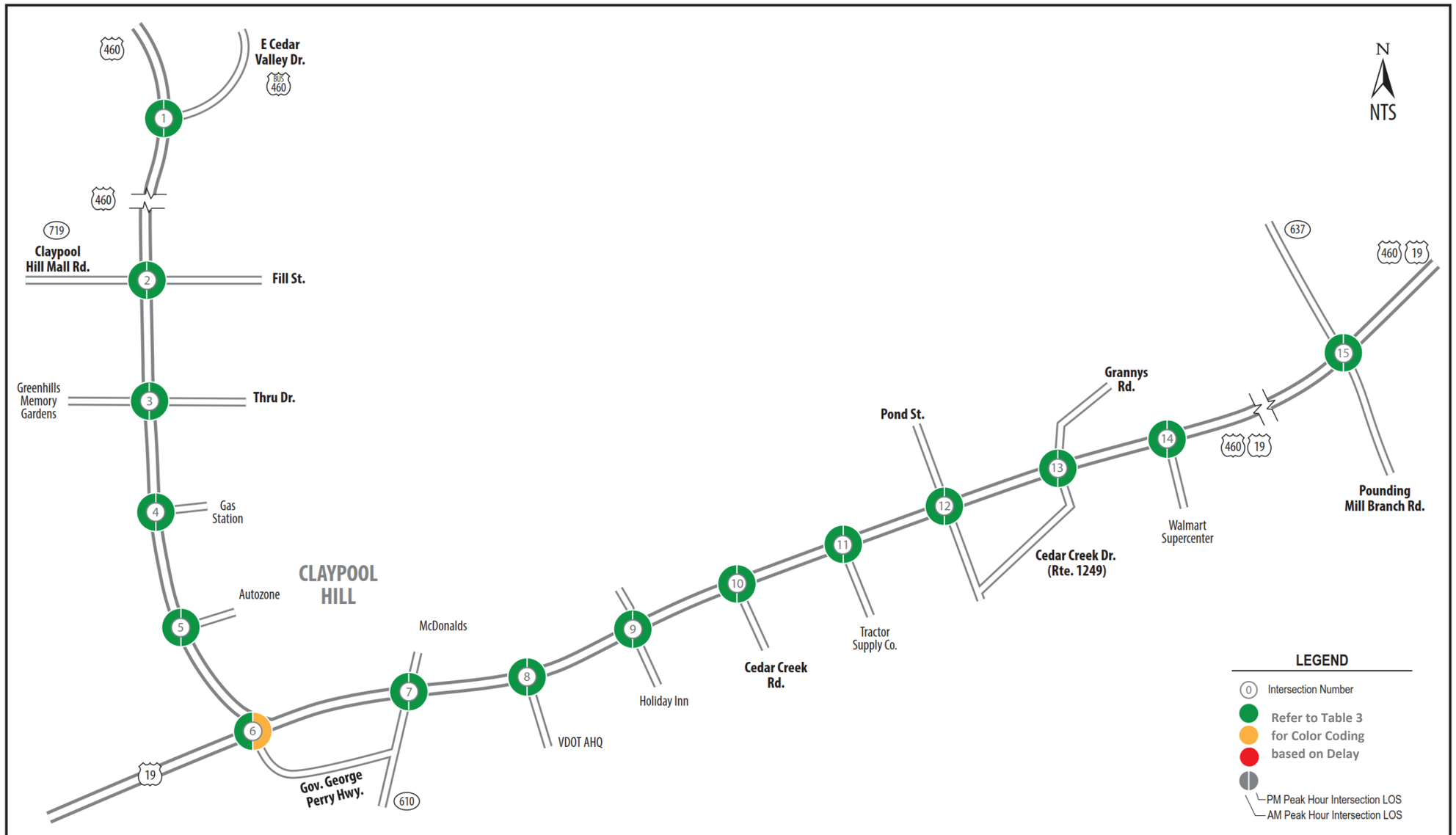
Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
7 US 460/19 and Route 610/ McDonalds Entrance			US 460/19		US 460/19		Route 610		McDonalds Entrance			
	Signal	Left	23.6	27.8	22.1	25.6	†	†	22.5	23.9	Delay	Delay
		Through	6.3	8.0	7.0	5.4	†	†	21.2	26.2	8.2	7.7
		Right	3.8	3.7	2.2	1.6	0.5	1.0	6.5	6.5		
		Approach	8.8	8.9	7.3	6.2	0.5	1.0	11.3	15.1		
8 US 460/19 and VDOT AHQ			US 460/19		US 460/19		VDOT AHQ					
	Two-Way Stop	Left	2.5	5.1	4.3	7.3	14.7	27.2	†	†	Delay	Delay
		Through	0.8	1.1	1.6	1.9	†	†	†	†	1.4	1.6
		Right	0.4	0.6	†	†	4.2	5.8	†	†		
		Approach	0.8	1.2	1.7	2.0	13.0	8.9	†	†		
9 US 460/19 and Holiday Inn Entrance			US 460/19		US 460/19		Holiday Inn Entrance					
	Signal	Left	17.9	0.0	23.4	28.3	33.2	29.9	†	†	Delay	Delay
		Through	3.0	11.8	3.7	4.4	†	†	†	†	4.2	9.4
		Right	1.8	9.3	†	†	4.9	7.6	†	†		
		Approach	3.7	11.6	4.2	5.8	24.3	18.1	†	†		
10 US 460/19 and Cedar Creek Road			US 460/19		US 460/19		Cedar Creek Rd					
	Two-Way Stop	Left	3.4	6.7	1.9	5.9	0.0	18.8	†	†	Delay	Delay
		Through	1.4	3.8	0.4	0.5	†	†	†	†	0.9	2.4
		Right	†	†	†	†	0.0	8.2	†	†		
		Approach	1.4	3.9	0.4	0.6	0.0	13.8	†	†		
11 US 460/19 and Tractor Supply Entrance			US 460/19		US 460/19		Tractor Supply Entrance					
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	0.6	1.5	0.5	0.7	†	†	†	†	0.6	1.1
		Right	0.0	0.7	†	†	3.7	4.7	†	†		
		Approach	0.5	1.5	0.5	0.7	3.7	4.7	†	†		
12 US 460/19 and Pond Street			US 460/19		US 460/19				Pond St			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	1.3	2.0	1.7	2.1	†	†	†	†	1.5	2.0
		Right	0.4	0.8	0.7	0.9	†	†	4.1	4.4		
		Approach	1.1	1.8	1.7	2.1	†	†	4.1	4.4		
13 US 460/19 and Grannys Lane/ Cedar Creek Dr (Rte 1249)			US 460/19		US 460/19		Grannys Rd		Grannys Rd			
	Signal	Left	16.4	25.6	21.3	0.0	14.7	17.4	17.7	31.3	Delay	Delay
		Through	4.7	7.6	6.6	10.0	7.8	13.3	0.0	28.7	6.5	9.8
		Right	0.0	1.8	0.0	5.7	4.6	4.9	5.4	7.6		
		Approach	5.1	7.3	6.7	10.0	11.8	16.8	8.5	17.2		

Existing (2017) SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19		US 460/19		Walmart Entrance					
	Two-Way Stop	Left	†	†	5.4	5.9	11.3	15.5	†	†	Delay	Delay
		Through	1.7	2.6	2.6	3.1	†	†	†	†	2.7	4.3
		Right	1.3	2.4	†	†	4.7	9.5	†	†		
		Approach	1.7	2.6	2.9	3.3	7.7	12.3	†	†		
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19		US 460/19		Route 637		Route 637			
	Two-Way Stop	Left	3.9	5.9	3.5	2.4	16.1	17.9	12.8	16.5	Delay	Delay
		Through	3.2	4.1	0.9	0.9	13.6	0.0	16.4	15.0	3.7	3.2
		Right	3.0	4.0	0.1	0.1	6.1	5.5	0.0	4.1		
		Approach	3.2	4.3	0.9	0.9	15.0	15.1	16.1	7.1		

NOTE: Microsimulation Delay (sec/veh) results shown represent an average of 10 SimTraffic runs.
† Movements without conflicting movements. Delay cannot be reported.

Figure 18. Existing (2017) AM(PM) Peak Intersection Operations Results



STARS VDOT Virginia Department of Transportation

US ROUTE 460, Claypool Hill, Virginia

US ROUTE 460 / US ROUTE 19 2017 EXISTING INTERSECTION LEVEL OF SERVICE

Queue length, or the distance to which stopped vehicles accumulate in a lane at an intersection, is another performance measure of intersection operations. Lengthy queues may be indicative of intersection capacity or operational issues, such as absence of or insufficient dedicated turn lanes, inefficient signal timings or phasing. A queuing analysis was completed for the study intersections during the AM and PM peak hours. SimTraffic Maximum Queue Lengths in feet were reported for each lane. These queue lengths are based on an average of 10 simulation runs. **Table 5** provides a summary of the maximum queue lengths during the AM and PM peak hours as compared to the available storage bay lengths. The highlighted queue lengths in **Table 5** are the movements where the reported maximum queue lengths value exceeds the storage length available for that turning movement. The *SimTraffic* output sheets including the maximum queue lengths are included in **Appendix**.

The results presented in Table 5 indicate the following intersection movements experience some queuing:

Intersection 6 – US 460 and US 460/US 19

- Eastbound left-turning movement (existing storage bay length of 160 ft.) showed queue lengths of 158 ft. and 159 ft. during AM and PM peaks respectively. This indicates that the queues are reaching storage capacity.
- Southbound right-turning movement (existing storage bay length of 50 ft.) showed queue lengths of 65 ft. and 66 ft. during AM and PM peaks respectively, indicating that the queues exceed the storage capacity.

The observed maximum queue lengths at all other study intersections were less than their respective storage bays, indicating no significant concern with queuing.

Table 5. 2017 Existing Conditions: Summary of Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 US 460 and Cedar Valley Drive						Cedar Valley Dr				US 460			US 460	
	Signal	Left	N/A	†	†	N/A	132	101	50	43	42	150	26	55
		Through	N/A	†	†	N/A	†	†	N/A	161	168	N/A	131	112
		Right	N/A	†	†	N/A	7	0	325	77	54	N/A	†	†
2 US 460 and Claypool Hill Mall Road				Claypool Hill Mall Rd			Claypool Hill Mall Rd			US 460			US 460	
	Signal	Left	N/A	129	206	N/A	69	49	270	97	107	125	37	80
		Through	N/A	†	†	N/A			N/A	177	209	N/A	171	194
		Right	340	66	112	N/A			N/A	179	215	220	55	134
3 US 460 and Thru St/ Greenhills Memorial Gardens Entrance				Greenhills Mem Gardens			Thru St			US 460			US 460	
	Two-Way Stop	Left	N/A	27	49	N/A	53	73	N/A	52	69	N/A	84	107
		Through	N/A			N/A			N/A			N/A		
		Right	N/A			N/A			N/A	2	33	N/A	23	77
4 US 460 and Gas Station Entrance						Gas Station Entrance				US 460			US 460	
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	6	†	N/A	†	†
		Right	N/A	†	†	N/A	79	56	N/A	†	†	N/A	†	†
5 US 460 and Autozone Entrance						Autozone Entrance				US 460			US 460	
	Two-Way Stop	Left	N/A	†	†	N/A	29	45	N/A	†	†	150	34	30
		Through	N/A	†	†	N/A	†	†	N/A	9	20	N/A	43	31
		Right	N/A	†	†	N/A	29	45	N/A	9	31	N/A	†	†
6 US 460 and US 460/19				US 460/19			US 460/19			US 460			US 460	
	Signal	Left	160	159	159	225	25	58	135	38	59	N/A	233	353
		Through	N/A	259	228	N/A	252	334	N/A	72	112	N/A	250	409
		Right	N/A	†	†	N/A	23	37	90	†	26	50	61	68
7 US 460/19 and Route 610/ McDonalds Entrance				US 460/19			US 460/19			Route 610			McDonalds Entrance	
	Signal	Left	230	109	78	150	68	87	N/A	†	†	N/A	78	80
		Through	N/A	157	214	N/A	167	163	N/A	†	†	N/A		
		Right	205	29	29	530	56	70	N/A	0	25	N/A	91	57
8 US 460/19 and VDOT AHQ				US 460/19			US 460/19			VDOT AHQ				
	Two-Way Stop	Left	75	44	44	140	50	40	N/A	54	37	N/A	†	†
		Through	N/A	10	8	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	2	2	N/A	†	†	N/A	54	37	N/A	†	†
9 US 460/19 and Holiday Inn/ New Peoples Bank				US 460/19			US 460/19			Holiday Inn Entrance				
	Signal	Left	245	81	0	230	49	83	N/A	41	85	N/A	†	†
		Through	N/A	134	287	N/A	123	122	N/A	†	†	N/A	†	†
		Right	50	44	52	N/A	135	128	N/A	33	56	N/A	†	†

2017 Existing Conditions: Summary of Maximum Queues (feet) (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
10 US 460/19 and Cedar Creek Road			US 460/19			US 460/19			Cedar Creek Rd					
	Two-Way Stop	Left	165	29	58	110	25	40	N/A	0	44	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	0	44	N/A	†	†
11 US 460/19 and Tractor Supply Entrance			US 460/19			US 460/19			Tractor Supply Entrance					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	32	35	N/A	†	†
12 US 460/19 and Pond Street			US 460/19			US 460/19			Pond St					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	2	27	N/A	0	5	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	†	†	N/A	40	36
13 US 460/19 and Grannys Lane/Route 1249			US 460/19			US 460/19			Grannys Rd			Grannys Rd		
	Signal	Left	275	44	40	285	31	6	N/A	59	103	N/A	34	37
		Through	N/A	125	163	N/A	117	164	N/A	47	105	N/A		
		Right	N/A	†	53	N/A	136	165	50	43	42	N/A		
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19			US 460/19			Walmart Entrance					
	Two-Way Stop	Left	N/A	†	†	230	52	43	N/A	72	165	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	170	2	9	N/A	†	†	N/A	72	165	N/A	†	†
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19			US 460/19			Pounding Mill Branch Rd			Pounding Mill Branch Rd		
	Two-Way Stop	Left	260	36	51	175	11	20	N/A	81	42	N/A	82	63
		Through	N/A	0	1	N/A	†	†	N/A			N/A		
		Right	90	1	1	N/A	†	†	N/A			N/A		

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.
† Queue length for movements with no conflicting volumes.
N/A Storage Bay Length not provided or the movements do not exist.

3.6 Future Traffic Volumes

The existing traffic volumes were forecasted to the Future Year 2027, which was determined by the SWG as the design year for the improvements suggested by this study. Projecting the traffic volumes at the study intersections to the design year with an appropriate growth rate was the first step in developing future conditions analysis. The methodology that was followed for development of growth rate is discussed below.

3.6.1 Traffic Forecasting Methodology

During the kick-off meeting held on September 27, 2017 at the VDOT Bristol District office, the members of SWG suggested that the growth experienced by Tazewell County in recent years has been low, and in fact, the population is in decline. It was suggested that, considering the declining population and limited number of future and planned developments along the study corridors, an annual growth rate of 0.5% would be suitable for this study.

To validate this growth rate, historic AADT volumes published by VDOT were reviewed from year 2004 to 2016 for the two study corridors for segments listed below:

- US 19/US 460: From US 460 Claypool Hill to Route 639 (Earls Branch Road)
- US 19/US 460: From Route 639 (Earls Branch Road) to US 19/BUS US 460
- US 460: From Cedar Bluff to US 19 intersection

Table 6 summarizes the AADT volumes per year from 2004 through 2016 along the three segments.

Table 6. VDOT Historic Traffic Volumes

Year	Roadway Segment/AADT Volume		
	US 460/US 19 Claypool Hill to Earls Branch Rd	US 460/US 19 Earls Branch Road to US 19, Bus 460	US 460 Cedar Bluff to US 19 West Intersection
2004	14000	13000	18000
2005	12000	12000	20000
2006	12000	12000	20000
2007	12000	11000	20000
2008	11000	12000	18000
2009	11000	12000	18000
2010	12000	12000	18000
2011	12000	12000	21000
2012	11000	12000	21000
2013	11000	11000	20000
2014	11000	11000	19000
2015	11000	11000	18000
2016	11000	10000	18000

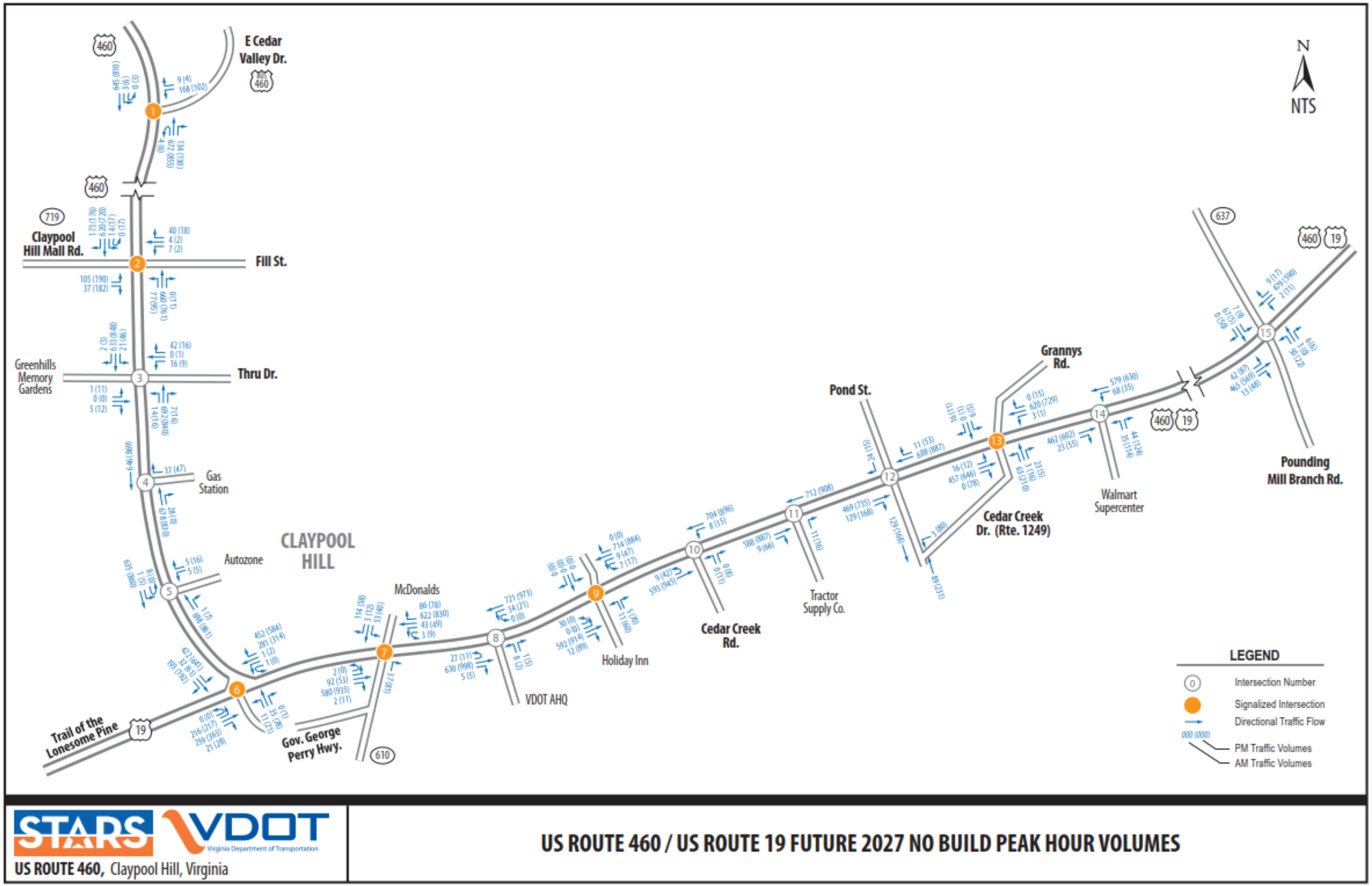
Linear growth rates were calculated for these segments three periods: 3-year, 9-year and 12-year and are summarized in **Table 7**.

Table 7. Historic Traffic Growth Rates

Roadway Segment	Linear Growth Rates		
	3-Year (2013-2016)	9-Year (2007-2016)	12-Year (2004-2016)
US 460 Claypool Hill to Earls Branch Rd	0.00%	-0.96%	-1.99%
Earls Branch Road to US 19, Bus 460	-3.13%	-1.05%	-2.16%
Cedar Bluff to US 19 West Intersection	-3.45%	-1.16%	0.00%

The calculated linear historic growth rate shows primarily negative or no growth in the study area. This validates the suggestion by the SWG about negative growth observed within Tazewell County. Based on this data and an understanding of the potential for development in the study area, the suggested linear growth rate of 0.5% was applied to the Existing 2017 traffic volumes to generate projected 2027 AM and PM peak hour traffic volumes. These volumes are presented in **Figure 19**.

Figure 19. Future (2027) AM(PM) Peak Hour Traffic Volumes



STARS VDOT Virginia Department of Transportation

US ROUTE 460, Claypool Hill, Virginia

US ROUTE 460 / US ROUTE 19 FUTURE 2027 NO BUILD PEAK HOUR VOLUMES

3.7 Intersection Operations: Future 2027 No-Build Conditions

Operational analysis was performed at each of the study intersections for the Future 2027 No-Build Conditions scenario. **Table 8** summarizes the average AM and PM peak hour delay and LOS for each movement for the study intersections along the US 460/19 corridor. **Figure 20** summarizes the overall intersection delay graphically. SimTraffic output sheets are provided in **Appendix**.

The results in **Table 8** show that, under Future 2027 No Build conditions, the highest Microsimulation Delay (sec/veh) that was reported was at the intersection of US 460/US 19 during the PM peak hour. All other intersections and their movements operate under satisfactory traffic conditions. The typical reported delay ranges from 0 sec/veh indicating no delay to 10 sec/veh indicating minor delay.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2027 No Build conditions. *SimTraffic* Maximum Queue Lengths in feet were reported for each lane. These queue lengths are based on an average of 10 simulation runs. **Table 9** summarizes the maximum queue lengths during the AM and PM peak hours.

The results presented in **Table 9** indicate the following intersection movements experience some queuing:

Intersection 6 – US 460 and US 460/US 19

- Eastbound left-turning movement (existing storage bay length of 160 ft.) showed queue lengths of 159 ft. and 159 ft. during AM and PM peaks respectively. This indicates that the queues are reaching storage capacity.
- Southbound right-turning movement (existing storage bay length of 50 ft.) showed queue lengths of 65 ft. and 63 ft. during AM and PM peaks respectively, indicating that the queues exceed the storage capacity.

The observed maximum queue lengths at all other study intersections were less than their respective storage bays, indicating no significant concern with queuing.

Table 8. Future 2027 No-Build SimTraffic AM(PM) Peak Hour Delay

Intersection Number and Description		Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
				AM	PM	AM	PM	AM	PM	AM	PM		
				Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
1	US 460 and Cedar Valley Drive					Cedar Valley Dr		US 460		US 460			
		Signal	Left	†	†	16.5	16.8	15.4	13.3	22.1	20.2	Delay	Delay
			Through	†	†	†	†	8.9	8.8	6.6	5.0	8.5	7.4
			Right	†	†	1.8	1.9	5.2	5.5	†	†		
			Approach	†	†	15.8	16.4	8.3	8.4	6.7	5.2		
2	US 460 and Claypool Hill Mall Rd/ Fill St			Claypool Hill Mall Rd		Claypool Hill Mall Rd		US 460		US 460			
		Signal	Left	27.3	33.5	30.3	26.8	28.3	32.2	39.2	40.6	Delay	Delay
			Through	†	†	27.1	55.5	9.6	13.4	15.9	18.6	13.5	17.3
			Right	6.4	10.4	8.7	10.1	†	8.0	5.0	5.9		
			Approach	21.7	22.3	12.7	15.8	11.4	15.5	14.0	17.0		
3	US 460 and Thru Dr/ Greenhills Memorial Gardens Entrance			Greenhills Memorial Gardens Entrance		Thru Dr		US 460		US 460			
		Two-Way Stop	Left	0.0	22.3	16.9	26.6	4.9	8.0	9.5	11.5	Delay	Delay
			Through	†	†	0.0	0.0	1.1	1.0	3.9	4.5	2.9	3.4
			Right	6.4	7.4	7.0	8.9	0.3	0.4	4.5	1.8		
			Approach	8.0	13.6	9.8	15.3	1.2	1.2	4.1	4.8		
4	US 460 and Gas Station Entrance					Gas Station		US 460		US 460			
		Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
			Through	†	†	†	†	0.5	0.4	1.1	1.5	0.8	1.1
			Right	†	†	4.6	5.5	0.1	†	†	†		
			Approach	†	†	4.7	5.5	0.5	0.4	1.1	1.5		
5	US 460 and Autozone Entrance					Autozone Entrance		US 460		US 460			
		Two-Way Stop	Left	†	†	25.9	54.5	†	†	5.0	13.3	Delay	Delay
			Through	†	†	†	†	9.7	8.7	0.8	1.5	5.7	5.3
			Right	†	†	8.9	7.8	8.1	7.5	†	†		
			Approach	†	†	18.4	17.6	9.7	8.6	0.9	1.6		
6	US 460 and US 460/19			US 460/19		US 460/19		US 460		US 460			
		Signal	Left	39.9	46.3	48.1	59.9	39.6	43.6	31.7	46.2	Delay	Delay
			Through	15.8	20.9	34.4	52.0	40.1	47.1	39.6	60.7	23.4	32.7
			Right	2.5	3.1	4.4	4.7	0.0	3.2	14.7	33.0		
			Approach	24.0	26.8	16.2	21.8	39.6	45.6	27.7	44.8		

Future 2027 No-Build SimTraffic AM and PM Peak Hour Delay (Continued)

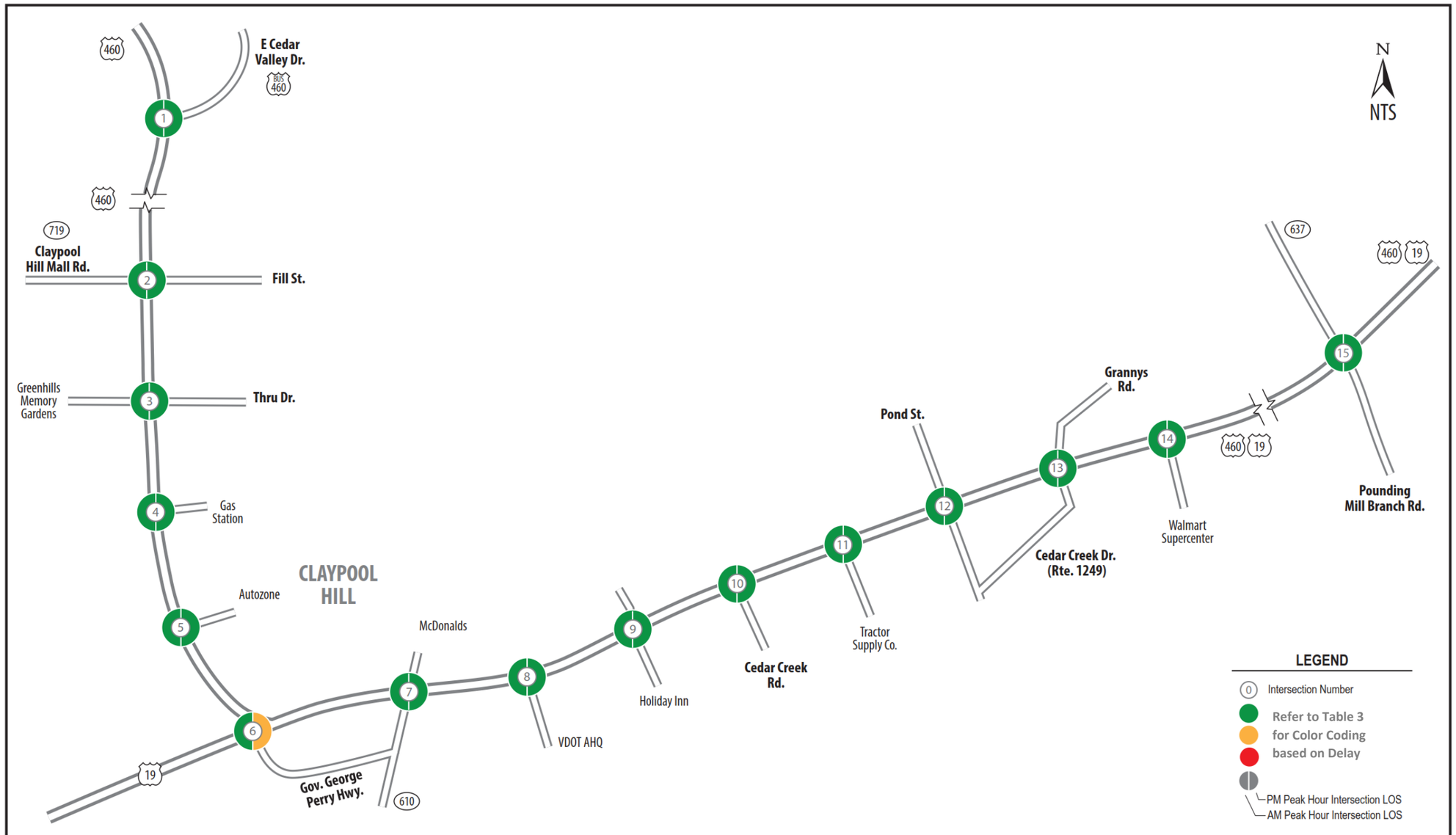
Intersection Number and Description		Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
				AM	PM	AM	PM	AM	PM	AM	PM		
				Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
7	US 460/19 and Route 610/ McDonalds Entrance			US 460/19		US 460/19		Route 619		McDonalds Entrance			
		Signal	Left	27.0	31.7	25.2	27.1	†	†	23.6	26.4	Delay	Delay
			Through	8.6	10.2	7.5	5.6	†	†	21.0	25.7	9.7	9.2
			Right	3.5	6.1	2.3	1.7	0.9	1.6	7.0	7.1		
			Approach	10.9	11.3	9.1	7.5	0.9	1.6	12.3	16.2		
8	US 460/19 and VDOT AHQ			US 460/19		US 460/19		VDOT AHQ					
		Two-Way Stop	Left	2.7	6.9	5.0	10.1	15.2	35.4	†	†	Delay	Delay
			Through	0.8	1.2	1.6	1.9	†	†	†	†	1.4	1.7
			Right	0.3	0.9	†	†	4.1	7.7	†	†		
			Approach	0.8	1.2	1.8	2.1	13.0	11.6	†	†		
9	US 460/19 and Holiday Inn Entrance			US 460/19		US 460/19		Holiday Inn Entrance					
		Signal	Left	18.7	†	25.0	29.4	30.7	30.9	†	†	Delay	Delay
			Through	2.8	12.0	3.8	4.4	†	†	†	†	4.10	9.6
			Right	1.7	9.4	†	†	4.4	7.7	†	†		
			Approach	3.5	11.8	4.2	6.0	21.9	18.4	†	†		
10	US 460/19 and Cedar Creek Road			US 460/19		US 460/19		Cedar Creek Rd					
		Two-Way Stop	Left	3.3	7.0	3.0	6.6	0.0	21.1	†	†	Delay	Delay
			Through	1.4	3.9	0.5	0.6	†	†	†	†	0.9	2.5
			Right	†	†	†	†	0.0	8.6	†	†		
			Approach	1.4	4.0	0.5	0.6	0.0	15.8	†	†		
11	US 460/19 and Tractor Supply Entrance			US 460/19		US 460/19		Tractor Supply Entrance					
		Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
			Through	0.6	1.6	0.6	0.7	†	†	†	†	0.6	1.2
			Right	0.1	0.7	†	†	4.1	4.5	†	†		
			Approach	0.6	1.5	0.6	0.7	4.1	4.8	†	†		
12	US 460/19 and Pond Street			US 460/19		US 460/19				Pond St			
		Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
			Through	1.4	2.0	1.9	2.1	†	†	†	†	1.6	1.9
			Right	0.4	0.8	0.7	1.0	†	†	4.8	4.7		
			Approach	1.2	1.8	1.8	2.1	†	†	4.8	4.7		
13	US 460/19 and Grannys Lane/ Cedar Creek Dr (Rte 1249)			US 460/19		US 460/19		Grannys Rd		Grannys Rd			
		Signal	Left	17.0	25.8	34.3	0.0	15.9	17.7	24.6	34.8	Delay	Delay
			Through	4.9	6.9	7.6	9.7	5.7	14.3	0.0	28.0	3.8	3.1
			Right	0.0	1.5	0.0	5.1	4.5	5.7	5.7	8.3		
			Approach	5.4	6.7	7.7	9.6	12.5	17.3	10.6	17.2		

Future 2027 No-Build SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description		Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
				AM Delay	PM Delay	AM Delay	PM Delay	AM Delay	PM Delay	AM Delay	PM Delay	AM	PM
14	US 460/19 and Walmart Parking Lot Entrance			US 460/19		US 460/19		Walmart Entrance					
		Two-Way Stop	Left	†	†	6.1	7.1	11.1	18.5	†	†	Delay	Delay
			Through	1.9	2.5	2.7	3.3	†	†	†	†	2.9	4.7
			Right	1.5	2.3	†	†	4.6	10.3	†	†		
			Approach	1.8	2.5	3.1	3.5	7.5	14.2	†	†		
15	US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19		US 460/19		Route 637		Route 637			
		Two-Way Stop	Left	4.2	5.8	3.1	2.7	16.4	16.9	12.1	15.1	Delay	Delay
			Through	3.3	4.0	1.0	0.9	18.4	0.0	17.3	21.3	3.8	3.1
			Right	3.7	4.0	0.1	0.1	6.5	3.6	0.0	4.4		
			Approach	3.4	4.2	1.0	0.9	15.3	14.1	16.8	7.2		

NOTE: Microsimulation Delay (sec/veh) results shown represent an average of 10 SimTraffic runs.
† Movements without conflicting movements. Delay cannot be reported.

Figure 20. Future 2027 No-Build AM(PM) Peak Intersection Operations Results



STARS VDOT Virginia Department of Transportation

US ROUTE 460, Claypool Hill, Virginia

US ROUTE 460 / US ROUTE 19 2017 EXISTING INTERSECTION LEVEL OF SERVICE

8

Table 9. Future 2027 No Build Conditions: Summary of Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 US 460 and Cedar Valley Drive						Cedar Valley Dr				US 460			US 460	
	Signal	Left	N/A	†	†	N/A	151	103	50	39	40	150	28	60
		Through	N/A	†	†	N/A	†	†	N/A	165	182	N/A	136	128
		Right	N/A	†	†	N/A	4	†	325	73	68	N/A	†	†
2 US 460 and Claypool Hill Mall Road			Claypool Hill Mall Rd			Claypool Hill Mall Rd				US 460			US 460	
	Signal	Left	N/A	130	210	N/A	68	59	270	86	126	125	48	84
		Through	N/A	†	†	N/A	64	54	N/A	172	228	N/A	192	219
		Right	340	52	121	N/A	†	†	N/A	190	229	220	59	129
3 US 460 and Thru St/ Greenhills Memorial Gardens Entrance			Greenhills Mem Gardens			Thru St				US 460			US 460	
	Two-Way Stop	Left	N/A	27	47	N/A	65	60	N/A	64	83	N/A	68	116
		Through	N/A			N/A			N/A			N/A		
		Right	N/A			N/A			N/A	9	25	N/A	7	85
4 US 460 and Gas Station Entrance						Exxon Gas Station Entrance				US 460			US 460	
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	9	0	N/A	0	5
		Right	N/A	†	†	N/A	76	59	N/A	10	0	N/A	†	†
5 US 460 and Autozone Entrance						Autozone Entrance				US 460			US 460	
	Two-Way Stop	Left	N/A	†	†	N/A	22	42	N/A	†	†	150	29	32
		Through	N/A	†	†	N/A	†	†	N/A	18	25	N/A	52	67
		Right	N/A	†	†	N/A	22	42	N/A	6	10	N/A	†	†
6 US 460 and US 460/19			US 460/19			US 460/19				US 460			US 460	
	Signal	Left	160	159	159	225	45	68	135	94	127	N/A	289	428
		Through	N/A	310	326	N/A	294	359	N/A	142	209	N/A	338	447
		Right	N/A	†	†	N/A	83	0	90	†	27	50	65	63
7 US 460/19 and Route 610/ McDonalds Entrance			US 460/19			US 460/19				Route 619			McDonalds Entrance	
	Signal	Left	230	110	108	150	104	115	N/A	†	†	N/A	88	79
		Through	N/A	186	258	N/A	178	185	N/A	†	†	N/A		
		Right	205	58	121	530	62	76	N/A	33	70	N/A	88	55
8 US 460/19 and VDOT AHQ			US 460/19			US 460/19				VDOT AHQ				
	Two-Way Stop	Left	75	46	32	140	54	53	N/A	52	36	N/A	†	†
		Through	N/A	0	2	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	52	36	N/A	†	†
9 US 460/19 and Holiday Inn/ New Peoples Bank			US 460/19			US 460/19				Holiday Inn Entrance				
	Signal	Left	245	70	0	230	42	90	N/A	38	99	N/A	†	†
		Through	N/A	136	284	N/A	139	125	N/A	†	†	N/A	†	†
		Right	50	43	53	N/A	139	132	N/A	37	59	N/A	†	†

Future 2027 No Build Conditions: Summary of Maximum Queues (feet) (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
10 US 460/19 and Cedar Creek Road			US 460/19			US 460/19			Cedar Creek Rd					
	Two-Way Stop	Left	165	30	52	110	27	43	N/A	0	46	N/A	†	†
		Through	N/A	0	4	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	0	46	N/A	†	†
11 US 460/19 and Tractor Supply Entrance			US 460/19			US 460/19			Tractor Supple Entrance					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	32	30	N/A	†	†
12 US 460/19 and Pond Street			US 460/19			US 460/19			Pond St					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	5	15	N/A	8	11	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	†	†	N/A	45	36
13 US 460/19 and Grannys Lane/Route 1249			US 460/19			US 460/19			Grannys Rd			Grannys Rd		
	Signal	Left	275	44	64	285	24	12	N/A	64	113	N/A	31	34
		Through	N/A	132	154	N/A	138	169	N/A	43	96	N/A		
		Right	N/A	†	50	N/A	163	170	50	46	40	N/A		
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19			US 460/19			Walmart Entrance					
	Two-Way Stop	Left	N/A	†	†	230	63	48	N/A	77	158	N/A	†	†
		Through	N/A	65	0	N/A	†	†	N/A	†	†	N/A	†	†
		Right	170	2	8	N/A	†	†	N/A	77	158	N/A	†	†
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19			US 460/19			Route 637			Route 637		
	Two-Way Stop	Left	260	40	49	175	12	21	N/A	80	52	N/A	87	67
		Through	N/A	†	†	N/A	†	†	N/A			N/A		
		Right	90	8	0	N/A	†	†	N/A			N/A		

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.
† Queue length for movements with no conflicting volumes.
N/A Storage Bay Length not provided or the movements do not exist.

4 Safety Analysis

In addition to the operational analysis, a safety analysis was performed along US 460 from US 460 BUS to US 19 and US 460/19 from US 460 to Route 637. The safety analysis, which included a review of crash data and existing field conditions, was conducted to evaluate the potential areas of improvement for safety that occur along the roadway segment, determine the likely factors contributing to crashes, and propose potential mitigation activities.

4.1 Procedure

Crash data for the most recent five (5) years (August 30, 2012 through August 30, 2017) were obtained from VDOT's *Crashtools* database. The crash data were evaluated to identify crash locations and patterns, severity of crashes, and likely causes for crashes. As part of the crash analysis, collision diagrams illustrating all crashes by year were developed and are included in **Appendix**. The crash data and collision diagrams were examined to identify crash locations on which to focus during field reviews. Field reviews were conducted, with focus on the crash patterns, to evaluate conditions in the field that could be influencing the crash locations shown in the collision diagrams. Field reviews were conducted during both the AM and PM peak periods to examine factors such as traffic conditions, human-vehicle interaction, geometric layout, and the presence and condition of signing, pavement markings, and delineation.

The crash data analysis and field review data were used to identify factors that could potentially contribute to crashes and to make recommendations regarding safety improvements that could mitigate future crashes.

4.2 Crash Data Analysis

4.2.1 Crashes by Year

A total of 236 crashes occurred on US 460/US 19 from US 460 BUS to the US 460/US 19 Intersection and from the US 460/US 19 Intersection to Route 637 between August 30, 2012 and August 30, 2017, as shown in **Figure 21**. Note that the 2012 and 2017 bars are striped since the data does not include a full calendar year. Because this safety analysis contains two separate roadways (i.e., US 460 and US 19), an AADT Factor was developed by adding the AADT of US 460 and the AADT of US 19 to associate the traffic volume with crashes per year, as shown in **Figure 21** (orange line). The AADT values steadily decreased from 2012 to 2015, and the total number of crashes slight decreased between 2013 and 2016.

Figure 22 shows that 1 fatal injury (0.4%), 45 visible injuries (19%), and 19 ambulatory injuries (8%) occurred in the study area within the five-year period. The majority of crashes that occurred were property damage only crashes, which accounted for 67% of all crashes. **Figure 23** is a crash density map of the overall corridor.

Figure 21. Number of crashes per year for the project study area.

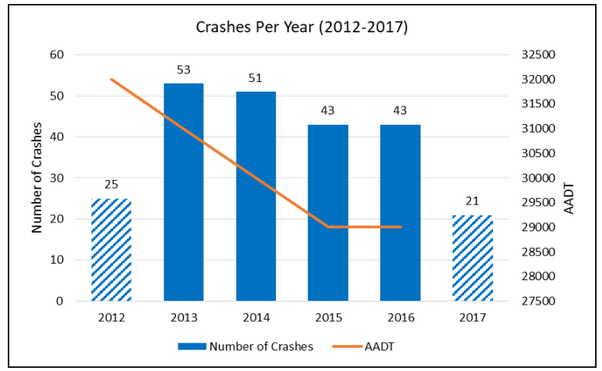


Figure 22. Severity of crashes for the project study area.

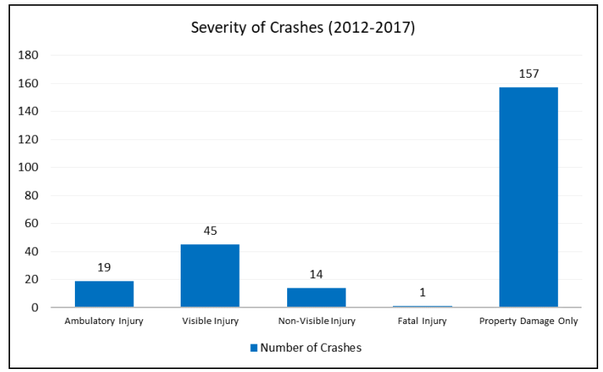
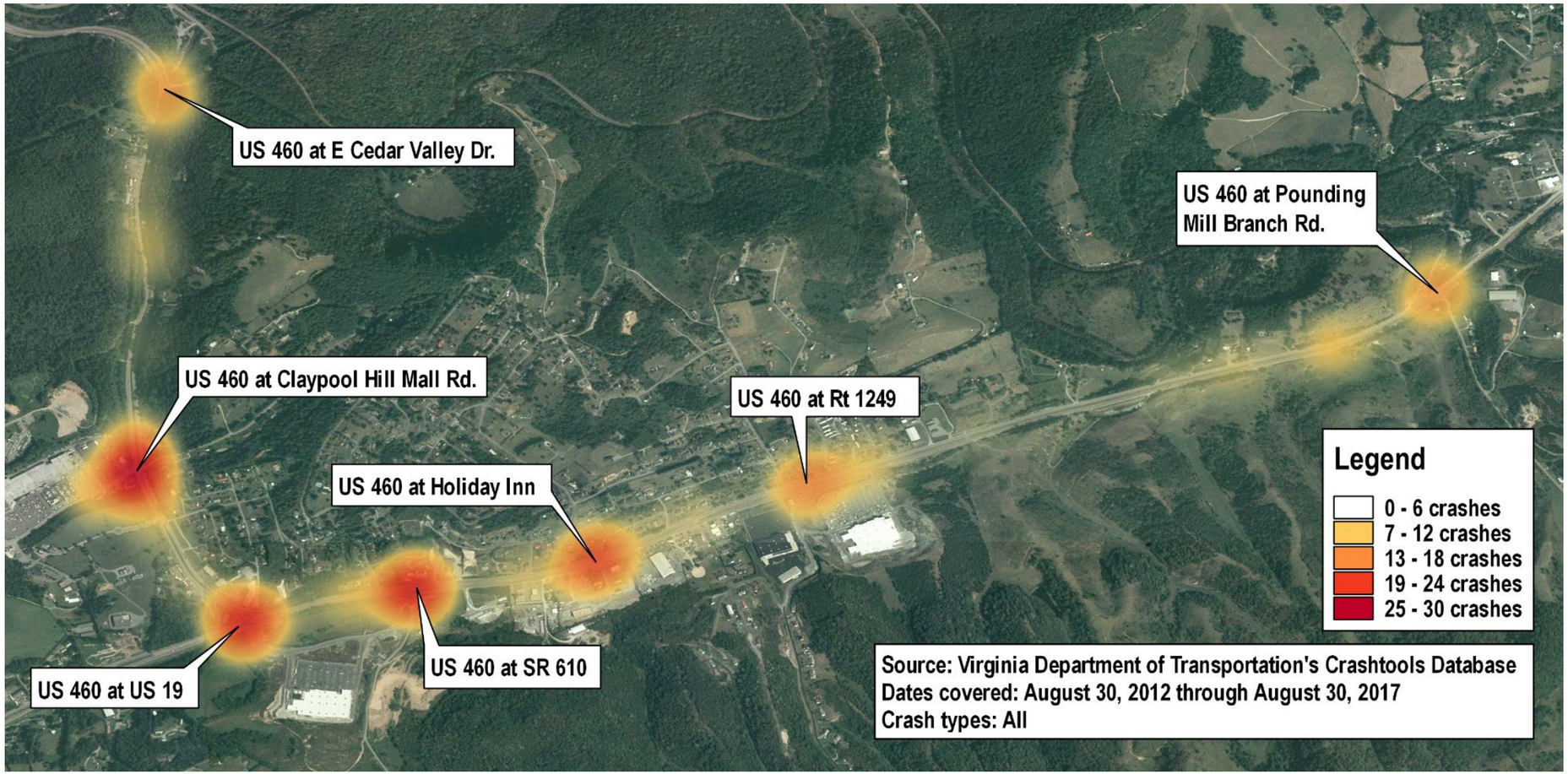


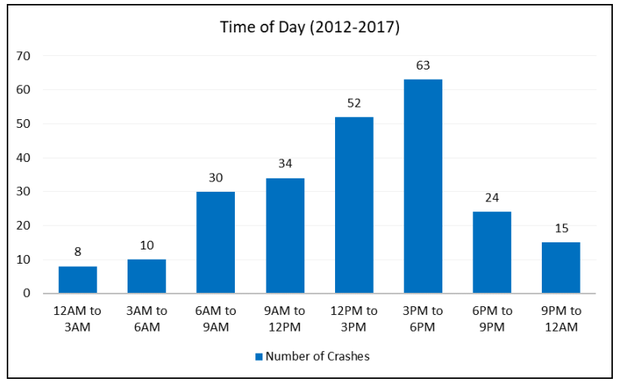
Figure 23. Crash Heat Map (2012-2017)



4.2.2 Crashes by Time of Day

Figure 24 displays the number of crashes that occurred by time of day, presented in 3-hour increments. The highest frequency of crashes occurred from 3PM–6PM (27%), from 12PM–3PM (22%), from 9AM–12PM (14%), and from 6AM–9AM (13%).

Figure 24. Number of crashes by time of day for the project study area.



4.2.3 Crashes by Type

As shown in **Figure 25**, the majority of crashes that occurred were rear-end crashes (44%), followed by angle crashes (22%), deer crashes (13%), fixed object off-road crashes (11%), and sideswipe same-direction crashes (7%); the remaining crash types each accounted for less than 1% of the overall crashes. It should be noted that 10 crashes were incorrectly categorized within the *Crashtools* database; these crash classifications were corrected and updated to ensure the accuracy of the crash type analysis.

Figure 25. Number of crashes by type of crash for the project study area.

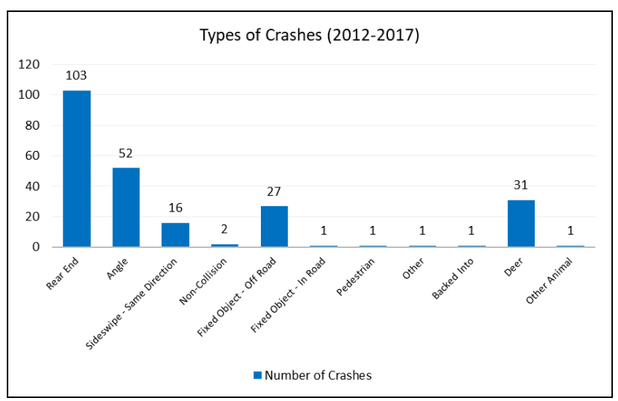


Table 10 includes the most prominent crash types along the route.

Table 10. Crash patterns along the project study area.

Location (Intersection, Segment)	Intersection Approach/Leg/Ramp	Most Prominent Crash Type(s)	Vulnerable Road User Crashes	Year(s)	Total Crashes (Highest Crash Type %)
US 460 at US 460 BUS (East Cedar Valley Drive)	NB approach	Rear-end, angle	N/A	2014; 2016	5 total (40% rear-end; 40% angle)
US 460 at Claypool Hill Mall Road	NB approach/NB lanes on the north leg	Rear-end	N/A	2014-2017	14 total (93% rear-end)
	SB approach/SB lanes on the south leg	Rear-end	N/A	2012-2017	16 total (69% rear-end)
	EB approach	Angle, rear-end	N/A	2013; 2016	6 total (50% angle; 33% rear-end)
US 460 at US 19	EB approach/EB lanes on the east leg	Rear-end	N/A	2014-2016	10 total (80% rear-end)
	WB approach	Other/Animal, rear-end	N/A	2013; 2015; 2017	10 total (40% other/animal, 30% rear-end)
	SB approach	Rear-end	N/A	2012-2014	6 total (83% rear-end)
US 460/US 19 at Route 610	EB approach	Rear-end	N/A	2012-2016	15 total (80% rear-end)
	WB approach/WB lanes on the west leg	Rear-end	N/A	2013; 2015	7 total (57% rear-end)
US 460/US 19 at Holiday Inn Entrance (Clay Drive)	EB approach/EB lanes on the east leg	Rear-end, angle	N/A	2013; 2015-2016	13 total (38% rear-end; 31% angle)
	WB approach/WB lanes on the west leg	Rear-end	N/A	2012-2017	16 total (81% rear-end)
US 140/US 19 at Route 1249 (Cedar Creek Drive)	EB approach/EB lanes on the east leg	Angle	N/A	2013-2014	5 total (80% angle)
	WB approach/WB lanes on the west leg	Rear-end	N/A	2014-2016	7 total (43% rear-end)
US 460/US 19 from Route 1249 (Cedar Creek Drive) to Route 637 (Pounding Mill Branch Road)	EB lanes	Other/Animal	1 Pedestrian (2013)	2013; 2015-2016	11 total (55% other/animal)

4.2.4 Crashes by Roadway and Weather Conditions

Figure 26 indicates the number of crashes by roadway surface condition. The majority (83%) of crashes occurred during dry roadway conditions. Wet conditions accounted for 14% of crashes. Additionally, **Figure 27** shows that most of the collisions occurred under clear/cloudy weather conditions (81%), followed by rainy weather conditions (11%).

Figure 26. Number of crashes by roadway surface condition for the project study area.

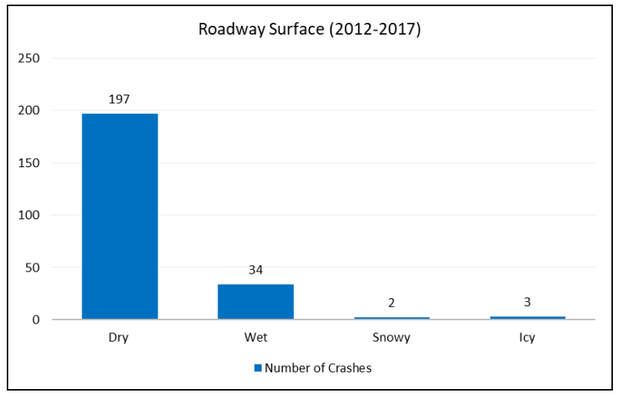
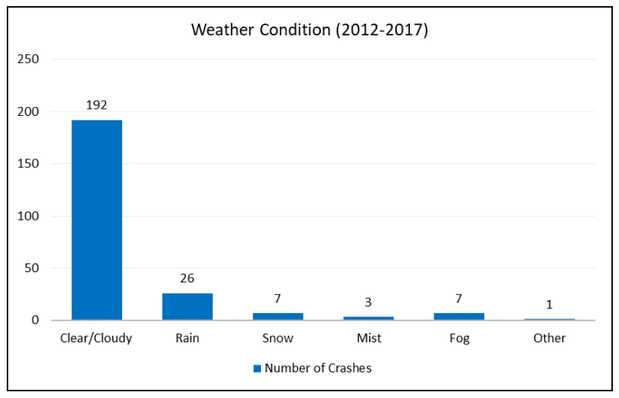


Figure 27. Number of crashes by weather condition for the project study area.



4.2.5 Crash Density by ¼-mile

Crash density histograms were developed in ¼-mile increments to provide a visual representation of crashes along the corridor based on crash type, crash severity, time-of-day, and roadway conditions. The histograms were separated into eastbound & westbound and southbound & northbound for US 460/US 19 and Route 460, respectively. Crash hot spots were identified along the corridor as locations with the highest crash density. **Figure 28, Figure 29, Figure 30, and Figure 31** illustrate the crash hotspots for the corridor. A discussion of the crash hotspots is provided below.

4.2.5.1 Route 460/US 19 Eastbound

HOTSPOT 1: US 460/US 19 INTERSECTION (MILEPOST 57.0-57.25)

A total of 9 crashes occurred at this hotspot. The majority of crashes were rear-end (78%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 6:00AM-9:00AM (33%), 12:00PM-3:00PM (22%), and 3:00PM-6:00PM (22%) and primarily under dry pavement conditions.

HOTSPOT 2: ROUTE 610 INTERSECTION (MILEPOST 57.25 – 57.50)

A total of 16 crashes occurred at this hotspot. The majority of crashes were rear-end (63%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 12:00PM-3:00PM (44%), 3:00PM-6:00PM (19%), and 6:00PM-9:00PM (19%) and primarily under dry pavement conditions.

HOTSPOT 3: HOLIDAY INN EXPRESS DRIVEWAY INTERSECTION (MILEPOST 57.50 – 57.75)

A total of 17 crashes occurred at this hotspot. The majority of crashes were angle (41%) and rear-end (24%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 12:00PM-3:00PM (35%) and 3:00PM-6:00PM (24%) and primarily under dry pavement conditions.

HOTSPOT 4: AT AND BETWEEN CEDAR CREEK DRIVE AND POND STREET (MILEPOST 58.0– 58.25)

A total of 11 crashes occurred at this hotspot. The majority of crashes were angle (73%) and rear-end (18%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 6:00PM-9:00PM (36%), 6:00AM-9AM (18%), 9:00AM-12:00PM (18%), and 3:00PM-6:00PM (18%) and primarily under dry pavement conditions.

HOTSPOT 5: POUNDING MILL BRANCH ROAD INTERSECTION (MILEPOST 59.25 – END)

A total of 8 crashes occurred at this hotspot. The majority of crashes were angle (38%) and fixed object off-road (38%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 6:00AM-9:00AM (25%) and 12:00PM-3:00PM (25%) and primarily under dry pavement conditions.

4.2.5.2 Route 460/US 19 Westbound

HOTSPOT 1: US 460/US 19 INTERSECTION (MILEPOST 57.0-57.25)

A total of 12 crashes occurred at this hotspot. The majority of crashes were rear-end (50%) and angle (33%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 3:00PM-6:00PM (42%) and 6:00AM-9:00AM (25%) and primarily under dry pavement conditions.

HOTSPOT 2: ROUTE 610 INTERSECTION (MILEPOST 57.25 – 57.50)

A total of 16 crashes occurred at this hotspot. The majority of crashes were rear-end (44%) and angle (25%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 9:00AM-12:00PM (25%), 3:00PM-6:00PM (25%), and 6:00PM-9:00PM (25%) and primarily under dry pavement conditions.

HOTSPOT 3: HOLIDAY INN EXPRESS DRIVEWAY INTERSECTION (MILEPOST 57.50 – 57.75)

A total of 11 crashes occurred at this hotspot. The majority of crashes were rear-end (91%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 3:00PM-6:00PM (64%), 9:00AM-12:00PM (18%), and 12:00PM-3:00PM (18%) and primarily under dry pavement conditions.

HOTSPOT 4: AT AND BETWEEN ROUTE 1249 (CEDAR CREEK DRIVE) AND POND STREET (MILEPOST 58.0– 58.25)

A total of 12 crashes occurred at this hotspot. The majority of crashes were rear-end (42%) crashes, with all crashes resulting in property damage. In addition, the crashes predominately occurred from 12:00PM-3:00PM (25%), 3:00PM-6:00PM (17%), and 6:00PM-9:00PM (17%) and primarily under dry pavement conditions.

Hotspot 5: Route 637 Intersection (Milepost 59.25 – End)

A total of 5 crashes occurred at this hotspot. All crashes were angle (100%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 3:00PM-6:00PM (40%), 9:00AM-12:00PM (20%), 12:00PM-3:00PM (20%), and 6:00PM-9:00PM (20%) and primarily under dry pavement conditions.

4.2.5.3 Route 460 Southbound

Hotspot 1: Claypool Hill Mall Road Intersection (Milepost 47.05-47.30)

A total of 21 crashes occurred at this hotspot. The majority of crashes were rear-end (48%) and angle (38%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 12:00PM-3:00PM (29%), 9:00AM-12:00PM (24%), and 3:00PM-6:00PM (24%) and primarily under dry pavement conditions.

4.2.5.4 Route 460 Northbound

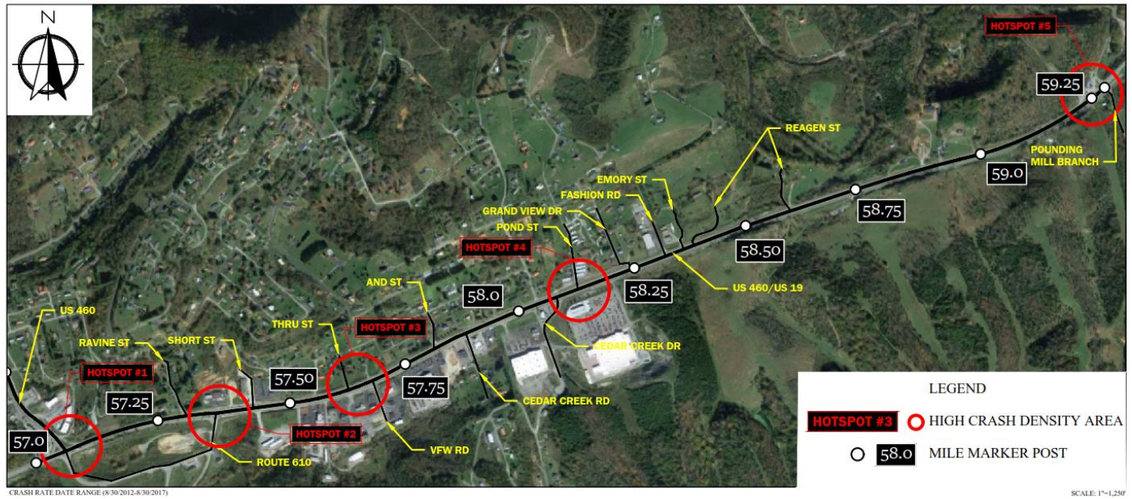
Hotspot 1: US 460 BUS (E. Cedar Valley Drive) (Milepost 46.3-46.55)

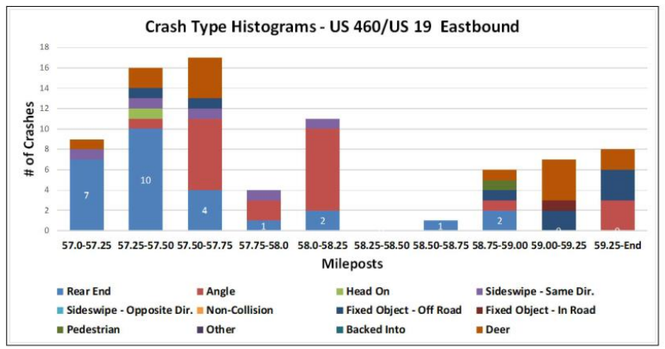
A total of 11 crashes occurred at this hotspot. The majority of crashes were rear-end (55%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 12:00PM-3:00PM (27%) and 3:00PM-6:00PM (27%) and primarily under dry pavement conditions.

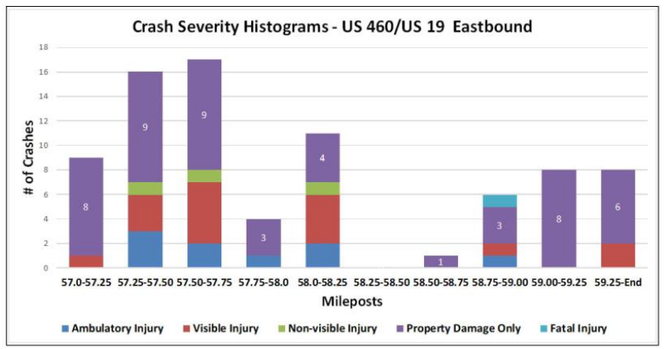
Hotspot 2: Claypool Hill Mall Road Intersection (Milepost 47.05-47.30)

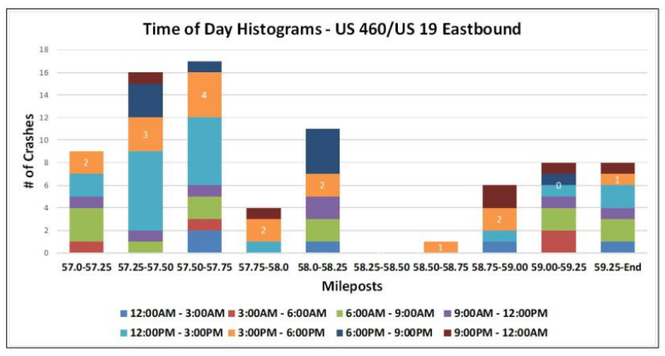
A total of 20 crashes occurred at this hotspot. The majority of crashes were rear-end (70%) crashes, with most crashes resulting in property damage. In addition, the crashes predominately occurred from 3:00PM-6:00PM (35%) and 12:00PM-3:00PM (30%) and primarily under dry pavement conditions.

Figure 28. Crash Density Histograms per ¼-mile (US 460/US 19 Eastbound).









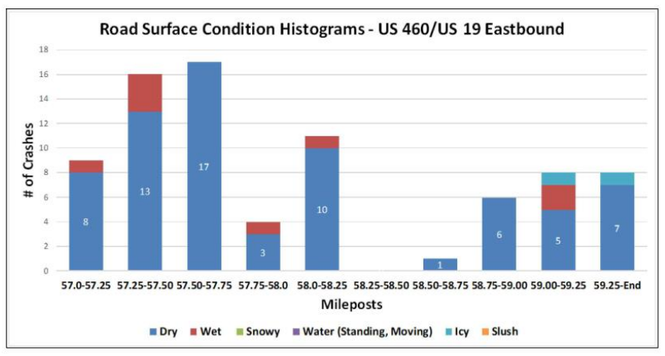
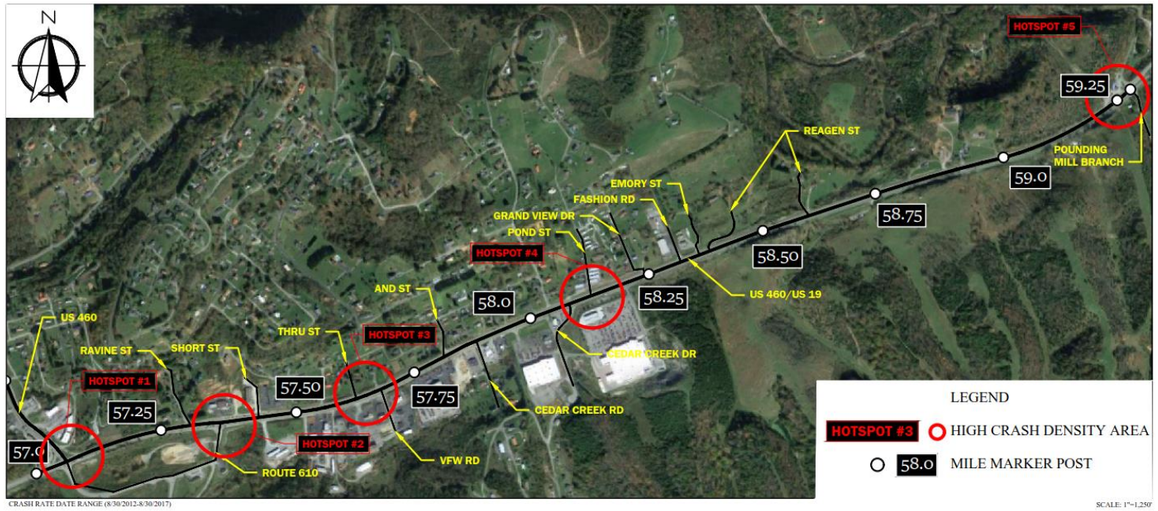
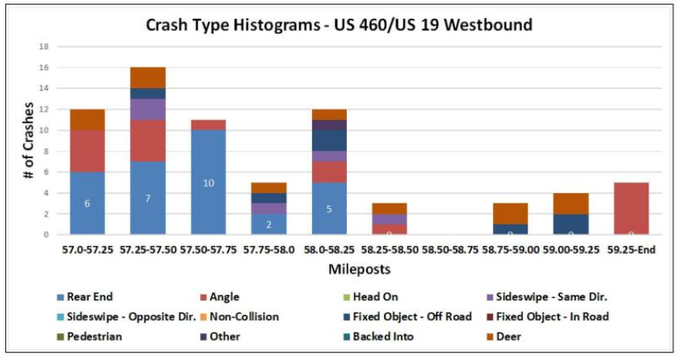
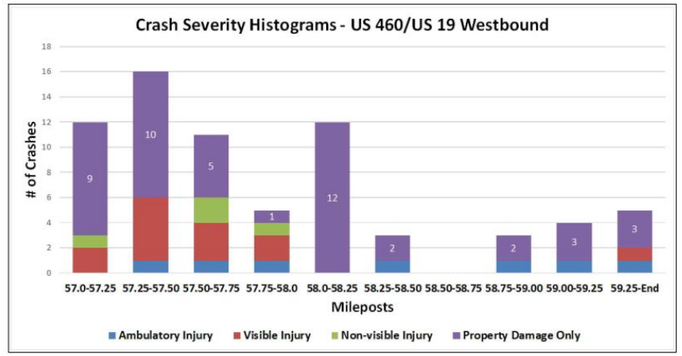
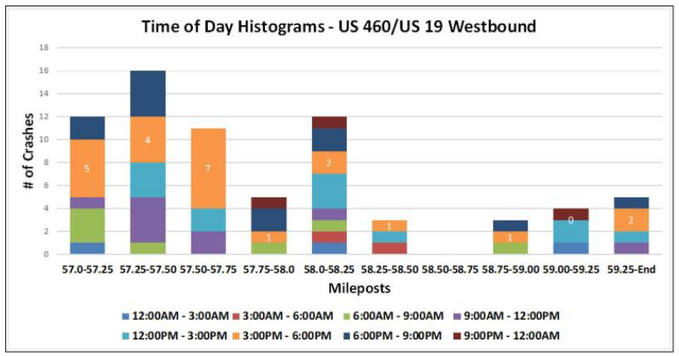


Figure 29. Crash Density Histograms per ¼-mile (US 460/US 19 Westbound).









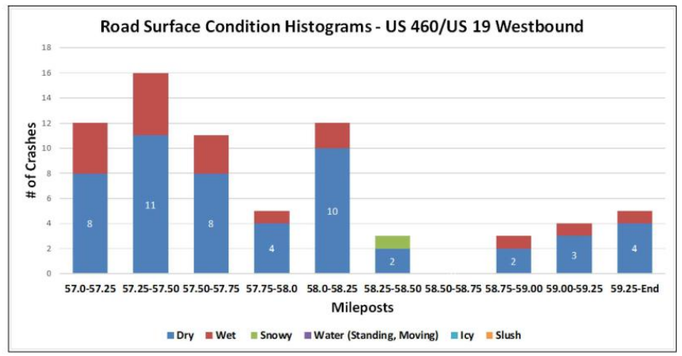
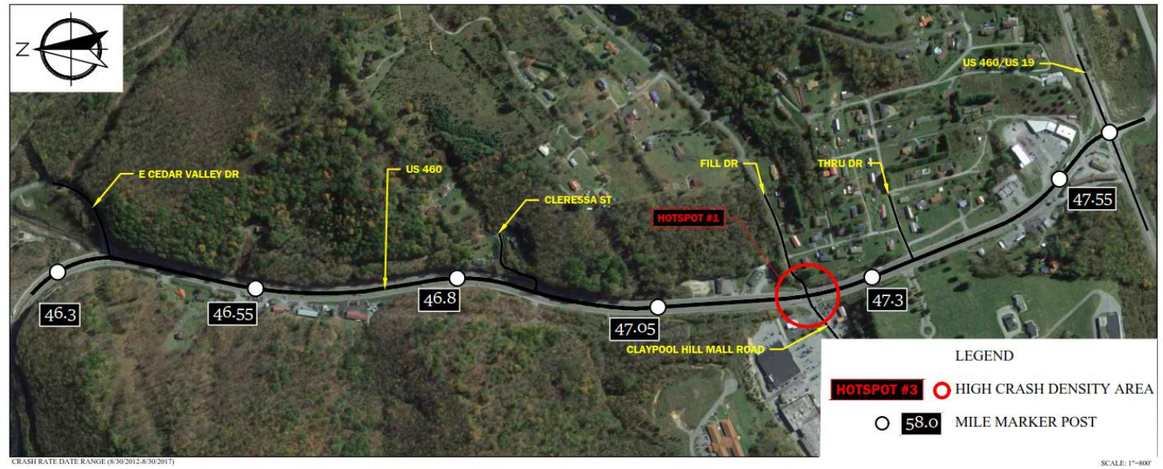
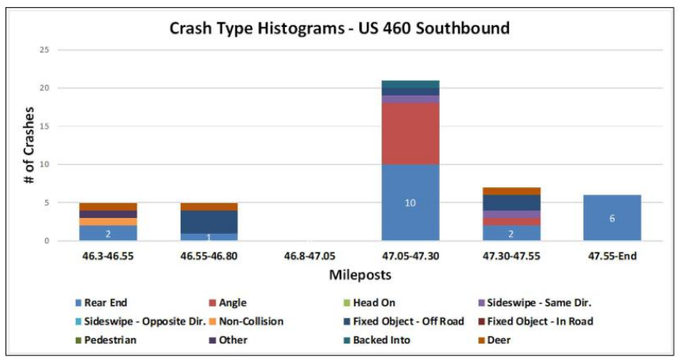
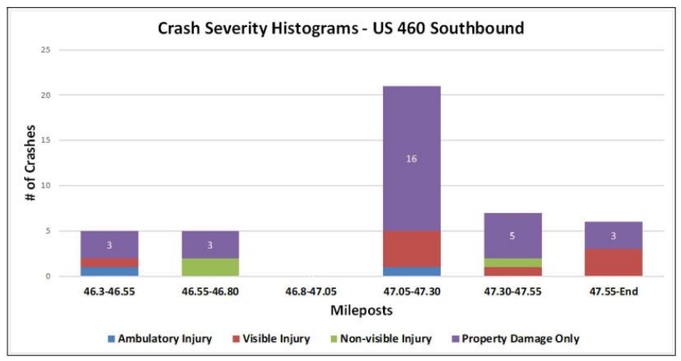
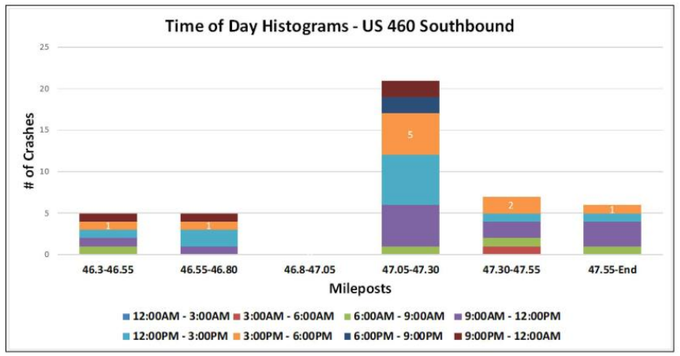


Figure 30. Crash Density Histograms per ¼-mile (US 460 Southbound).









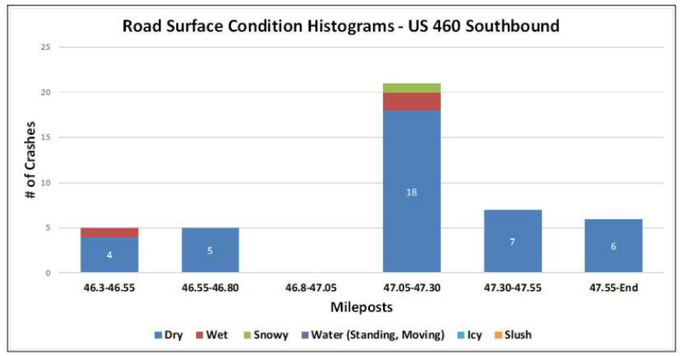
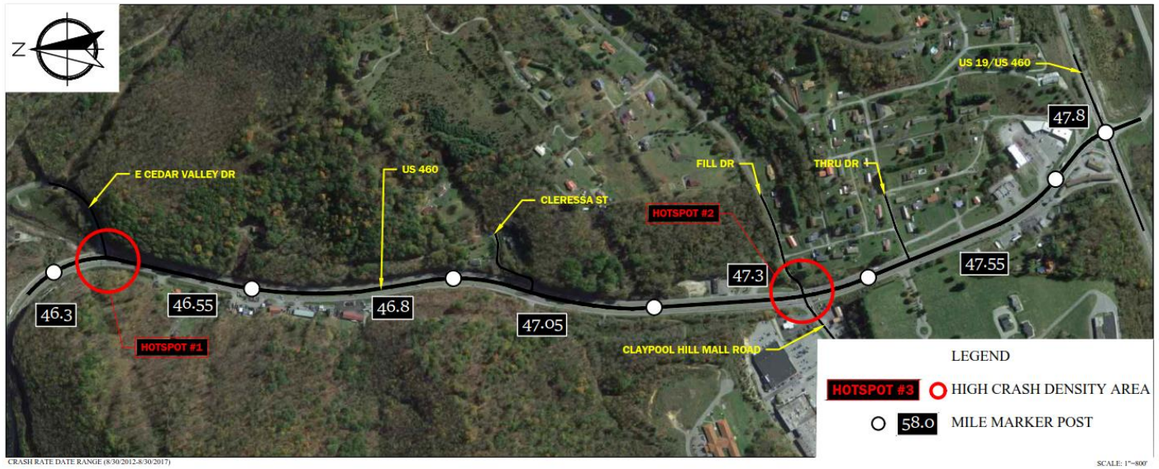
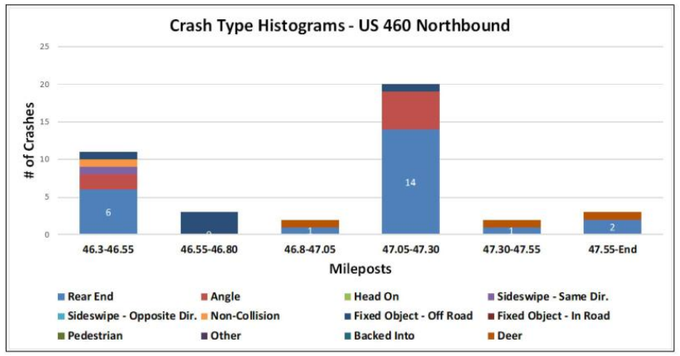
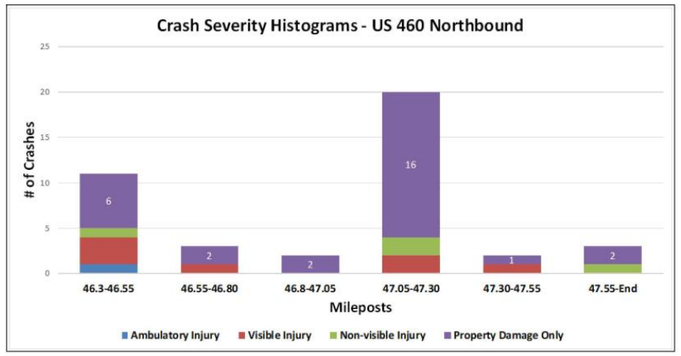
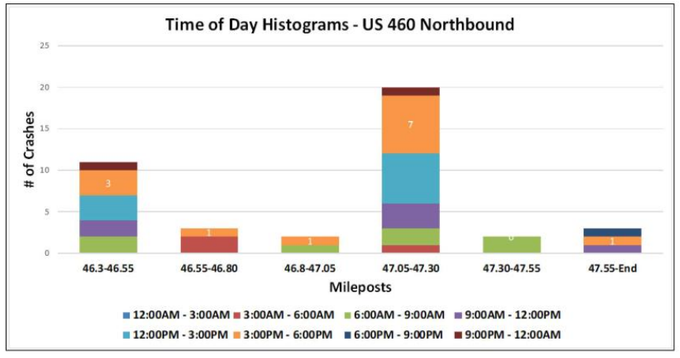


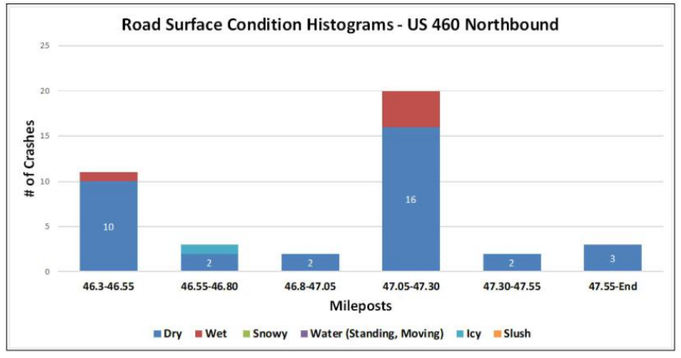
Figure 31. Crash Density Histograms per ¼-mile (US 460 Northbound).











4.2.6 Crash Rate (by intersection and segment)

The crash rates were calculated utilizing the rate calculations described in the *Highway Safety Manual*. For our project areas, crash rates were calculated by using the road segment equation and intersection equation. These areas are provided in **Table 11** and **Table 12**. Road segments that exceed the statewide average for the same type of facility are shaded in red in **Table 12**.

Table 11. Crash rates (intersections).

Intersection	Total Crash Rate (Per MEV)	Fatal Crash Rate (Per MEV)	Injury Crash Rate (Per MEV)	PDO Crash Rate (Per MEV)
US 460 BUS (E Cedar Valley Dr.)	0.24	0.00	0.11	0.13
Claypool Hill Mall Rd.	0.51	0.00	0.17	0.34
US19	0.53	0.00	0.16	0.37
SR610	0.62	0.00	0.30	0.32
Holiday Inn	0.47	0.00	0.27	0.21
Rte 1249 (Cedar Creek Drive)	0.38	0.00	0.14	0.24

Table 12. Crash rates (segments).

Segment	Total CR (Per 100 MVM)		Statewide Average (2015)	Fatal CR (Per 100 MVM)		Statewide Average (2015)	Injury CR (Per 100 MVM)		Statewide Average (2015)	PDO CR (Per 100 MVM)		Statewide Average (2015)
US 460 BUS to Claypool Hill Mall Rd.	66.28	≤	151.62	NA	≤	0.86	15.78	≤	51.77	50.50	≤	98.99
Claypool Hill Mall Rd. to US19	99.44	≤	151.62	NA	≤	0.86	30.60	≤	51.77	68.84	≤	98.99
US460/US19 intersection to SR610	119.80	≤	151.62	NA	≤	0.86	9.98	≤	51.77	109.82	≥	98.99
SR610 to Holiday Inn	140.47	≤	151.62	NA	≤	0.86	70.23	≥	51.77	70.23	≤	98.99
Holiday Inn to Rte 1249	88.73	≤	151.62	NA	≤	0.86	40.33	≤	51.77	48.40	≤	98.99
Rte 1249 to SR637	116.07	≤	151.62	3.41	≥	0.86	27.31	≤	51.77	85.34	≤	98.99

Exceeds the state average crash rate

4.2.7 Crash Data Summary

The following observations were made for crashes that occurred during the five (5) year period on the US 460/US 19 route:

- One (1) fatal pedestrian crash occurred in 2013 during the 12AM to 3AM time period. The collision occurred under dry roadway conditions and in clear weather. The pedestrian was standing in the roadway and was struck by a vehicle.
- 33 percent (33%) of crashes resulted in non-fatal injuries (78 crashes) (i.e., ambulatory, visible, and non-visible injuries).
- 83 percent (83%) of crashes occurred under dry pavement conditions (197 crashes).
- 14 percent (14%) of crashes occurred under wet pavement conditions (34 crashes).
- 44 percent (44%) of crashes that occurred over the five (5) year period were rear-end crashes (103 crashes).
- 22 percent (22%) of crashes that occurred over the five (5) year period were angle crashes (52 crashes).
- 14 percent (14%) of crashes occurred during dark lighting conditions, which includes the following time periods: 9PM–12AM, 12AM–3AM, and 3AM–6AM (33 crashes).
- 13 percent (13%) of crashes (30 crashes) occurred during the AM peak period (6AM–9AM). 27 percent (27%) of crashes (63 crashes) occurred during the PM peak period (3PM–6PM).

4.3 Field Review

Field observations were conducted at the project study area from Monday, January 22, 2018 through Wednesday, January 24, 2018 during the AM and PM peak periods to assess traffic operations, roadway geometrics, safety, queuing, vehicle interaction conflicts, and existing signage. In order to evaluate these conditions within the field, various engineering manuals (e.g. Manual on Uniform Traffic Control Devices (MUTCD), Virginia Supplement to MUTCD, VDOT Traffic Engineering Design Manual (TEDM), 2010 ADA Standards for Accessible Design (ADA)) were used. It should be noted, that while collision diagrams were utilized to determine crash patterns and areas of focus, other recommendations and/or observations were noted that may not be directly related to crash patterns but may reduce the risk of crashes. However, it was important to record all field recommendations and/or observations.

Table 13 lists common observations/recommendations from the field and the respective standards. Note that existing standards will be cited within the Field Review and Recommendations sections for any unique observations/recommendations that are not listed within **Table 13**.

Table 13. Common field observations/recommendations and the associated standards.

Observation/Recommendation	Associated Standard
Pavement marking line extensions through intersections	MUTCD Section 3B.08
Pavement marking arrows	MUTCD Section 3B.24
Stop bar/yield lines are faded and should be refurbished	MUTCD Section 3B.16
Stop sign is not present and should be installed	MUTCD Section 2B.10
Pavement marking stripings	MUTCD Section 3B
Street name sign letter height appears smaller than recommended	MUTCD Section 2D.43

A field review reference figure has been provided in **Appendix** to provide specified locations of each of the numbered field review observations listed in the following sections.

4.3.1 US 460 at US 460 BUS (East Cedar Valley Drive)

- Currently the signal heads for all approaches of the intersection have backplates. With the exception of the southbound approach signal head located on the northwest corner mast arm pole, the signal heads do not have yellow retroreflective borders. Despite having the advanced warning flashing signs prior to intersection along the southbound and northbound approaches, the location, limited lighting, and horizontal and vertical alignment and curvature of the intersection makes visibility of the approaching intersection difficult. *(See Recommendation A1)*
- Overhead street signs on the mast arms are not provided for southbound, northbound, or westbound vehicles. A small street sign post is provided on the northeast corner of the intersection (**Figure 32**). *(See Recommendation A2)*

Figure 32

- The southbound and northbound approach pavement markings are faded (**Figure 32**). Additionally, left turn lane guidance pavement markings are not provided through the intersection for westbound and southbound left-turning vehicles. This intersection does not provide adequate overhead lighting and thus can make these typical turning movements difficult for vehicles to gauge. *(See Recommendation A3)*

4.3.2 US 460 at Fill Street/Claypool Hill Mall Road

- Currently the signal heads for all approaches of the intersection have backplates, however the signal heads do not have yellow retroreflective borders. Based on collision diagrams, rear-end crashes were prominent from 2012 through 2014 and 2016 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A4)*
- Pavement markings are faded for all approaches at the intersection. *(See Recommendation A5)*
- The westbound left sight distance may be obstructed due to the horizontal and vertical alignment of the northbound approach (**Figure 33**). Vehicles were observed making right turn movements from Fill Street onto northbound US 460, which occasionally caused northbound vehicles to brake and/or change lanes suddenly. Based on the collision diagrams, rear-end crashes and side-swipe crashes were prominent along the northbound approach and north leg of the intersection in 2014, 2015, and 2017, and westbound right-turning vehicles entering northbound 460 could be contributing to these crash statistics. *(See Recommendation A6)*

Figure 33

- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the southwest and northeast corners of the intersection. *(See Recommendation A7)*

Figure 34

- The northbound approach right lane does not provide a separate lane for right-turning vehicles and thus acts as a shared through-right lane for northbound approaching vehicles (**Figure 34**). During field reviews, vehicles traveling in the right lane were observed braking abruptly and in some cases changing lanes quickly at the intersection in order to avoid rear-ending northbound right-turning vehicles. Based on the collision diagrams, rear-ends were prominent along the northbound approach in 2014, 2015, and 2017, and the lack of lane assignment notice could be attributing to these crash statistics. *(See Recommendation A8)*

4.3.3 US 460 from Claypool Hill Mall Road to US 460/US 19

- At the intersection of US 460 and Greenhills Memorial Gardens Entrance, the northbound left turn lane does not provide left turn arrow pavement markings and the median delineation (yellow dashed lines) stripings are faded. *(See Recommendation A9)*
- At the intersection of US 460 and Autozone Entrance, the southbound left turn lane does not provide left turn arrow pavement markings and the median delineation (yellow dashed lines) stripings are faded. *(See Recommendation A10)*

Figure 35

- Currently, approximately 830 feet east of the Claypool Hill Mall Road intersection, along the northbound lanes, two signal ahead advanced warning sign panels (W3-3) are provided on the sides of the road. The sign panel on the left side of the road, along the northbound lanes, is complemented with flashers; however, no flashing signal is provided with the advanced warning sign panel on the right side of the road (**Figure 35**). Based on the collision diagrams, rear-end crashes were prominent along the northbound lanes during 2014, 2016, and 2017, which could be attributed to these less distinct advanced warning signal signs. *(See Recommendation A11)*

4.3.4 US 460 at US 460/US 19

- Currently the signal heads for all approaches of the intersection have backplates, however the signal heads do not have yellow retroreflective borders. Based on collision diagrams, rear-end crashes were prominent from 2012 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A12)*
- Pavement markings are faded for all approaches and legs at the intersection. *(See Recommendation A13)*
- Overhead street signs on the mast arms are not provided for any approaching vehicles. Route shield signs for the eastbound, westbound, and southbound approaches are provided. *(See Recommendation A14)*
- The southbound approach to the intersection, based on the horizontal alignment of the approach, may have limited sight distance and ultimately has an obstructed view due to the Timberline Lodge building located on the northwest corner of the intersection (**Figure 36 and Figure 37**). Additionally, the plaque sign located on the northwest corner is obstructed due to vegetation. Based on the collision diagrams, rear-end crashes were prominent from 2012 through 2014 along the southbound approach. The lack of advanced warning signage provided along the southbound approach could be contributing to these crash statistics. *(See Recommendation A15)*

Figure 36

Figure 37

Figure 38

- Currently, the eastbound left turn channelized pocket lane is approximately 110 feet long. During the AM and PM peak hours, vehicle queues were observed extending outside of the lane, and ultimately extending into the eastbound through lane (**Figure 38**). Additionally, vehicles were observed unable to make it through the left turn phase in one cycle during the AM and PM peak hours. *(See Recommendation A16)*
- Currently, vegetation, located on the northwest corner of the intersection, is obstructing southbound vehicles views (exiting the Timberline Lodge) of southbound US 460 right turning vehicles. *(See Recommendation A17)*

Figure 39

- Currently, the northbound approach right turn lane operates as a free-flow right turn lane, and vehicles are provided a receiving lane along the east leg of the intersection (**Figure 39**). Based on the collision diagrams, rear-end crashes were observed along the east leg of the intersection in 2016 and 2017. This free-flow right turn could be factoring into these crash statistics. *(See Recommendation A18)*
- Currently, a yield condition exists for southbound right turning vehicles proceeding westbound (**Figure 40**). Vehicles were observed stopping along the right turn approach, in order to yield into the westbound through lane, despite having their own receiving lane. *(See Recommendation A19)*

Figure 40

Figure 41

- Currently, a yield condition exists for westbound right turning vehicles proceeding northbound (**Figure 41**). Vehicles were observed stopping along the right turn approach, in order to yield into the northbound through lane, despite having their own receiving lane. *(See Recommendation A20)*
- During the PM peak hour period, vehicle queues were observed extending back north along the southbound approach and ultimately prevented vehicles from making right turns until the southbound through phase had green indication (**Figure 42**). This is partially due to the fact that the existing conditions do not provide a separate right turn lane for the southbound approach, therefore queued vehicles in the southbound through lane created vehicle blockages for the southbound right turn lane and partially because the signal timings may need to be adjusted. Additionally, during the PM peak hours, current green times do not provide the adequate times necessary for vehicles to proceed through in one cycle. *(See Recommendation A21)*

Figure 42

4.3.5 US 460/US 19 from US 460 to Route 610

- Currently, this eastbound stretch of corridor along US 460/US 19 is a downhill stretch to the next intersection, approximately 1,600 feet north. While the intersection of US 460/US 19 at Route 610 is in sight for eastbound approaching vehicles, there are no advanced warning signal signs. Due to the vertical and horizontal alignments of this section, vehicles appear to be observed traveling in excess of the posted speed limit of 45 mph. Vehicles proceeding along this section of corridor were observed either abruptly stopping or braking harder, due to the excessive speeds and the reaction to the US 460/US 19 at Route 610 red light signal. Based on the collision diagrams, rear-end crashes were prominent from 2012 through 2014, and could be correlated with the proximity of these two intersections and lack of signage. *(See Recommendation A22)*

4.3.6 US 460/US 19 at Route 610

- Currently the signal heads for all approaches of the intersection have backplates, however the signal heads do not have yellow retroreflective borders. Based on collision diagrams, rear-end crashes were prominent from 2012 through 2015, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A23)*
- Pavement markings are faded for the eastbound, westbound, and northbound approaches, as well as the lane guidance striping in the intersection. Additionally, the southbound approach does not currently provide a stop bar. Vehicles were observed stopped in locations that extended into the intersection (**Figure 43**). *(See Recommendation A24)*
- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the southeast corner of the intersection. *(See Recommendation A25)*

Figure 43

Figure 45

- Currently, the northbound approach exists as a right turn only condition. To enforce this right turn only condition, delineation posts are provided to act as a make-shift right turn channelized lane; however, these posts are broken and do not completely direct vehicles to the east leg receiving/merge lane. Additionally, two no left turn sign panels (R3-2) and a "Right Turn Only" sign panel (R3-5R) are provided along the right side of the northbound approach (**Figure 44**). Despite having all of these features, vehicles were observed make an illegal left turn as the design of the northbound approach does not provide a physical restriction for the northbound right turn conditions (**Figure 45**). In 2012 and 2013, angle related crashes related to the northbound approach occurred and may be due to these insufficient approach restrictions. *(See Recommendation A26)*

Figure 44

- During PM peak hour observations, vehicle queues, due to the McDonald's drive thru, were observed extending back to the intersection (**Figure 46 and Figure 47**). In some scenarios, westbound right turning vehicles and eastbound left turning vehicles were unable to turn into the driveway due to the drive thru queues. In these scenarios, vehicles were left extending into the intersection. Please note that there is not a feasible option to mitigate this issue; however, this condition should be further evaluated as it is impacting operations at the intersection.

Figure 46

Figure 47

4.3.7 US 460/US 19 from Route 610 to Holiday Inn Entrance (Clay Drive)

- At the intersection of US 460/US 19 at Short Street, the southbound approach does not provide a stop bar or "Stop" sign panel (R1-1).
- At the intersection of US 460/US 19 at Rink Street, the southbound approach pavement markings are faded. *(See Recommendation A27)*
- At the intersection of US 19/US 460 at Clay Drive, the northbound approach pavement markings are faded. *(See Recommendation A28)*
- At the intersection of US 19/US 460 at Thru Drive, the southbound approach pavement markings are faded. *(See Recommendation A29)*
- Currently, this eastbound stretch of corridor along *US 460/US 19* is a downhill stretch to the next intersection. While the intersection of *US 460/US 19* at Clay Drive is in sight for eastbound approaching vehicles, no advanced warning signal sign panels or flashers are provided along the sides of the road. Due to the vertical alignment of this section, vehicles appeared to be traveling in excess of the speed limit of 45 mph. Vehicles proceeding along this section of corridor were observed either abruptly stopping or braking harder, due to their increased speeds and in reaction to the US 460/US 19 at Clay Drive red light signal. Based on the collision diagrams, rear-end crashes were prominent from 2015 through 2016, and could be correlated with the lack of signage. *(See Recommendation A30)*
- Currently, a partially paved shoulder lane exists between the intersection of US 460/US 19 at Route 610 and the intersection of US 460/US 19 at Clay Drive. Along this stretch of corridor, several commercial driveways and unpaved roadway entrances exist along the right side of the road along the eastbound lanes (**Figure 48**). The stretch of road is a downhill segment in which vehicles appear to be traveling in excess of the posted speed limit of 45 mph. During the field review, vehicles were entering and exiting these driveways along this stretch of corridor frequently. *(See Recommendation A31)*

Figure 48

4.3.8 US 460/US 19 at Holiday Inn Entrance (Clay Drive)

- Currently, the signal heads for all approaches of the intersection have backplates, however the signal heads do not have yellow retroreflective borders. Based on collision diagrams, rear-end crashes were prominent from 2013 through 2014 and from 2016 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A32)*
- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the southeast corner of the intersection. *(See Recommendation A33)*
- Pavement markings are faded along the southbound and westbound approaches of the intersection. Additionally, the westbound right lane acts as a through/right lane, and does not provide a shared through/right pavement marking arrow. *(See Recommendation A34)*
- Currently, the northbound right turn lane is a right turn only condition; however, no signage is provided for vehicles.

4.3.9 US 460/US 19 from Holiday Inn Entrance (Clay Drive) to Route 1249 (Cedar Creek Drive)

- At the intersection of US 460/US 19 at And Street, the southbound approach does not provide a stop bar or pavement markings. Additionally, the westbound right turn lane does not provide a right turn pavement marking arrow. *(See Recommendation A35)*

- At the intersection of US 460/US 19 at Pond Street, the southbound approach does not provide a stop bar or pavement markings. Additionally, the westbound right turn lane does not provide a right turn pavement marking arrow. *(See Recommendation A36)*
- Currently, a partially paved shoulder lane exists between the intersection of US 460/US 19 at Clay Drive and the intersection of US 460/US 19 at Route 1249. Along this stretch of corridor, several commercial driveways and unpaved roadway entrances exist along the right side of the road along the eastbound lanes (**Figure 49**). The stretch of road is a downhill segment in which vehicles appear to be traveling in excess of the posted speed limit of 45 mph. During the field review, vehicles were entering and exiting these driveways along this stretch of corridor frequently. *(See Recommendation A37)*

Figure 49

4.3.10 US 460/US 19 at Route 1249 (Cedar Creek Drive)

- Currently the signal heads for all approaches of the intersection have backplates, however the signal heads do not have yellow retroreflective borders. *(See Recommendation A38)*
- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the southwest corner of the intersection. *(See Recommendation A39)*
- Pavement markings are faded along all approaches of the intersection. *(See Recommendation A40)*
- Currently, the eastbound right turn lane is a terminal lane; however, no indication is provided for vehicles that the lane is a right turn only condition. *(See Recommendation A41)*
- The northbound right turn lane left sight distance may be obstructed due to the location of the stop bar for the northbound through and left turn lanes (**Figure 50**). *(See Recommendation A42)*

Figure 50

4.3.11 US 460/US 19 from Route 1249 (Cedar Creek Drive) to Route 637 (Pounding Mill Branch Road)

- At the intersection of *US 460/US 19* at Emory Street, the southbound approach does not provide a stop bar or "Stop" sign panel (R1-1). *(See Recommendation A43)*
- At the intersection of *US 460/US 19* at Grand View Drive, the southbound approach does not provide a stop bar or "Stop" sign panel (R1-1). *(See Recommendation A44)*
- At the intersection of *US 19/US 460* at Reagan Street, the southbound approach does not provide a stop bar or "Stop" sign panel (R1-1). *(See Recommendation A45)*
- Currently, the eastbound and westbound lanes speeds transition from 45 mph to 55 mph from just north of the Route 1249 intersection to north of the Route 637 intersection. Despite the posted speed limits, vehicles appeared to be traveling in excess of the posted speed limits. Additionally, along the stretch of corridor, several private driveways and small streets exist, which vehicles were observed frequently entering or exiting. These sporadic driveways do not provide channelized pocket lanes for vehicles to decelerate upon exiting US 460/US 19. During field reviews, vehicles attempting to turn right in either the eastbound or westbound direction were forced to significantly reduce their speeds from 55 mph in order to safely take the right turn. The right lane operates as a shared through right lane for vehicles turning onto these driveways or streets. This shared lane condition coupled with little overhead lighting forced (as observed in the field) through vehicles to brake or change lanes abruptly in order to avoid near-miss rear-end collisions. The limited lighting and high posted speed along this corridor posed unsafe conditions for through and right turning vehicles. Based on the collision diagrams, non-collision crashes, such as overturns, fire/explosion, running of road, or cargo loss, along with one pedestrian crash occurred from 2012 through 2017, and were a result of speeding and visibility issues along this corridor segment's eastbound and westbound lanes. *(See Recommendation A46)*

4.3.12 US 460/US 19 at Route 637 (Pounding Mill Branch Road)

- The pavement marking for all approaches at the intersection are faded. *(See Recommendation A47)*
- Currently, the northbound left sight distance is limited due to the horizontal and vertical alignment of the eastbound approach (**Figure 51**). The eastbound approach provides vehicles advanced warning intersection sign panels (W2-1) and 45 mph speed limit advisory signs, with advanced flashing signals along the side of the road; however, vehicles appeared to be not adhering to this cautionary speed limit. Northbound vehicles were observed making turning movements within inadequate gaps in order to proceed eastbound or westbound due to the limited sight distance and the speeds of eastbound traveling vehicles. *(See Recommendation A48)*

Figure 51

4.3.13 Overall Corridor

- Private driveways occur frequently along the US 460/US 19 corridor, and in most cases, these driveways provide little to no pavement markings and/or signage. While the County of Tazewell or VDOT is not responsible for the maintenance of private driveways the lack of these improvements could be contributing to unsafe vehicular movements and crashes along the corridor.
- No pedestrian facilities are provided along the corridor. Additionally, intersections along both roadway sections provide little to no pedestrian accommodation. Please note, while this corridor is not occupied by high densities of pedestrian traffic, this corridor does have the right-of-way to provide adequate pedestrian facilities. *(See Recommendation A49)*
- The corridor provides little to no overhead lighting along the sides of the road for this stretch of roadway. Businesses along the corridor provide overhead lighting which helps light the corridor; however, this is not adequate lighting for the subject roadway. *(See Recommendation A50)*
- Signalized intersections along the corridor experienced queuing issues at some approaches, and in some scenarios prevented or blocked other movements from proceeding. These blockages could be contributing to some of the crashes as vehicles approach or proceed through the intersection. *(See Recommendation A51)*

4.4 Recommendations

4.4.1 US 460 at US 460 BUS (East Cedar Valley Drive)

A1. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A2. Consider installing sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.
A3. Refurbish pavement markings for southbound and northbound approaches. Additionally, consider providing pavement lane guidance striping through the intersection for southbound and westbound left-turning vehicles, per standards outlined in **Table 13**.

4.4.2 US 460 at Claypool Hill Mall Road

A4. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.
A5. Refurbish pavement markings for all approaches of the intersection, per standards outlined in **Table 13**.
A6. Consider implementing a no turn on red condition for the westbound approach and install a "No Turn On Red" sign panel (R10-11) on the mast arm. Preventing permissive right-turning movements for the westbound approach could mitigate future rear-end crashes and side-swipe crashes.
A7. Consider installing sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.
A8. Consider installing "Right Lane Must Turn Right" sign panel (R3-7R) along the eastbound side of road.
A9. Consider installing a through/right overhead lane assignment sign panel (R3-6R) on the northbound approach mast arm. Additionally, consider installing through/right turn pavement marking arrows along the northbound right lane, per standards outlined in **Table 13**. Implementing advanced warning countermeasures as these could mitigate future rear-end crashes along the northbound approach and through the intersection.

4.4.3 US 460 from Claypool Hill Mall Road to US 19

A10. Refurbish the median delineation pavement stripings, install a stop bar (westbound approach), and install left turn arrow pavement markings (northbound left turn lane), per standards outlined in **Table 13.**
A11. Refurbish the median delineation pavement stripings and install left turn arrow pavement markings on the southbound left turn channelized lane, per standards outlined in **Table 13.**
A12. Consider installing a supplementary flasher to the existing advanced warning signal sign panel (W3-3) on the right side of the road. Providing a more accurate precautionary warning to northbound approaching vehicles could mitigate future rear-end crashes.

4.4.4 US 460 at US 19

A13. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.
A14. Refurbish pavement markings for all approaches, legs, and lane guidance markings (in the intersection) of the intersection, per standards outlined in **Table 13**.
A15. Consider installing sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.
A16. Consider installing a signal ahead advanced warning sign panel (W3-3), along the sides of the road of the southbound approach. Additionally, trim vegetation on the northwest corner of the intersection that is currently obstructing the plaque sign for southbound approaching vehicles. Providing advanced warning signs for the upcoming signal to southbound traveling vehicles could improve and mitigate future rear-end crashes along the southbound approach.
A17. Consider extending the channelized left-turn lane further west to adequately handle the vehicle queues that were observed during the AM and PM peak hours.
A18. Trim the vegetation that is located on the northwest corner of the intersection.
A19. Consider installing a raised corner island at the southeast corner of the intersection for the northbound channelized right turn lane**.** Implementing this median could mitigate future rear-end and side swipe crashes along the east leg of the intersection. Additionally, consider installing lane ends merge left sign panel (W4-2) along the right side of the northbound to eastbound right turn receiving lane.
A20. Consider installing an added lane sign panel (W4-3) in the landscape section in between the southbound right turn lane and the westbound through lane (facing westbound through vehicles) and along the southbound right turn lane.
A21. Consider installing an added lane sign panel (W4-3) in the landscape section in between the westbound right turn lane and the northbound through lane (facing northbound through vehicles) and along the westbound right turn lane.
A22. Evaluate the need to construct and extend the current channelized right turn lane to extend back north along the southbound approach. Providing the additional lane could improve PM peak queues as well as mitigate rear-end crashes that were prominent along the southbound approach.

4.4.5 US 460/US 19 from US 460 to Route 610

A23. Consider installing advanced warning signal sign panels (W3-3) along the sides of the road. For the purposes of consistency, we are providing this recommendation as these advanced warning signs were used up-stream between the intersections of US 460/US 19 at Clay Drive and US 460/US 19 at Route 1249 (Cedar Creek Drive). Providing advanced warning signs along this eastbound approach could provide additional warning to eastbound vehicles and mitigate future rear-end crashes.

4.4.6 US 460/US 19 at Route 610

A24. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.
A25. Refurbish pavement markings for the eastbound, westbound, and northbound approaches and legs. Additionally, refurbish the lane guidance pavement striping (in the intersection), per standards outlined in **Table 13**. Install a stop bar for the southbound approach per standards outlined in **Table 13**.
A26. Consider installing street name sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.
A27. Consider constructing a raised triangle island on the southeast corner of the intersection to enforce the northbound right turn only condition. Implementing this channelized condition would restrict northbound vehicles from attempting to illegally make a northbound left turn at the intersection, and could mitigate future angle crashes for the intersection.

4.4.7 US 460/US 19 from Route 610 to Holiday Inn Entrance (Clay Drive)

A28. Refurbish pavement markings at the southbound approach at the intersection of *US 460/US 19* at Rink Street, per standards outlined in **Table 13**.
A29. Refurbish pavement markings at the northbound approach at the intersection of *US 460/US 19* at Clay Drive, per standards outlined in **Table 13**.
A30. Refurbish pavement markings at the southbound approach at the intersection of *US 460/US 19* at Thru Drive, per standards outlined in **Table 13**.
A31. Consider installing advanced warning signal sign panels (W3-3) along the sides of the road. For the purposes of consistency, we are providing this recommendation as these advanced warning were used up-stream between the intersections of US 460/US 19 at Clay Drive and US 460/US 19 at Cedar Creek Drive. Providing

advanced warning signs along this eastbound approach could provide additional warning to eastbound vehicles and mitigate future rear-end crashes.

A32. Consider constructing an auxiliary right lane along the eastbound lanes of US 1US 460/US 19 for vehicles entering and exiting driveways. Providing this additional lane could mitigate future crashes occurring along this segment of the corridor. Additionally, consider installing a "Watch For Turning Vehicles" warning sign panel along the eastbound lanes sides of the road. Providing additional signage could improve driver's awareness and could potentially mitigate future rear-end crashes.

4.4.8 US 460/US 19 at Holiday Inn Entrance (Clay Drive)

A33. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A34. Consider installing street name sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.

A35. Refurbish the southbound and westbound approaches pavement markings and install a through/right turn pavement marking arrow for the westbound approach right lane, per standards outlined in **Table 13.**

4.4.9 US 460/US 19 from Holiday Inn Entrance (Clay Drive) to Route 1249 (Cedar Creek Drive)

A36. Refurbish the pavement markings and install a stop bar along the southbound approach and install a right turn pavement marking arrow along the westbound right turn lane at the intersection of US 460/US 19 at And Street, per standards outlined in **Table 13**.

A37. Refurbish the pavement markings and install a stop bar along the southbound approach and install a right turn pavement marking arrow along the westbound right turn lane at the intersection of US 460/US 19 at Pond Street, per standards outlined in **Table 13**.

4.4.10 US 460/US 19 at Route 1249 (Cedar Creek Drive)

A38. Consider installing retroreflective yellow borders to all signal heads.

A39. Consider installing street name sign panels on the mast arms for all of the approaches at the intersection, per standards outlined in **Table 13**.

A40. Refurbish pavement markings for all approaches, per standards outlined in **Table 13.**

A41. Consider installing a "Right Turn Only" sign panel (R3-5R) on the mast arm over the eastbound right turn lane.

A42. Due to the proximity of the right turn lane stop bar to the intersection, adjusting the location of the right turn stop bar is not feasible. Consider relocating the northbound through and right turn lanes stop bar further back from the intersection.

4.4.11 US 460/US 19 from Route 1249 (Cedar Creek Drive) to Route 637 (Pounding Mill Branch Road)

A43. Install a "Stop" sign panel (R1-1) and stop bar at the southbound approach of the intersection of US 460/US 19 at Emory Street, per standards outlined in **Table 13.**

A44. Install a "Stop" sign panel (R1-1) and stop bar at the southbound approach of the intersection of US 460/US 19 at Grand View Drive, per standards outlined in **Table 13.**

A45. Install a "Stop" sign panel (R1-1) and stop bar at the southbound approach of the intersection of US 460/US 19 at Reagan Street, per standards outlined in **Table 13.**

A46. Consider implementing overhead lighting along the eastbound and westbound lanes between the intersections of US 460/US 19 at Route 1249 and US 460/US 19 at Route 637. Additionally, consider installing "Hidden Driveway" and/or "Watch For Turning Vehicles" sign panels along the eastbound and westbound sides of the road along this segment. Additionally, consider updating the existing shoulder lane on the driveway/street approaches and legs in order to provide a full auxiliary deceleration/acceleration lane for vehicles entering and exiting the US 460/US 19 corridor. Propose increased law enforcement along this stretch of corridor to potentially promote safer speeds.

4.4.12 US 460/US 19 at Route 637 (Pounding Mill Branch Road)

A47. Refurbish pavement markings for all approaches, per standards outlined in **Table 13.**

A48. Consider performing a speed study in order to assess the need for the speed limit to be adjusted to a regulated 45 mph speed. Adjusting the speed limit for this stretch of corridor could provide drivers with more time to react for both eastbound and northbound vehicles, which could mitigate future angle and rear-end crashes at the intersection. Additionally, propose increased law enforcement for this area to enforce speeds and regulate the speed for approaching eastbound and westbound vehicles.

4.4.13 Overall Corridor

A49. Consider evaluating the need for pedestrian facilities along the corridor and at subject intersections, per standards outlined in **Table 13.**

A50. Consider conducting a lighting study to evaluate the lighting along the corridor.

A51. Consider evaluating and/or optimizing current signal timings along the corridor to help alleviate congestion and queuing issues.

Note: While these recommendations were provided based on the field review, it is up to Tazewell County and the VDOT to provide both input and the final decision on what is to be modified, replaced, and/or updated.

5 Improvement Alternatives

This section summarizes the improvement alternatives considered for the US 460/US 19 corridor. The proposed improvements along US 460/US 19 are primarily driven by a need to address existing and future safety and operational concerns. The alternatives were developed based upon the results of the Existing Conditions and No-Build Conditions analyses, field observation, review of prior studies/recommendations, as well as coordination with VDOT Bristol District, Tazewell County, and the Town of Richlands. An in-person Alternatives Development Workshop was held on February 16, 2018 at the Tazewell County Administration Building.

5.1 Future Year 2027 Build Alternatives

The approximately 4.4-mile study corridor of US 460/US 19 comprises of 15 intersections:

- US 460 and US 460/US 19
- US 460/US 19 and Route 610
- US 460 and Claypool Hill Mall Road
- US 460/US 19 and Holiday Inn Entrance
- US 460/US 19 and Cedar Creek Drive/Pond Street
- US 460/US 19 and Pounding Mill Branch Road

The discussion during the Alternatives Development Workshop primarily focused on these intersection locations, since the congestion and safety issues within the study corridor are centered on these intersections. Several preliminary improvement alternatives were presented based on the operational and safety analysis results. The improvement alternatives were vetted and prioritized by the Study Work Group (SWG) and a list of "Preferred Alternatives" were selected to move forward for the Future 2027 Build Analysis. Planning level conceptual layouts for each of these preferred alternatives were developed and are briefly summarized below. The layouts presented below cover only those locations where improvements are proposed.

5.1.1 Year 2027 Build Option 1

5.1.1.1 Alternative 1A: US 460/US 19 Intersection

This improvement alternative proposes to improve the capacity in the northern quadrant of the intersection by widening the southbound US 460 approach to add right-turn lane storage. An acceleration lane is proposed for the westbound channelized right-turn lane by widening on the outside. The existing chevron markings along westbound US 460/US 19 will be eradicated and restriped as a through lane; the new lane configuration for the westbound approach will be left, 2-throughs, and a right-turn lane. A deceleration lane along westbound US 460 is proposed to accommodate the second through lane westbound. The existing signal timings/splits and phasing are proposed to be optimized to accommodate the geometric improvements and signal coordination. The existing signal is proposed to be coordinated with adjacent signals. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs). **Figure 52** shows the conceptual layout of Alternative 1A at this location.

5.1.1.2 Alternative 1B: US 460/US 19 Intersection

This improvement alternative proposes to improve the intersection by adding capacity in both the northwest and southeast quadrants of the intersection. In addition to the improvements proposed in Alternative 1A, the eastbound receiving deceleration lane for the northbound right turns will be extended to meet the current roadway design standards. The existing signal heads are proposed to be retrofitted with HVBPs. **Figure 53** shows the conceptual layout of Alternative 1B at this location.

5.1.1.3 Alternative 2: US 460/US 19 and Route 610 Intersection

A private developer is planning to develop the southwest quadrant of the intersection. As part of this development, the developer will construct a raised median in the middle of northbound SR 610 approach to create a physical barrier to prohibit left turns. To compliment this planned improvement, this STARS study improvement alternative proposes to install a signal control for the northbound right turns, eliminating the existing free-flow condition. The receiving lane along the eastbound US 460/US 19 for the northbound channeling right-turn lane is proposed to be eliminated. The signal is proposed to be coordinated with the US 460/US 19 intersection and the Holiday Inn (Clay Drive) intersection. In addition, existing signal heads are proposed to be retrofitted with HVBPs. **Figure 54** shows the conceptual layout of Alternative 2 at this location.

5.1.1.4 Alternative 3: US 460 and Claypool Hill Mall Road Intersection

The improvement alternative proposes to convert the entrances to National Bank and the Claypool Gill Mall to right in/right out only access. In addition, existing signal heads are proposed to be retrofitted with HVBPs. **Figure 55** shows the conceptual layout of Alternative 3 at this location.

5.1.1.5 Alternative 4: US 460/US 19 and Holiday Inn (Clay Drive) Intersection

The improvement alternative proposes to coordinate the signal with upstream and downstream signals, optimize signal timings/phasing and splits, and adjust yellow and all red intervals. In addition, existing signal heads are proposed to be retrofitted with HVBPs. **Figure 56** shows the conceptual layout of Alternative 4 at this location.

5.1.1.6 Alternative 5: US 460/US 19 and Cedar Creek Drive/Pond Street Intersection

The improvement alternative proposes to coordinate the signal with upstream and downstream signals, optimize signal timings/phasing and splits, and adjust yellow and all red intervals. Complete intersection lighting is proposed to be installed at the intersection. In addition, existing signal heads are proposed to be retrofitted with HVBPs. **Figure 57** shows the conceptual layout of Alternative 5 at this location.

5.1.1.7 Alternative 6: US 460/US 19 and Pounding Mill Branch Road Intersection

The improvement alternative proposes to install Intersection Conflict Warning System (ICWS), including detection of approaching/stopped vehicles on the minor street approaches and alerting the drivers on the major street approaches via flashing beacons with warning signs and larger regulatory and warning signs to command attention of the drivers. A splitter island is proposed at the northbound and southbound approaches with STOP signs installed on both sides, along with pavement markings with supplementary message "STOP AHEAD" for these approaches. **Figure 58** shows the conceptual layout of Alternative 6 at this location.

5.1.1.8 Alternative 7: Access Management Measures

The improvement alternative proposes to address access management issues throughout the corridor.

Figure 52. Alternative 1A (Option 1) Conceptual Layout (US 460/US 19 Intersection)

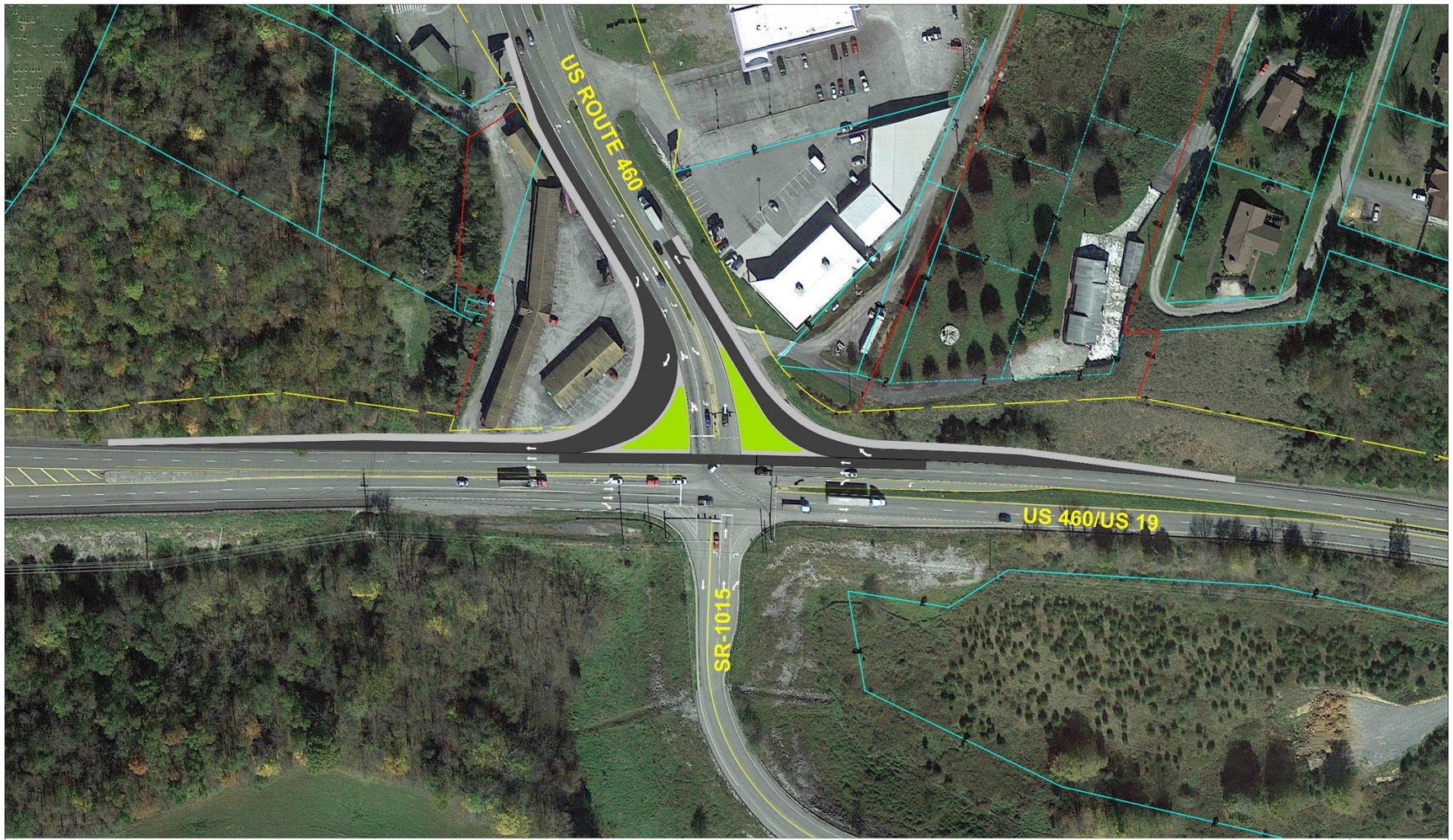


Figure 53. Alternative 1B (Option 1) Conceptual Layout (US 460/US 19 Intersection)

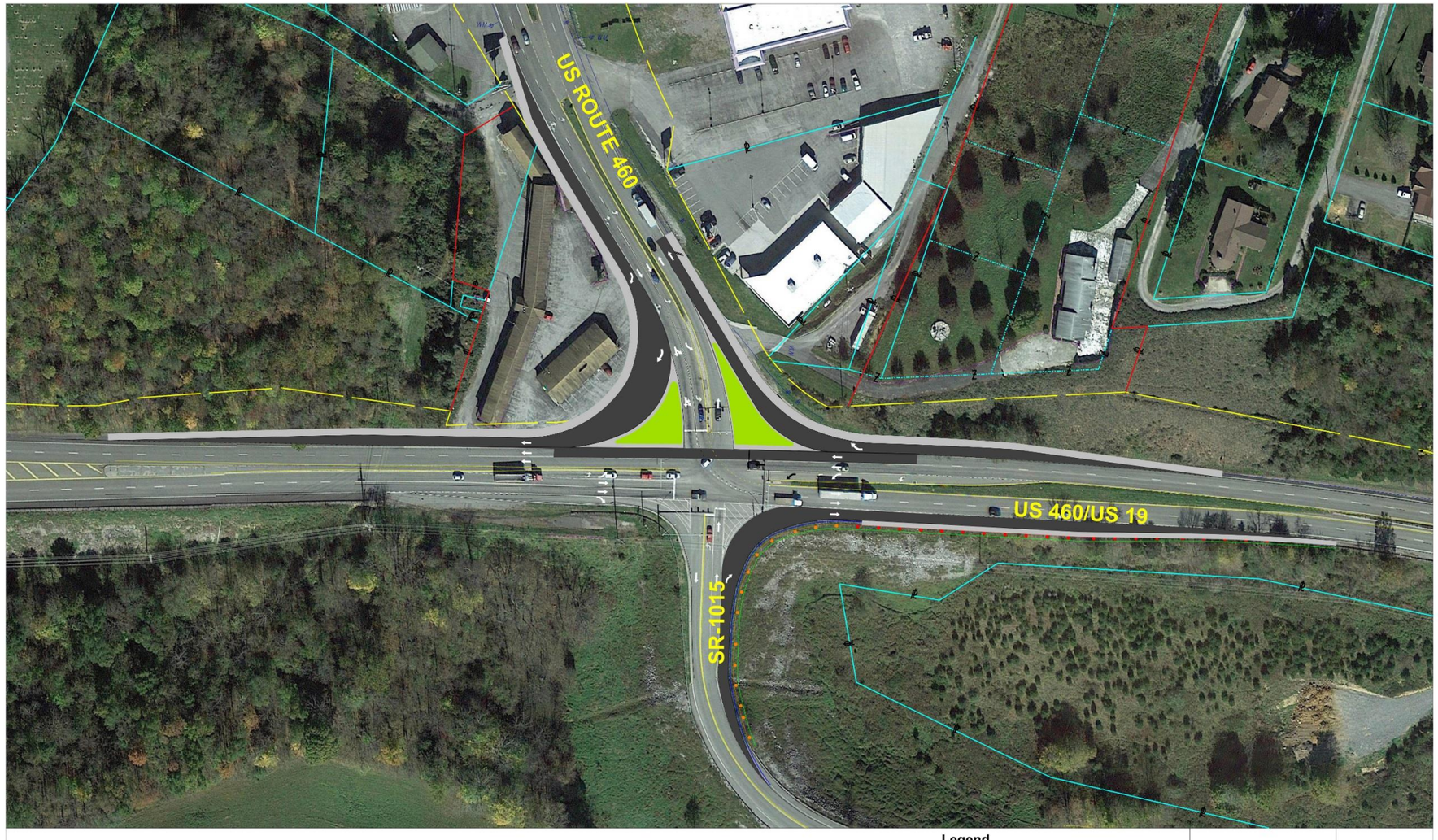


Figure 54. Alternative 2 (Option 1) Conceptual Layout (US 460/US 19/SR 610 Intersection)

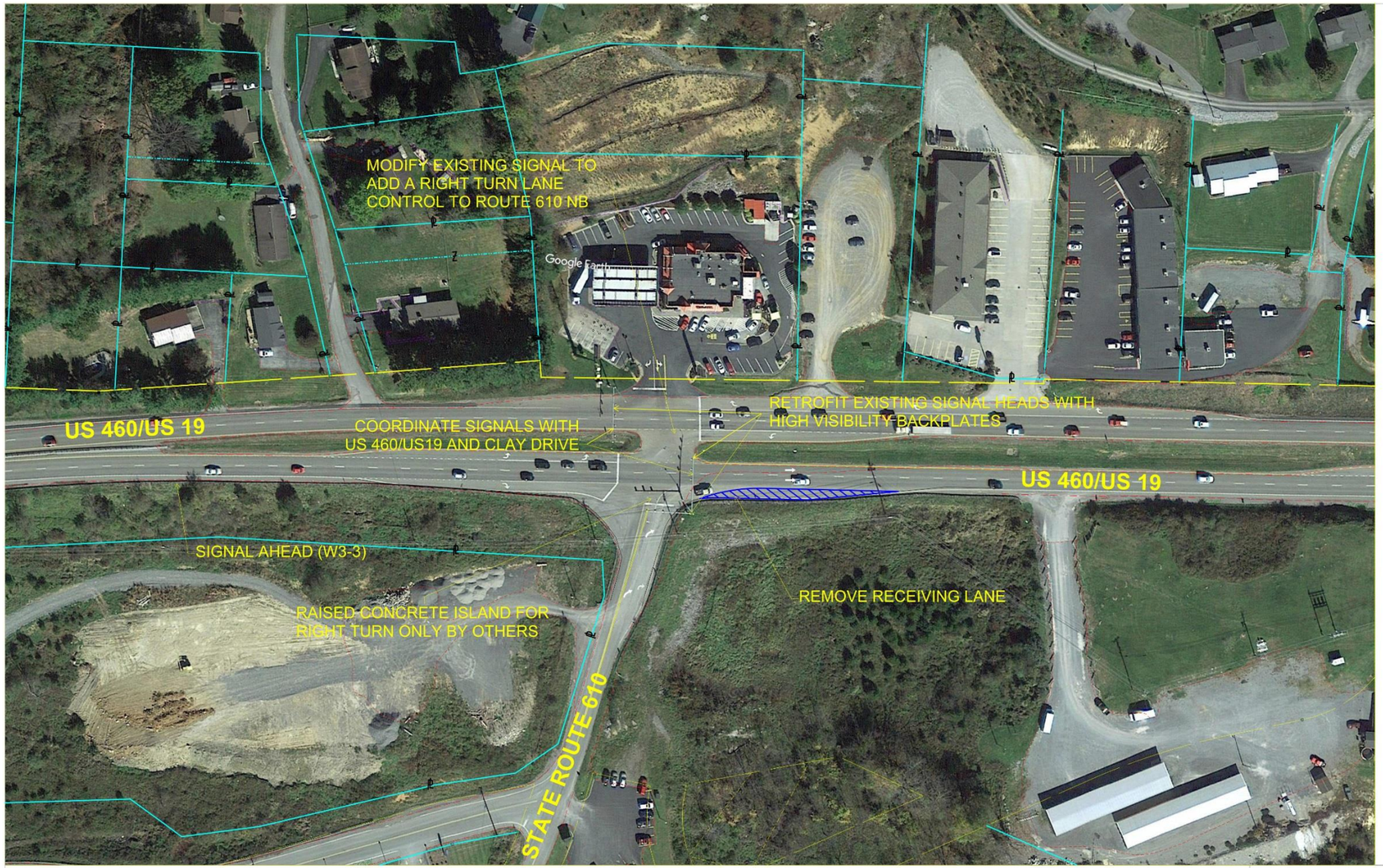


Figure 55. Alternative 3 (Option 1) Conceptual Layout (US 460/SR 610 Intersection)

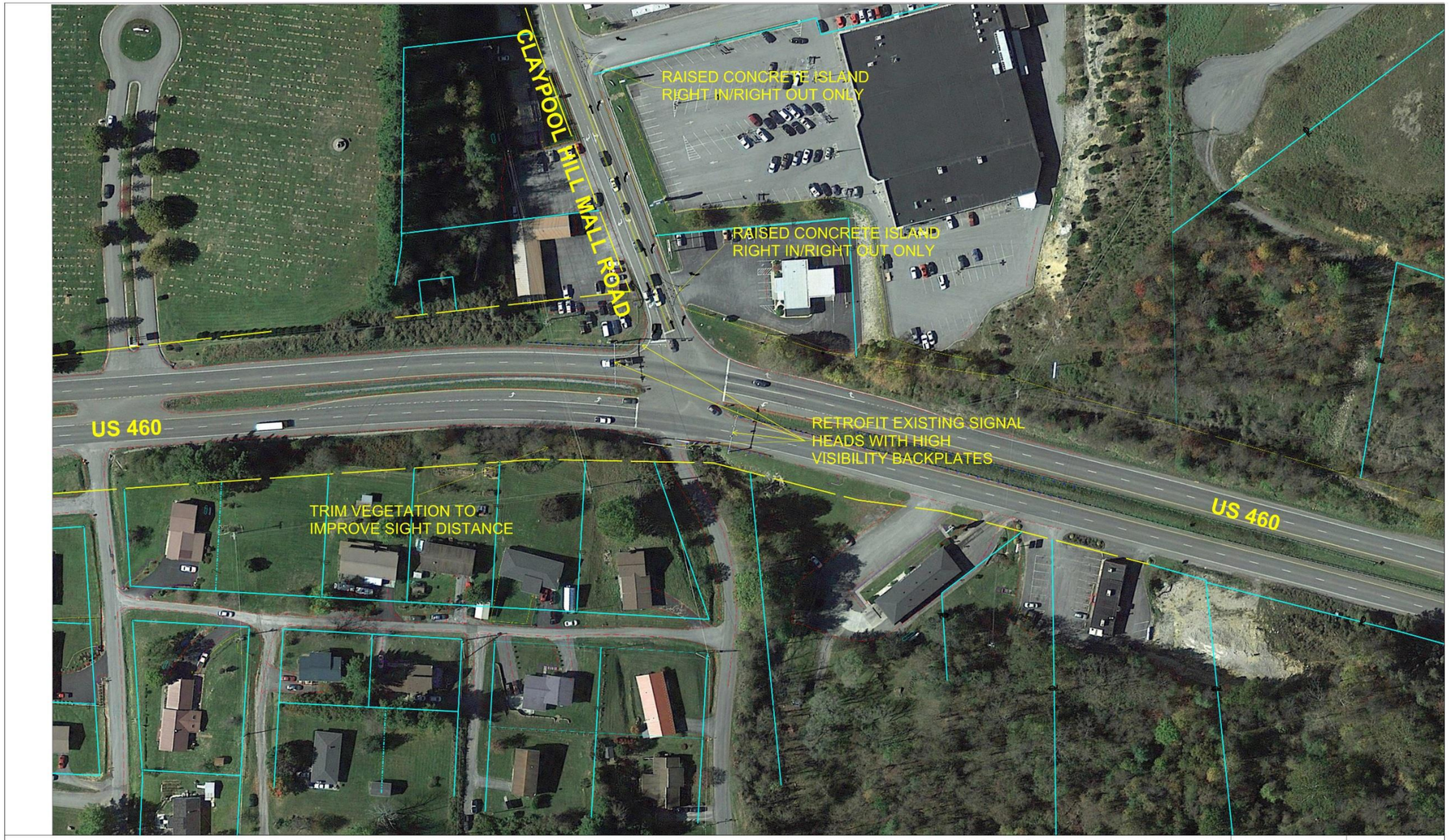


Figure 56. Alternative 4 (Option 1) Conceptual Layout (US 460/US 19/Clay Drive Intersection)

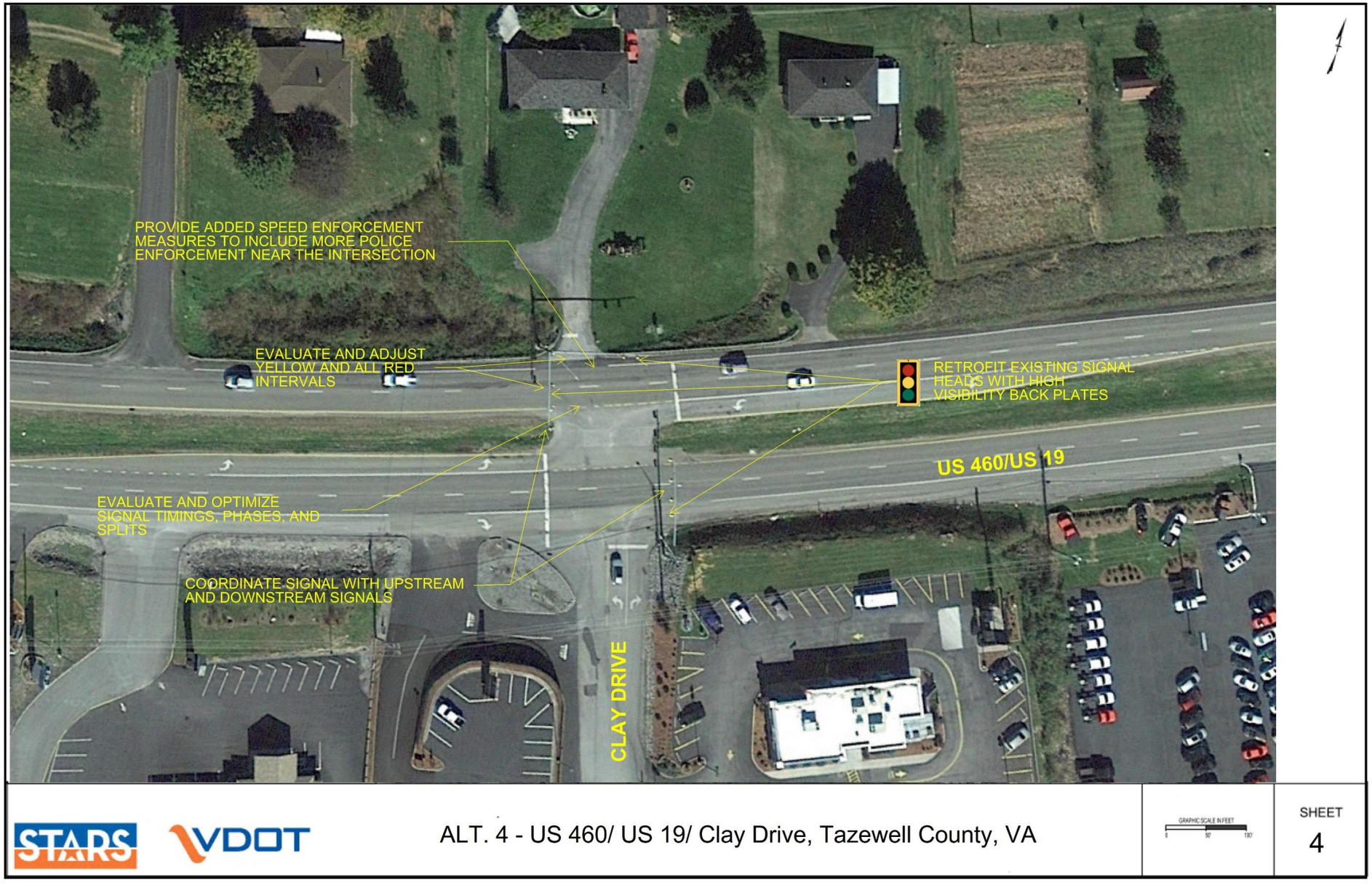


Figure 57. Alternative 5 (Option 1) Conceptual Layout (US 460/US 19/Cedar Creek Drive Intersection)

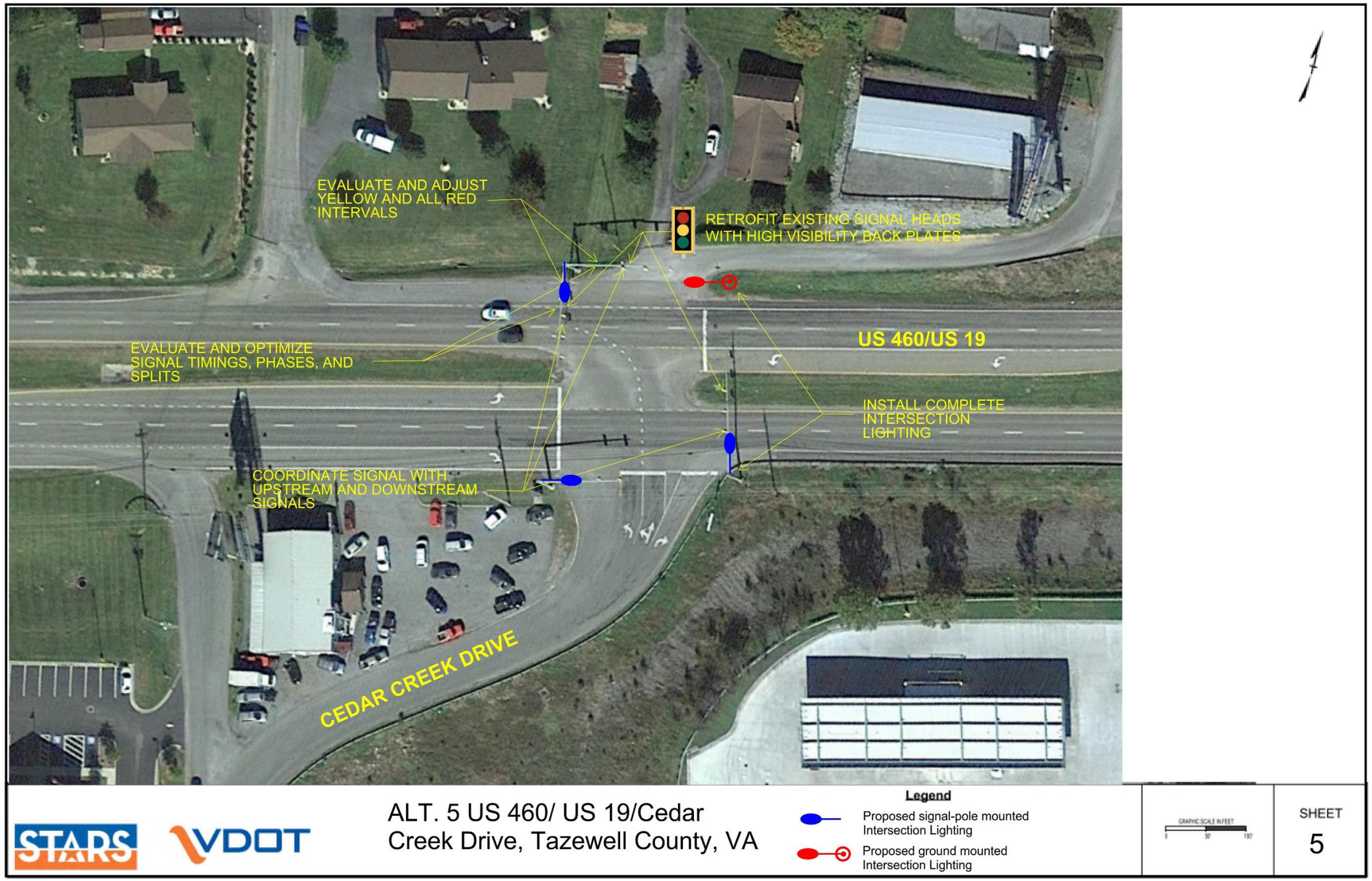
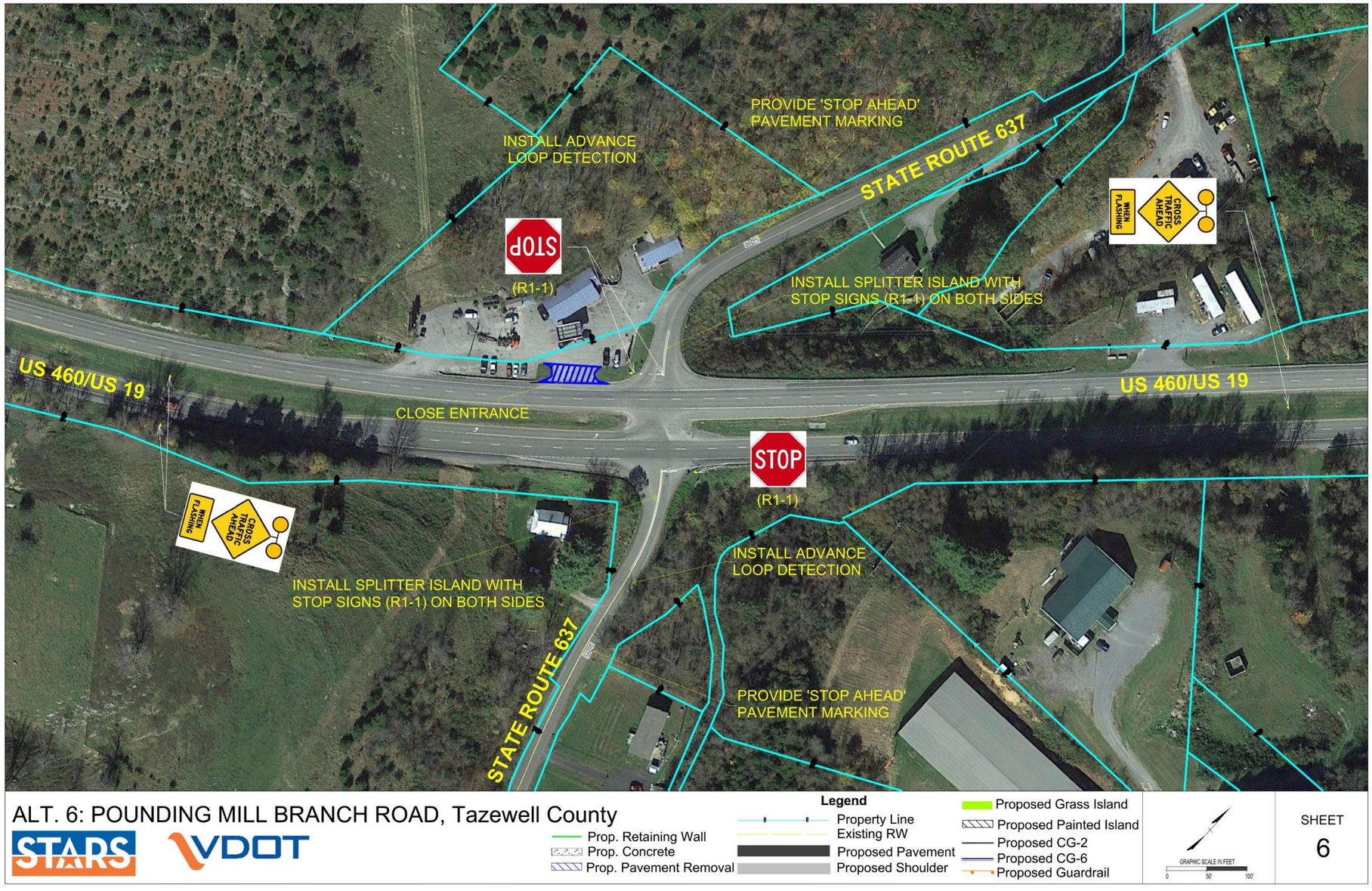


Figure 58. Alternative 6 (Option 1) Conceptual Layout (US 460/US 19/SR 637 Intersection)



5.1.2 Year 2027 Build Option 2

5.1.2.1 Alternative 2: US 460/US 19 and Route 610 Intersection

The improvement alternative proposes to convert the intersection to a Restricted Crossing U-Turn (RCUT) layout. The signal is proposed to be coordinated with the upstream and downstream signals intersection. In addition, the existing signal heads are proposed to be retrofitted with HVBPs. **Figure 59** shows the conceptual layout of Alternative 2 at this location.

5.1.2.2 Alternative 3: US 460 and Claypool Hill Mall Road Intersection

The improvement alternative proposes to convert the intersection to a Continuous Green-T layout, by permanently closing the westbound approach of Fill Street and detouring it to Link Street. To accommodate the proposed detour traffic from Fill Street, it is recommended to improve Link Street within the available right-of-way. In addition, the existing signal heads are proposed to be retrofitted with HVBPs. **Figure 60** shows the conceptual layout of Alternative 3 at this location.

Figure 59. Alternative 2 (Option 2) (RCUT Intersection) Conceptual Layout (US 460/US 19/SR 610 Intersection)

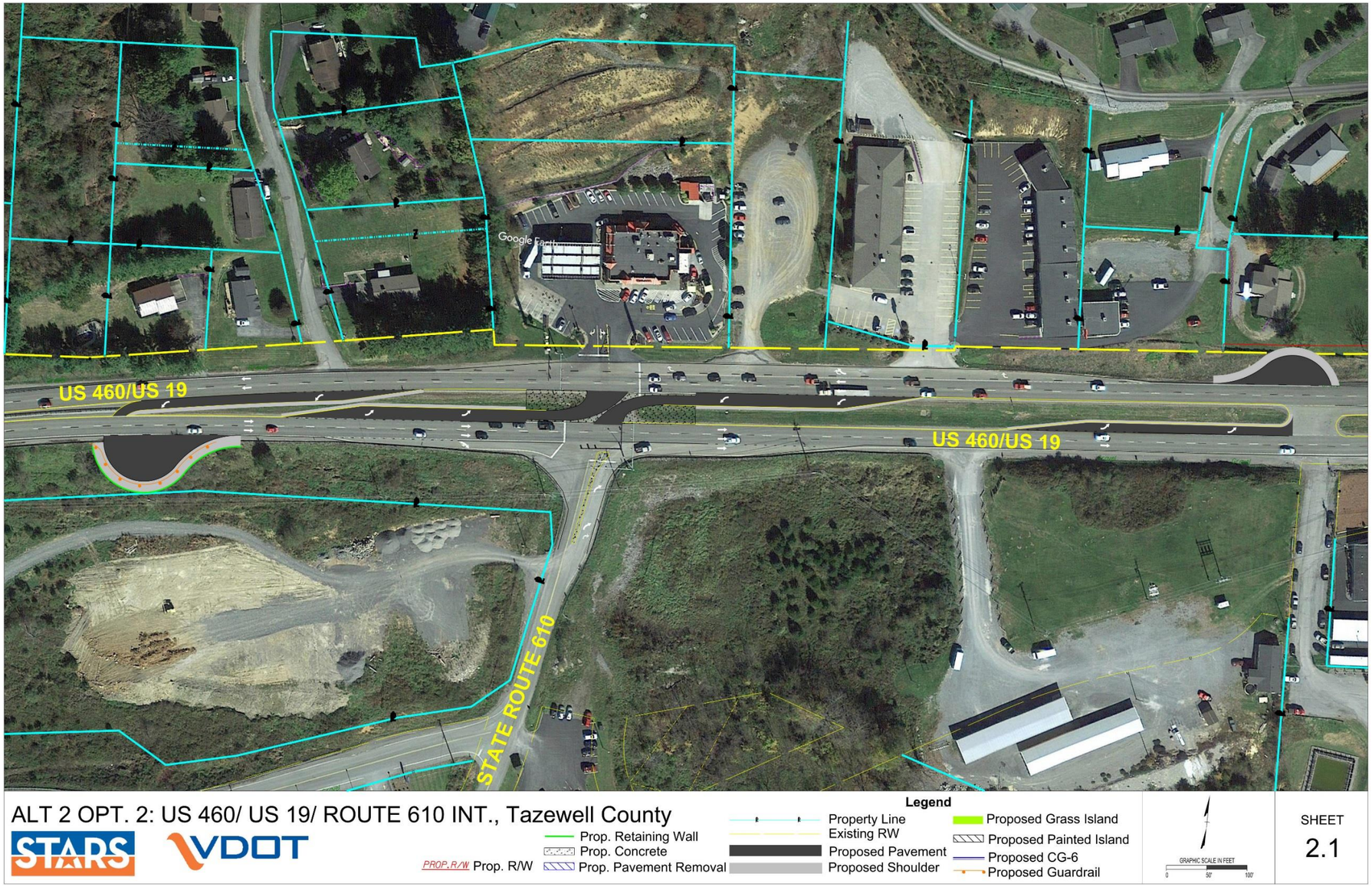
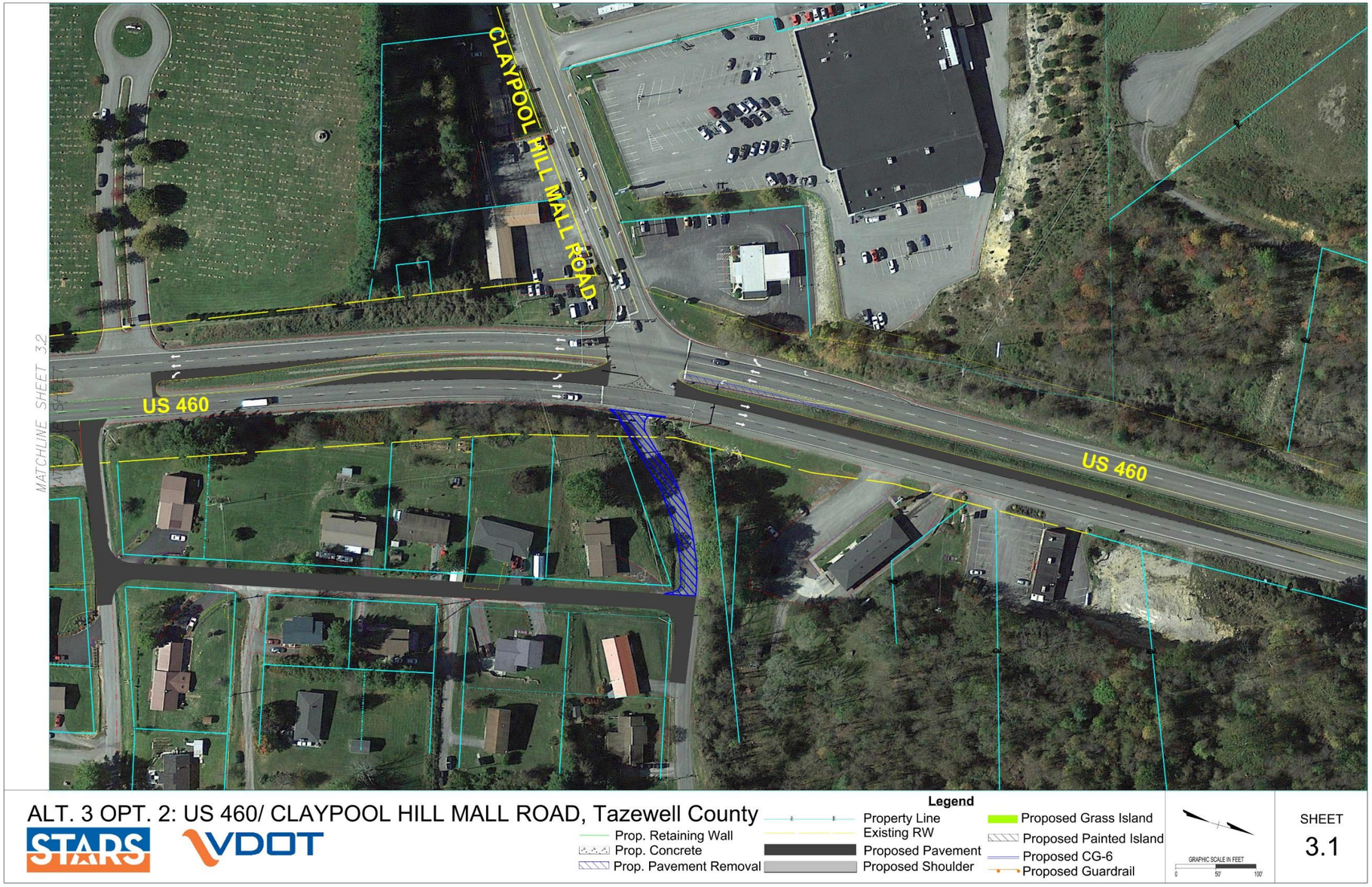


Figure 60. Alternative 3 (Option 2) (Continuous Green-T Intersection) Conceptual Layout (US 460/Claypool Hill Mall Road Intersection)



6 FUTURE 2027 BUILD CONDITIONS

The “Preferred Alternatives” from the alternatives development exercise were distributed among the members of SWG for feedback. Their feedback was further discussed, vetted and included in the final alternative conceptual layouts. These alternatives were modeled in Synchro and evaluated using SimTraffic for the Future 2027 Build condition traffic operations.

6.1 Intersection Operations: Future 2027 Build Condition

Operational analysis was performed at each of the study intersections for the 2027 Future Build Condition. The Synchro models were developed to test the combination of alternatives for the entire corridor. For example, Option 1A alternative at the intersection of US 460/US 19 was tested in combination with the Option 1 improvement alternatives at all other intersections. Similarly, Option 1B alternative at US 460/US 19 intersection was tested in combination with the Option 2 alternatives at intersections where these improvements are proposed. **Table 14** summarizes the Option 1 average AM and PM peak hour delay for each movement for the study intersections along the corridor. The SimTraffic outputs and screen capture of *VDOT Sample Size Determination Tool* can be found in **Appendix**. **Figure 61** shows the intersection delay for Option 1 graphically.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2027 Build conditions. *SimTraffic* Maximum Queue Lengths in feet were reported for each lane. These queue lengths are based on an average of 10 simulation runs. **Table 15** summarizes the maximum queue lengths during the AM and PM peak hours for Option 1.

Table 16 summarizes the Option 2 average AM and PM peak hour delay for each movement for the study intersections along the corridor. **Figure 62** shows the intersection delay for Option 2 graphically. **Table 17** summarizes the maximum queues during the AM and PM peak hours for Option 2.

Table 14. Future 2027 Build (Option 1) SimTraffic AM(PM) Peak Hour Delay

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
1 US 460 and Cedar Valley Drive					Cedar Valley Dr		US 460		US 460			
	Signal	Left	†	†	15.9	16.8	16.2	14.3	34.1	22.2	Delay	Delay
		Through	†	†	†	†	9.0	8.4	6.6	5.1	8.4	7.3
		Right	†	†	1.8	1.3	5.1	5.6	†	†		
		Approach	†	†	15.2	16.2	8.5	8.1	6.7	5.2		
2 US 460 and Claypool Hill Mall Rd/ Fill St			Claypool Hill Mall Rd		Claypool Hill Mall Rd		US 460		US 460			
	Signal	Left	26.1	25.9	33.4	40.1	28.1	37.4	40.8	46.7	Delay	Delay
		Through	†	†	34.1	47.0	9.4	16.9	15.9	22.7	13.4	19.4
		Right	5.4	8.8	9.0	9.5	0.0	12.0	5.2	6.8		
		Approach	20.8	17.6	14.2	16.0	11.1	19.0	14.1	20.5		
3 US 460 and Thru Dr/ Greenhills Memorial Gardens Entrance			Greenhill Mem Gardens		Thru Dr		US 460		US 460			
	Two-Way Stop	Left	0.0	21.3	16.0	27.5	5.2	8.9	9.4	11.9	Delay	Delay
		Through	†	†	0.0	38.2	1.1	1.1	4.0	5.0	2.9	3.6
		Right	4.8	10.0	7.0	7.5	0.5	0.5	2.5	3.6		
		Approach	5.7	14.4	9.6	15.3	1.2	1.2	4.1	5.4		
4 US 460 and Gas Station Entrance					Gas Station Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	†	†	†	†	0.6	0.4	1.1	1.5	0.9	1.1
		Right	†	†	5.1	5.8	0.1	†	†	†		
		Approach	†	†	5.1	5.8	0.6	0.4	1.1	1.5		
5 US 460 and Autozone Entrance					Autozone Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	29.5	75.3	†	†	7.0	13.4	Delay	Delay
		Through	†	†	†	†	7.9	9.2	0.7	1.0	4.6	5.5
		Right	†	†	4.1	11.4	6.5	7.4	†	†		
		Approach	†	†	16.8	25.9	7.9	9.2	0.8	1.0		
6 US 460 and US 460/19			US 460/19		US 460/19		US 460		US 460			
	Signal	Left	31.2	39.0	26.2	31.5	30.2	33.7	28.4	35.3	Delay	Delay
		Through	11.7	16.8	25.2	33.5	34.4	42.1	27.9	42.5	19.0	23.7
		Right	1.4	1.8	6.0	6.4	0.0	4.8	4.0	5.1		
		Approach	19.9	22.0	13.2	15.9	33.3	39.8	21.9	29.8		

Future 2027 Build (Option 1) SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
8 US 460/19 and VDOT AHQ			US 460/19		US 460/19		VDOT AHQ					
	Two-Way Stop	Left	5.3	8.1	4.8	9.1	19.7	23.8	†	†	Delay	Delay
		Through	3.0	3.8	1.6	1.9	†	†	†	†	2.4	3.0
		Right	3.2	4.6	†	†	4.9	8.0	†	†		
		Approach	3.0	3.9	1.7	2.0	16.4	12.5	†	†		
9 US 460/19 and Holiday Inn Entrance			US 460/19		US 460/19		Holiday Inn Entrance					
	Signal	Left	21.6	†	21.7	32.5	24.5	36.5	†	†	Delay	Delay
		Through	3.2	13.9	3.3	3.6	†	†	†	†	3.9	10.4
		Right	2.2	11.5	†	†	5.1	8.3	†	†		
		Approach	3.8	13.7	3.7	5.4	16.8	20.7	†	†		
10 US 460/19 and Cedar Creek Road			US 460/19		US 460/19		Cedar Creek Rd					
	Two-Way Stop	Left	4.5	7.4	3.4	6.0	0.0	30.8	†	†	Delay	Delay
		Through	1.6	4.1	0.5	0.6	†	†	†	†	1.0	2.7
		Right	†	†	†	†	0.0	10.6	†	†		
		Approach	1.6	4.2	0.5	0.6	0.0	22.3	†	†		
11 US 460/19 and Tractor Supply Entrance			US 460/19		US 460/19		Tractor Supply Entrance					
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	0.6	1.7	0.5	0.6	†	†	†	†	0.6	1.1
		Right	0.0	0.7	†	†	3.9	4.8	†	†		
		Approach	0.6	1.5	0.5	0.6	3.9	4.8	†	†		
12 US 460/19 and Pond Street			US 460/19		US 460/19				Pond St			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	0.9	1.9	1.5	1.9	†	†	†	†	1.2	1.8
		Right	0.4	0.8	0.7	0.9	†	†	4.3	5.2		
		Approach	0.8	1.7	1.5	1.8	†	†	4.3	5.2		
13 US 460/19 and Grannys Lane/ Cedar Creek Dr (Rte 1249)			US 460/19		US 460/19		Grannys Rd		Grannys Rd			
	Signal	Left	15.9	24.7	17.9	16.4	12.3	14.7	19.7	30.4	Delay	Delay
		Through	2.9	4.5	5.0	7.5	9.2	11.5	0.0	14.4	4.7	7.0
		Right	0.0	1.3	0.0	4.0	4.2	4.6	4.6	6.6		
		Approach	3.2	4.5	5.0	7.4	10.1	14.2	7.9	12.7		

Future 2027 Build (Option 1) SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19		US 460/19		Walmart Entrance					
	Two-Way Stop	Left	†	†	6.6	7.0	14.5	22.8	†	†	Delay	Delay
		Through	1.9	2.2	2.8	3.5	†	†	†	†	3.0	5.2
		Right	1.6	1.9	†	†	5.8	15.0	†	†		
		Approach	1.9	2.2	3.2	3.7	9.5	18.8	†	†		
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19		US 460/19		Route 637		Route 637			
	Two-Way Stop	Left	4.5	6.2	2.0	2.9	17.6	23.1	19.2	18.9	Delay	Delay
		Through	3.5	4.2	1.0	1.0	16.2	0.0	19.5	21.6	3.9	3.4
		Right	2.9	4.1	0.0	0.2	6.2	6.5	0.0	4.6		
		Approach	3.5	4.4	1.0	1.0	16.3	20.3	19.4	8.3		

NOTE: Microsimulation Delay (sec/veh) results shown represent an average of 10 SimTraffic runs.
† Movements without conflicting movements. Delay cannot be reported.

Figure 61. Future 2027 Build (Option 1) AM(PM) Peak Intersection Operations Results

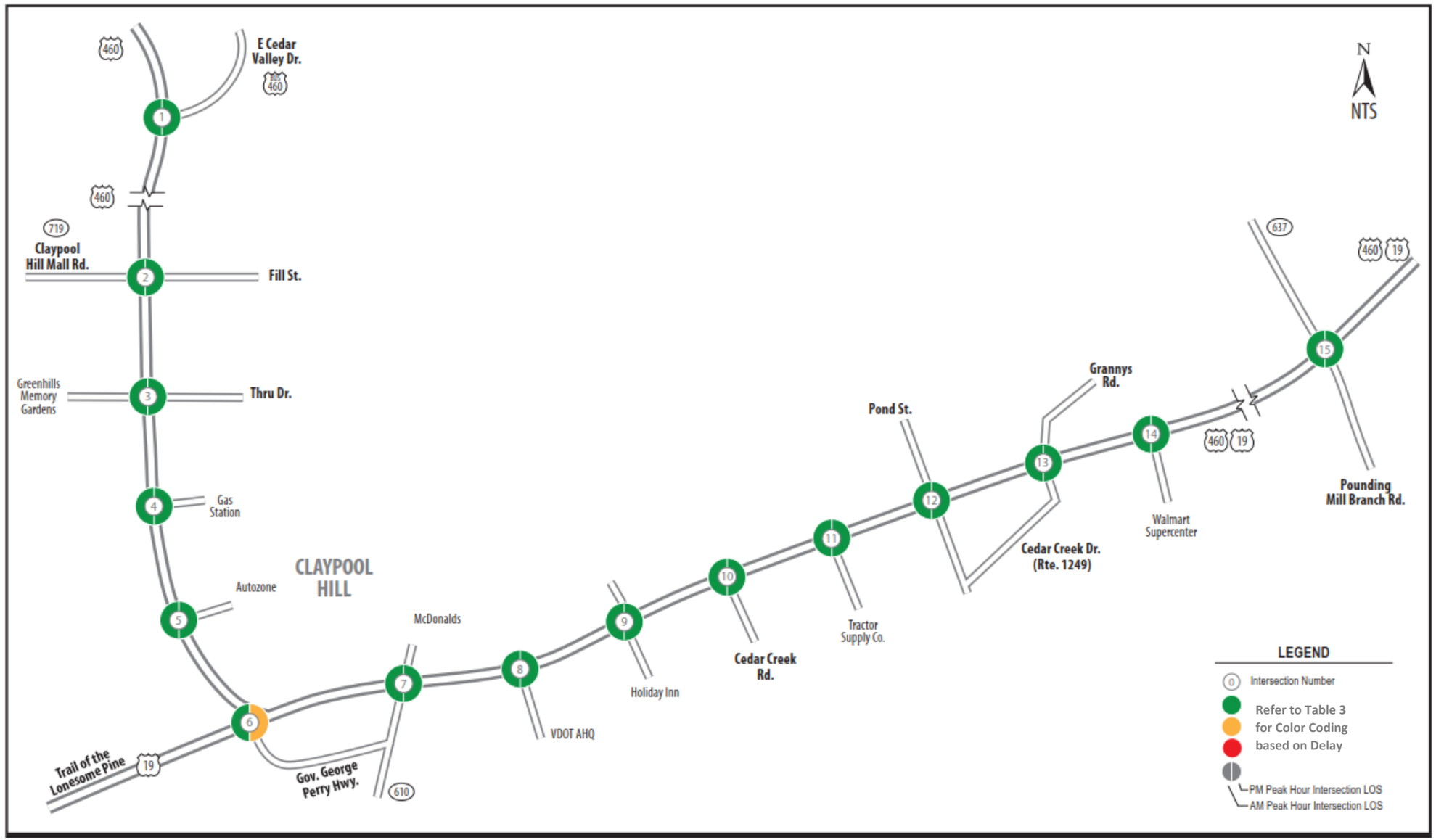


Table 15. Future 2027 Build (Option 1) Conditions: Summary of Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 US 460 and Cedar Valley Drive						Cedar Valley Dr			US 460			US 460		
	Signal	Left	N/A	†	†	N/A	139	104	50	40	39	150	29	74
		Through	N/A	†	†	N/A	†	†	N/A	182	158	N/A	151	152
		Right	N/A	†	†	N/A	14	0	325	72	67	N/A	†	†
2 US 460 and Claypool Hill Mall Road			Claypool Hill Mall Rd			Claypool Hill Mall Rd			US 460			US 460		
	Signal	Left	N/A	114	180	N/A			270	108	169	125	66	106
		Through	N/A	†	†	N/A	69	51	N/A	162	258	N/A	187	267
		Right	340	56	135	N/A			N/A	175	267	220	138	171
3 US 460 and Thru St/ Greenhills Memorial Gardens Entrance			Greenhills Mem Gardens			Thru St			US 460			US 460		
	Two-Way Stop	Left	N/A			N/A			N/A	55	65	N/A	81	114
		Through	N/A	29	45	N/A	64	55	N/A			N/A		
		Right	N/A			N/A			N/A	7	13	N/A	19	97
4 US 460 and Gas Station Entrance						Gas Station Entrance			US 460			US 460		
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	6	0	N/A	0	0
		Right	N/A	†	†	N/A	76	50	N/A	16	0	N/A	†	†
5 US 460 and Autozone Entrance						Autozone Entrance			US 460			US 460		
	Two-Way Stop	Left	N/A	†	†	N/A	24	55	N/A	†	†	150	34	34
		Through	N/A	†	†	N/A	†	†	N/A	23	38	N/A	42	32
		Right	N/A	†	†	N/A	24	55	N/A	15	25	N/A	†	†
6 US 460 and US 460/19			US 460/19			US 460/19			US 460			US 460		
	Signal	Left	160	138	139	225	23	27	135	84	107	N/A	218	301
		Through	N/A	266	293	N/A	140	166	N/A	121	158	N/A	210	318
		Right	N/A	0	39	N/A	0	0	90	†	24	50	0	243
7 US 460/19 and Route 610/ McDonalds Entrance			US 460/19			US 460/19			Route 610			McDonalds Entrance		
	Signal	Left	230	124	137	150	121	129	N/A	†	†	N/A	85	86
		Through	N/A	172	246	N/A	211	228	N/A	†	†	N/A		
		Right	205	47	79	530	61	50	N/A	32	61	N/A	91	59
8 US 460/19 and VDOT AHQ			US 460/19			US 460/19			VDOT AHQ					
	Two-Way Stop	Left	75	43	36	140	49	54	N/A	46	31	N/A	†	†
		Through	N/A	0	2	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	46	31	N/A	†	†
9 US 460/19 and Holiday Inn/ New Peoples Bank			US 460/19			US 460/19			Holiday Inn Entrance					
	Signal	Left	245	67	0	230	43	94	N/A	33	96	N/A	†	†
		Through	N/A	152	305	N/A	136	110	N/A	†	†	N/A	†	†
		Right	50	52	51	N/A	139	138	N/A	34	63	N/A	†	†

Future 2027 Build (Option 1) Conditions: Summary of Maximum Queues (feet) (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
10 US 460/19 and Cedar Creek Road			US 460/19			US 460/19			Cedar Creek Rd					
	Two-Way Stop	Left	165	32	56	110	28	37	N/A	0	48	N/A	†	†
		Through	N/A	0	0	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	0	48	N/A	†	†
11 US 460/19 and Tractor Supply Entrance			US 460/19			US 460/19			Tractor Supply Entrance					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	30	34	N/A	†	†
12 US 460/19 and Pond Street			US 460/19			US 460/19			Pond St					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	0	30	N/A	0	0	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A			N/A	†	†	N/A	39	37
13 US 460/19 and Grannys Lane/Route 1249			US 460/19			US 460/19			Grannys Rd			Grannys Rd		
	Signal	Left	275	39	36	285	22	14	N/A	54	106	N/A	30	24
		Through	N/A	113	156	N/A	111	159	N/A	58	88	N/A		
		Right	N/A	†	51	N/A	128	182	50	48	41	N/A		
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19			US 460/19			Walmart Entrance					
	Two-Way Stop	Left	N/A	†	†	230	57	42	N/A	84	191	N/A	†	†
		Through	N/A	0	0	N/A	†	†	N/A	†	†	N/A	†	†
		Right	170	6	6	N/A	†	†	N/A	84	191	N/A	†	†
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19			US 460/19			Pounding Mill Branch Rd			Pounding Mill Branch Rd		
	Two-Way Stop	Left	260	40	50	175	12	23	N/A	66	57	N/A	95	65
		Through	N/A	†	†	N/A	†	†	N/A			N/A		
		Right	90	3	3	N/A	†	†	N/A			N/A		

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.

† Queue length for movements with no conflicting volumes.

N/A Storage Bay Length not provided or the movements do not exist.

Table 16. Future 2027 Build (Option 2) SimTraffic AM(PM) Peak Hour Delay

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
1 US 460 and Cedar Valley Drive					Cedar Valley Dr		US 460		US 460			
	Signal	Left	†	†	16.3	16.9	10.9	13.0	21.1	20.6	Delay	Delay
		Through	†	†	†	†	8.1	8.2	6.4	5.3	8.0	7.2
		Right	†	†	1.8	1.3	4.9	4.9	†	†		
		Approach	†	†	15.4	16.2	7.6	7.8	6.5	5.5		
2 US 460 and Claypool Hill Mall Rd/ Fill St			Claypool Hill Mall Rd		Claypool Hill Mall Rd		US 460		US 460			
	Signal	Left	21.8	25.0	†	†	22.7	28.7	†	†	Delay	Delay
		Through	†	†	†	†	1.1	0.0	12.9	19.9	12.8	18.3
		Right	5.9	10.0	†	†	†	†	4.5	6.2		
		Approach	17.1	28.7	†	†	22.1	17.4	11.3	17.9		
3 US 460 and Thru Dr/ Greenhills Memorial Gardens Entrance			Greenhill Mem Gardens		Thru Dr		US 460		US 460			
	Two-Way Stop	Left	6.9	29.6	17.9	25.5	4.8	7.6	7.6	9.9	Delay	Delay
		Through	†	†	0.0	41.9	1.1	0.8	0.8	1.1	1.8	1.8
		Right	6.2	8.0	8.3	10.9	0.4	0.4	0.6	0.6		
		Approach	6.3	17.4	10.4	15.6	1.1	0.9	1.1	1.7		
4 US 460 and Gas Station Entrance					Gas Station Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	†	†	†	†	0.6	0.4	0.7	1.0	0.7	0.8
		Right	†	†	4.9	5.5	0.1	0.0	†	†		
		Approach	†	†	4.9	5.5	0.6	0.4	0.7	1.0		
5 US 460 and Autozone Entrance					Autozone Entrance		US 460		US 460			
	Two-Way Stop	Left	†	†	24.0	43.4	†	†	8.6	11.5	Delay	Delay
		Through	†	†	†	†	7.7	9.2	0.5	0.8	4.4	5.3
		Right	†	†	6.5	11.1	5.6	7.7	†	†		
		Approach	†	†	15.3	19.9	7.7	9.2	0.6	1.1		
6 US 460 and US 460/19			US 460/19		US 460/19		US 460		US 460			
	Signal	Left	31.8	38.4	30.0	61.2	29.7	34.9	24.5	28.2	Delay	Delay
		Through	11.5	16.5	21.2	29.3	33.1	41.4	24.8	33.2	17.4	21.1
		Right	1.5	1.9	5.5	6.2	0.0	2.6	3.7	4.5		
		Approach	19.9	21.6	12.1	15.1	31.7	39.7	18.9	23.7		

Future 2027 Build (Option 2) SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
7 US 460/19 and Route 610/ McDonalds Entrance			US 460/19		US 460/19		Route 610		McDonalds Entrance			
	Signal	Left	28.0	35.8	28.7	31.4	†	†	†	†	Delay	Delay
		Through	9.9	8.3	11.1	7.2	†	†	†	†	5.5	8.5
		Right	2.8	3.1	2.3	1.8	0.7	1.4	0.8	0.5		
		Approach	12.0	9.5	12.2	9.2	0.7	1.4	0.8	0.5		
8 US 460/19 and VDOT AHQ			US 460/19		US 460/19		VDOT AHQ					
	Two-Way Stop	Left	4.1	4.6	5.2	10.1	15.5	31.7	†	†	Delay	Delay
		Through	0.6	0.6	1.6	1.8	†	†	†	†	1.3	1.4
		Right	0.2	0.0	†	†	5.9	8.2	†	†		
		Approach	0.7	0.7	1.8	2.0	13.8	14.1	†	†		
9 US 460/19 and Holiday Inn Entrance			US 460/19		US 460/19		Holiday Inn Entrance					
	Signal	Left	20.3	†	26.9	34.9	22.0	35.1	†	†	Delay	Delay
		Through	3.2	14.3	4.1	3.5	†	†	†	†	4.0	10.5
		Right	2.2	11.6	†	†	4.9	8.5	†	†		
		Approach	3.3	14.0	3.9	5.5	16.3	21.3	†	†		
10 US 460/19 and Cedar Road			US 460/19		US 460/19		Cedar Creek Rd					
	Two-Way Stop	Left	3.8	8.0	3.6	5.5	0.0	30.0	†	†	Delay	Delay
		Through	1.6	4.2	0.5	0.6	†	†	†	†	1.0	2.7
		Right	†	†	†	†	0.0	11.3	†	†		
		Approach	1.6	4.3	0.5	0.6	0.0	20.2	†	†		
11 US 460/19 and Tractor Supply Entrance			US 460/19		US 460/19		Tractor Supply Entrance					
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	0.6	1.6	0.6	0.8	†	†	†	†	0.6	1.2
		Right	0.1	0.8	†	†	4.2	5.4	†	†		
		Approach	0.6	1.5	0.6	0.8	4.2	5.4	†	†		
12 US 460/19 and Pond			US 460/19		US 460/19				Pond St			
	Two-Way Stop	Left	†	†	†	†	†	†	†	†	Delay	Delay
		Through	1.4	2.0	1.1	2.0	†	†	†	†	1.2	1.9
		Right	0.4	0.8	0.6	0.9	†	†	4.3	4.4		
		Approach	1.2	1.8	1.1	1.9	†	†	4.3	4.4		
13 US 460/19 and Grannys Cedar Creek Dr (Rte 1249)			US 460/19		US 460/19		Grannys Rd		Grannys Rd			
	Signal	Left	14.8	22.9	28.4	0.0	13.5	14.7	19.8	30.1	Delay	Delay
		Through	3.3	4.9	4.9	7.3	9.6	11.6	0.0	34.7	4.9	7.1
		Right	0.0	1.4	0.0	3.3	3.8	5.0	5.3	6.7		
		Approach	3.6	4.9	5.0	7.2	10.8	14.2	9.5	12.9		

Future 2027 Build (Option 2) SimTraffic AM(PM) Peak Hour Delay (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound		Overall	
			AM	PM	AM	PM	AM	PM	AM	PM		
			Delay	Delay	Delay	Delay	Delay	Delay	Delay	Delay	AM	PM
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19		US 460/19		Walmart Entrance					
	Two-Way Stop	Left	†	†	6.6	7.8	16.6	20.4	†	†	Delay	Delay
		Through	1.6	2.3	4.1	3.5	†	†	†	†	3.6	4.9
		Right	1.3	2.1	†	†	6.4	13.3	†	†		
		Approach	1.5	2.3	4.3	3.7	10.9	16.9	†	†		
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19		US 460/19		Route 637		Route 637			
	Two-Way Stop	Left	4.5	6.5	0.9	2.1	18.5	23.0	18.6	13.9	Delay	Delay
		Through	3.5	4.3	1.0	1.0	19.1	0.0	20.9	19.5	4.1	3.4
		Right	2.9	4.2	0.1	0.2	5.0	7.9	0.0	4.4		
		Approach	12.5	4.5	1.9	1.0	17.1	19.2	20.7	6.9		

NOTE: Microsimulation Delay (sec/veh) results shown represent an average of 10 SimTraffic runs.
† Movements without conflicting movements. Delay cannot be reported.

Figure 62. Future 2027 Build (Option 2) AM(PM) Peak Intersection Operations Results

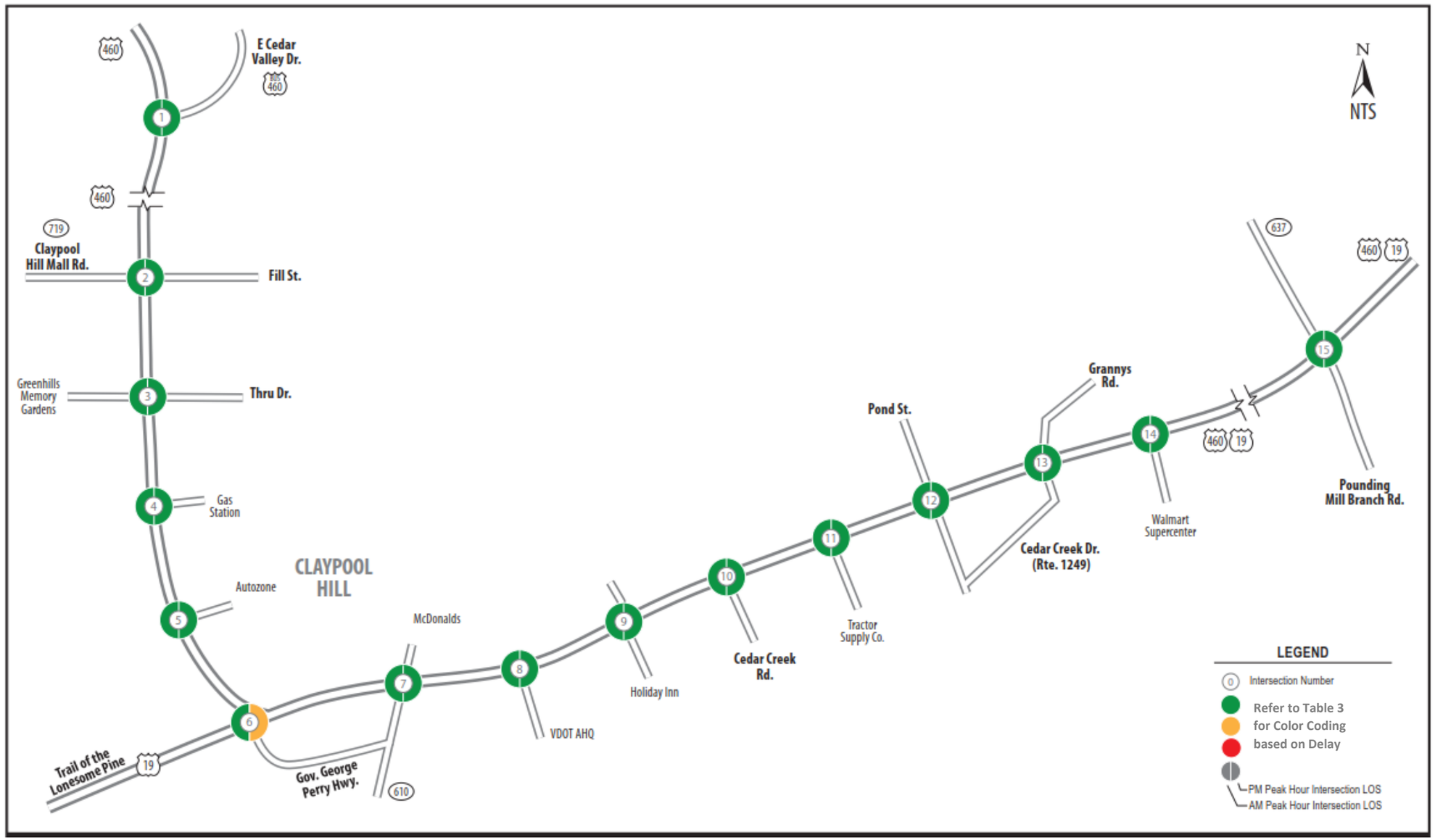


Table 17. Future 2027 Build (Option 2) Conditions: Summary of Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 US 460 and Cedar Valley Drive						Cedar Valley Dr			US 460			US 460		
	Signal	Left	N/A	†	†	N/A	135	100	50	34	40	150	26	70
		Through	N/A	†	†	N/A	†	†	N/A	136	159	N/A	146	133
		Right	N/A	†	†	N/A	0	0	325	76	59	N/A	†	†
2 US 460 and Claypool Hill Mall Road			Claypool Hill Mall Rd			Claypool Hill Mall Rd			US 460			US 460		
	Signal	Left	N/A	130	180	N/A	†	†	270	109	128	125	†	†
		Through	N/A	†	†	N/A	†	†	N/A	0	0	N/A	190	267
		Right	340	60	117	N/A	†	†	N/A	†	†	220	94	174
3 US 460 and Thru St/ Greenhills Memorial Gardens Entrance			Greenhills Mem Gardens			Thru St			US 460			US 460		
	Two-Way Stop	Left	N/A	27	48	N/A	87	68	N/A	22	18	N/A	53	70
		Through	N/A			N/A			N/A	0	1	N/A	0	11
		Right	N/A			N/A			N/A	0	2	N/A	0	5
4 US 460 and Gas Station Entrance						Gas Station Entrance			US 460			US 460		
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	11	0	N/A	0	0
		Right	N/A	†	†	N/A	75	55	N/A	0	0	N/A	†	†
5 US 460 and Autozone Entrance						Autozone Entrance			US 460			US 460		
	Two-Way Stop	Left	N/A	†	†	N/A	30	50	N/A	†	†	150	33	49
		Through	N/A	†	†	N/A	†	†	N/A	32	29	N/A	19	49
		Right	N/A	†	†	N/A	30	50	N/A	28	20	N/A	†	†
6 US 460 and US 460/19			US 460/19			US 460/19			US 460			US 460		
	Signal	Left	160	139	139	225	38	22	135	65	119	N/A	200	281
		Through	N/A	257	289	N/A	146	171	N/A	112	180	N/A	216	300
		Right	N/A	0	33	N/A	52	26	90	0	32	50	0	108
7 US 460/19 and Route 610/ McDonalds Entrance			US 460/19			US 460/19			Route 610			McDonalds Entrance		
	Signal	Left	230	115	100	150	116	132	N/A	†	†	N/A	†	†
		Through	N/A	169	218	N/A	189	196	N/A	†	†	N/A	†	†
		Right	205	28	62	530	60	52	N/A	40	59	N/A	65	44
8 US 460/19 and VDOT AHQ			US 460/19			US 460/19			VDOT AHQ					
	Two-Way Stop	Left	75	38	39	140	58	48	N/A	56	31	N/A	†	†
		Through	N/A	7	7	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	2	†	N/A	†	†	N/A	56	31	N/A	†	†
9 US 460/19 and Holiday Inn/ New Peoples Bank			US 460/19			US 460/19			Holiday Inn Entrance					
	Signal	Left	245	73	0	230	47	112	N/A	37	101	N/A	†	†
		Through	N/A	151	323	N/A	117	94	N/A	†	†	N/A	†	†
		Right	50	41	50	N/A	138	136	N/A	40	64	N/A	†	†

Future 2027 Build (Option 2) Conditions: Summary of Maximum Queues (feet) (Continued)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
10 US 460/19 and Cedar Creek Road			US 460/19			US 460/19			Cedar Creek Rd					
	Two-Way Stop	Left	165	25	59	110	27	34	N/A	0	55	N/A	†	†
		Through	N/A	0	0	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	0	55	N/A	†	†
11 US 460/19 and Tractor Supply Entrance			US 460/19			US 460/19			Tractor Supply Entrance					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	†	†	N/A	30	36	N/A	†	†
12 US 460/19 and Pond Street			US 460/19			US 460/19			Pond St					
	Two-Way Stop	Left	N/A	†	†	N/A	†	†	N/A	†	†	N/A	†	†
		Through	N/A	0	14	N/A	5	7	N/A	†	†	N/A	†	†
		Right	N/A	†	†	N/A	0	0	N/A	†	†	N/A	31	31
13 US 460/19 and Grannys Lane/Route 1249			US 460/19			US 460/19			Grannys Rd			Grannys Rd		
	Signal	Left	275	53	43	285	32	7	N/A	62	105	N/A	39	31
		Through	N/A	121	150	N/A	162	124	N/A	40	86	N/A		
		Right	N/A	†	48	N/A	174	147	50	45	42	N/A		
14 US 460/19 and Walmart Parking Lot Entrance			US 460/19			US 460/19			Walmart Entrance					
	Two-Way Stop	Left	N/A	†	†	230	57	40	N/A	80	191	N/A	†	†
		Through	N/A	0	0	N/A	†	†	N/A	†	†	N/A	†	†
		Right	170	2	8	N/A	†	†	N/A	80	191	N/A	†	†
15 US 460/19 and Route 637 (Pounding Mill Branch Rd)			US 460/19			US 460/19			Pounding Mill Branch Rd			Pounding Mill Branch Rd		
	Two-Way Stop	Left	260	34	59	175	4	20	N/A	70	55	N/A	97	68
		Through	N/A	†	†	N/A	2	0	N/A			N/A		
		Right	90	3	0	N/A			N/A			N/A		

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.

† Queue length for movements with no conflicting volumes.

N/A Storage Bay Length not provided or the movements do not exist.

7 Crash Reduction Analysis

A crash reduction analysis was conducted for US Route 460/US Route 19 from Cedar Valley Drive to the US Route 460/US Route 19 intersection and from the US Route 460/US Route 19 intersection to Pounding Mill Branch Road. As part of the crash reduction methodology, the *FHWA Desktop Reference for Crash Reduction Factors*[1] was utilized to calculate the Crash Reduction Factors (CRFs) associated with each proposed alternative from the Virginia Department of Transportation (VDOT). The CRFs were applied to the crash history data from the *VDOT Crashtools Database*[2] to determine the expected number of crashes and the percent reduction in crashes per alternative. Expected crashes were projected to the year 2027 (base build year) and then calculated over a 20-year life cycle to 2047. The expected crashes were then utilized to compare the Build and No Build conditions based on the 20-year projection to evaluate the efficacy of the proposed alternatives.

7.1 Analysis Methodology

The following sections describe the methodology that was used to determine the crash expectancy and cost savings associated with the proposed modifications.

7.1.1 Proposed Roadway Modifications and CRFs

The crash reduction factors (CRFs) were taken from the *FHWA Desktop Reference for Crash Reduction Factors*. The CRFs were selected based on the improvements designated for the *2027 Build* conditions. **Appendix** includes: 1) the countermeasures proposed, 2) categories of countermeasures obtained from the FHWA Desktop Reference source, 3) applicable crash type and severity, 4) percent of applicable crashes, and 5) notes for selected CRFs. It should be noted that CRFs are not provided for all roadway modifications in the *FHWA Desktop Reference for Crash Reduction Factors*. Roadway modifications without designated CRFs were not given a CRF for this analysis; therefore, those improvements did not have any impact on the expected crashes. Additionally, to avoid inflating crash reduction percentages, only one CRF was used to capture overlapping alternatives. For example, at the intersection of US 460/US 19, Alternative 1A proposes a new lane configuration for the WB US 460/US 19 approaches, which is accounted for within the countermeasures of Alternative 1A.

In order to accurately calculate CRFs for each alternative, a combined CRF was calculated using **Equation 1**. Some alternatives required multiple combined CRFs, depending on the specific improvements.

Equation 1. Combined CRF Calculation

$$Combined\ CRF = 1 - [(1 - CRF_1) * (1 - CRF_2) * \ldots * (1 - CRF_i)]$$

7.1.2 Applicable Crash Calculations

To properly determine how the improvements impact the 2027 and 2047 expected crashes, a detailed evaluation was conducted of historical crash data (2012-2017). Not every crash at a specific location would be eliminated due to an improvement. For example, at the intersection of US 460/US 19, when widening and installing a right-turn lane along the southbound approach, only 22% of all crashes at the intersection (along the southbound approach) would be expected to be reduced with this countermeasure. Therefore, the CRF should only be applied to the specific crashes that may have been affected by the improvement. As a result, for each improvement with a known CRF, the number of crashes impacted by the improvement was determined by analyzing each crash within the *VDOT Crashtools Database* from the five (5) most recent calendar years of crash data (2012-2017). Then, the percent of applicable crashes (i.e., number of applicable crashes across the five calendar years divided by the total number of crashes across the five calendar years) was determined for each improvement with a known CRF, as shown in **Equation 2**.

Equation 2. Percentage of Applicable Crashes Calculation

$$\%\ of\ Applicable\ Crashes = \frac{\#\ of\ Applicable\ Crashes}{Total\ \#\ of\ Crashes} * 100$$

7.1.3 Crash Reduction Evaluation

Based on the 2012-2017 crash data within the *VDOT Crashtools Database*, the average numbers of property damage only (PDO), injury, and fatal crashes over the most recent five years were calculated. The existing average crashes were then projected into 2027 (i.e., 10-year projection assuming a 0.5% growth rate) to which a base build year was established. These estimates were then projected out to the year 2047 (i.e., 20-year projection) to estimate the expected number of PDO, injury, and fatal crashes for the *Build* conditions over the 20-year life cycle, assuming a 0.5% growth rate.

To calculate the expected number of PDO, injury, and fatal crashes for the *Build* conditions where 100% of the crashes were applicable, the appropriate combined CRF was utilized for proposed improvements, as shown in **Equation 3**.

Equation 3. Expected Crashes for the 2027 Build Conditions (100% Applicable Crashes)

$$2027\ Build\ Expected\ Crashes = 2027\ No\ Build\ Expected\ Crashes * (1 - Combined\ CRF)$$

To calculate the expected number of PDO, injury, and fatal crashes for the *Build* conditions where only a portion of the crashes were applicable, the appropriate combined CRF was utilized for proposed improvements, as shown in **Equation 4**.

Equation 4. Expected Crashes for the 2027 Build Conditions (<100% Applicable Crashes)

$$2027\ Build\ Expected\ Crashes = 2027\ No\ Build\ Expected\ Crashes * \%\ Applicable\ Crashes * (1 - Combined\ CRF)$$

The percent reduction in PDO, injury, and fatal crashes between the *2047 No-Build* and *Build* conditions per alternative was calculated for each intersection and segment along the US Route 460/US 19 corridor over the 20-year cycle life.

Projected crashes and crash reductions to the base build year (2027) is provided in **Appendix**. This base condition was then projected each year over the 20-year life cycle to determine the crash reductions through 2047.

[1] Federal Highway Administration. (2014). *Desktop Reference for Crash Reduction Factors*. Washington, DC. Retrieved from https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/.

[2] Virginia Department of Transportation. (2017). *Crash Analysis Tool*. Retrieved from https://public.tableau.com

7.2 Analysis Results

The total crash reduction values over the 20-year cycle life (i.e., from 2027 to 2047) and percentages for each alternative are provided in **Table 18**.

Table 18. Crash Reduction per Alternative (20-Year Life Cycle)

Alternative	PDO Crashes (Reduction)	Injury Crashes (Reduction)	Fatal Crashes (Reduction)	Total % Reduction (No Build vs. Build)
Alternative 1A	36.36	15.91	0.00	49%
Alternative 1B	36.36	15.91	0.00	49%
Alternative 2 Option 1	25.20	23.10	0.00	45%
Alternative 2 Option 2	40.76	37.36	0.00	73%
Alternative 3 Option 1	8.45	4.22	0.00	13%
Alternative 3 Option 2	37.29	18.64	0.00	57%
Alternative 4	10.52	13.52	0.00	32%
Alternative 5	14.26	8.15	0.00	44%
Alternative 6 (to RT 637)	87.38	27.96	3.50	75%
Alternative 6 (to RT 637) without fatality[2][3]	87.38	27.96	0.00	75%
Alternative 6 (at RT 637)[3]	15.67	6.97	0.00	38%
Alternative 7[1]	-	-	-	-

Crash Rate reduction percentages are assumed to remain the same over the 10-year and 20-year projections due to the assumed constant growth rate over the corridor.

[1] Alternative 7 had no crash reduction factor application available due to the rural setting in which this corridor exists, and thus, no crash reduction percentages were obtained.

[2] Represents Alternative 6 segment without the fatality included.

[3] Alternative 6, based on the proposed countermeasures, was analyzed from a segment and intersection standpoint, and thus is provided in two separate rows, but is ultimately observed as one alternative ("Alternative 6 to RT 637 + Alternative 6 at RT 637" and ("Alternative 6 to RT 637 w/o fatality + Alternative 6 at RT 637")

8 Improvement Prioritization

The Improvement Prioritization process involved development of planning level cost estimates for the preferred alternatives, development of 20-year life-cycle operational and safety benefits for each improvement alternative and calculation of the Benefit-Cost ratios. These elements are described in the following sections.

8.1 Planning Level Cost Estimates

Planning level cost estimates were developed for all the preferred improvement alternatives using the *VDOT Project Cost Estimating System (PCES), Version 7.10* for VDOT Bristol District. The 2018 costs obtained from the PCES tool were inflated to future year 2027 at a rate of 3% per year. The cost estimates included Construction (CN), Right-of-Way and Utilities Relocation (ROW) and Preliminary Engineering (PE) costs. **Table 19** summarizes the cost estimates for each improvement alternative proposed and are expressed in year 2027 dollars. The PCES cost estimates are included in **Appendix**.

Table 19. Planning Level Cost Estimates (Year 2027 US Dollars)

Alternative/Location	Cost Estimate			
	Preliminary Engineering (PE)	Right-of-Way/Utilities (ROW)	Construction (CN)	Total
ALTERNATIVE 1A: US 460/US 19 Intersection	$193,970.19	$1,629,296.37	$1,009,371.23	$2,832,637.79
ALTERNATIVE 1B: US 460/US 19 Intersection	$749,215.11	$1,629,296.37	$5,025,789.28	$7,404,300.77
ALTERNATIVE 2 OPTION 1: US 460/US 19/Route 610 Intersection	$42,780.90	$0.00	$213,142.53	$255,923.43
ALTERNATIVE 2 OPTION 2: US 460/US 19/Route 610 Intersection	$641,296.02	$4,331.85	$4,008,312.80	$4,653,940.67
ALTERNATIVE 3 OPTION 1: US 460/Claypool Hill Mall Road	$7,764.71	$0.00	$38,327.71	$46,092.42
ALTERNATIVE 3 OPTION 2: US 460/Claypool Hill Mall Road	$235,097.95	$0.00	$1,239,294.45	$1,474,392.39
ALTERNATIVE 4: US 460/US 19/Holiday Inn Entrance (MP 57.50 - 57.75)	$2,798.74	$0.00	$13,797.98	$16,596.71
ALTERNATIVE 5: US 460/US 19/Cedar Creek Drive/Pond Street (MP 58.0 - 58.25)	$20,430.14	$0.00	$101,185.16	$121,615.30
ALTERNATIVE 6: At/around Pounding Mill Branch Road (MP 59.0 - End)	$39,118.40	$0.00	$194,704.78	$233,823.18
ALTERNATIVE 7: Access Management Measures (corridor-wide)	$18,620.42	$0.00	$92,175.70	$110,796.12
			Sum	**$17,150,119**

The planning level cost estimates were developed to get a preliminary idea of the funding requirements for the proposed improvements along the corridor. The estimated costs include 10% contingency for CN and ROW.

8.2 Planning Level Schedule Estimates

Planning level schedules were developed for all improvement alternatives. Schedule estimates were based on familiarity with complexity of projects within the Bristol District as well as discussions with the SWG. **Table 20** summarizes schedules by phases of project: Preliminary Engineering (PE), ROW and Utility Relocation (ROW) and Construction (CN).

Table 20. Planning Level Schedules (months)

Alternative/Location	Schedule Estimate (months)			
	Preliminary Engineering (PE)[1]	Right-of-Way/Utilities (ROW)	Construction (CN)[2]	Total
ALTERNATIVE 1A: US 460/US 19 Intersection	12	18	4	34
ALTERNATIVE 1B: US 460/US 19 Intersection	12	12	5	29
ALTERNATIVE 2 OPTION 1: US 460/US 19/Route 610 Intersection	7.5	0	3	10.5
ALTERNATIVE 2 OPTION 2: US 460/US 19/Route 610 Intersection	10	12	4	26
ALTERNATIVE 3 OPTION 1: US 460/Claypool Hill Mall Road	7.5	0	3	10.5
ALTERNATIVE 3 OPTION 2: US 460/Claypool Hill Mall Road	8	0	4	12
ALTERNATIVE 4: US 460/US 19/Holiday Inn Entrance (MP 57.50 - 57.75)	8	0	2.5	10.5
ALTERNATIVE 5: US 460/US 19/Cedar Creek Drive/Pond Street (MP 58.0 - 58.25)	7.5	6	3.5	17
ALTERNATIVE 6: At/around Pounding Mill Branch Road (MP 59.0 - End)	7.5	0	3.5	11
ALTERNATIVE 7: Access Management Measures (corridor-wide)[3]	8	10	4	22

Notes:

1. PE durations assume 3 design submittals with 3-week review period
2. Construction includes pre-submittals (1.5) and close out/punch list items (1)
3. ROW for access management includes permit modifications

8.3 Benefit-Cost Analysis

A Benefit-Cost (B/C) analysis was conducted for the candidate projects to evaluate their cost effectiveness. An analysis period of 20-years was used to evaluate the life cycle benefits. A 20-year period is typically used for small to medium size transportation projects. The following factors were considered in the B/C calculations for each of the improvement alternatives evaluated:

8.3.1 Operational Benefit

The determination of operational benefit for each improvement alternative was based on the methodology of calculating reduction in travel delay because of the proposed improvements. This methodology converts the vehicle delay into person delays by accounting for the vehicle occupancy. Consistent with the *2009 National Household Travel Survey (NHTS)*[3], average vehicle occupancies of 1.13 and 1.74 were assumed for work trips and non-work trips, respectively, assuming 250 work days per year and 60% of peak hour volumes are work trips.

Similarly, USDOT's *"Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2016"*[4], *Table 4* was used to determine the hourly values for travel time savings for each occupant in a vehicle as $25.40/hour and $13.60/hour for work and non-work trips, respectively.

To determine annual peak hour delay savings, the calculated delay reduction per vehicle (*SimTraffic* analyses) in each respective peak hour was multiplied by the peak hour traffic volume at each intersection to obtain a compounded delay. Using the compounded delay savings and identified values for travel time savings, the annual cost benefits for each alternative were determined. The Present Value of Benefits (PVB_D) of the annual delay reduction benefits over a 20-year life-cycle was calculated using **Equation 5**:

Equation 5. Present Value of Benefits (PVB_D)

$$(P/A, i, n) = \frac{(1+i)^n - 1}{i(1+i)^n}$$

Where,

$(P/A, i, n)$ = Factor that converts a series of uniform annual amounts to its present value
i = Minimum attractive rate of return or discount rate = 3%
n = Years in the service life of the improvements = 20 years

Table 21 shows the delay reduction cost savings per alternative. The detailed calculations are summarized and included in the **Appendix.**

Table 21. Delay Savings Analysis

Alternative	Total Cost Savings
Alternative 1A	$1,243,115.00
Alternative 1B	$1,160,948.00
Alternative 2 Option 1	-$378,652.00
Alternative 2 Option 2	$314,148.00
Alternative 3 Option 1	$0.00
Alternative 3 Option 2	-$37,852.00
Alternative 4	-$49,385.00
Alternative 5	-$11,452.00
Alternative 6	-$14,918.00
Alternative 7[1]	-

[1]Alternative 7 had no crash reduction factor application available due to the rural setting in which this corridor exists, and thus, no cost savings were provided

8.3.2 Safety Benefit

As part of the crash analysis, the differences in crashes between the *2027 No-Build* and *Build* conditions were calculated for PDO, injury, and fatal crashes over the 20-year life cycle. To further analyze the impact of the proposed alternatives, societal costs were applied to the crash reduction values, as provided by the *VDOT Highway Safety Improvement Program (HSIP)*[5]. Cost savings per crash type are provided below:

- Fatal Crash = $5,000,000
- Injury Crash = $142,667
- PDO = $9,000

Total cost savings per alternative are provided in **Table 22.** Additionally, the breakdown of the crash reduction and cost savings (PVB_S) over the 20-year life cycle are provided in **Appendix**.

[3] FHWA Report No. FHWA-PL-11-022, Summary of Travel Trends: 2009 National Household Travel Survey
[4] USDOT Guidance: "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations, Revision 2 (2016 Update)"
[5] Virginia Department of Transportation (VDOT) Highway Safety Improvement Program (HSIP) http://www.virginiadot.org/business/ted_app_pro.asp

Table 22. Crash Cost Savings Analysis (PVB_S Over 20-Year Life Cycle)

Alternative	PDO	Injury	Fatal	Total Cost Savings
Alternative 1A	$246,076.28	$1,706,588.59	-	$1,952,664.88
Alternative 1B	$246,076.28	$1,706,588.59	-	$1,952,664.88
Alternative 2 Option 1	$170,552.37	$2,478,279.19	-	$2,648,831.56
Alternative 2 Option 2	$275,874.81	$4,008,708.69	-	$4,284,583.50
Alternative 3 Option 1	$57,188.49	$453,272.77	-	$520,461.25
Alternative 3 Option 2	$252,377.19	$2,000,327.59	-	$2,252,704.78
Alternative 4	$71,191.31	$1,450,950.04	-	$1,522,141.34
Alternative 5	$96,481.26	$873,948.67	-	$970,429.92
Alternative 6 (to RT 637)[3]	$591,394.38	$2,999,909.77	$13,142,097.39	$16,733,401.54
Alternative 6 (to RT 637) without fatality[2][3]	$591,394.38	$2,999,909.77	-	$3,591,305
Alternative 6 (at RT 637)[3]	$106,083.14	$747,385.87	-	$853,469.01
Alternative 7[1]	-	-	-	-

Values shown represent savings over a 20-year life cycle, from 2027 to 2047, assuming 2027 is the base build year.

[1]Alternative 7 had no crash reduction factor application available due to the rural setting in which this corridor exists, and thus, no cost savings were provided

[2]Represents Alternative 6 segment without the fatality included.

[3]Alternative 6, based on the proposed countermeasures, was analyzed from a segment and intersection standpoint, and thus is provided in two separate rows, but is ultimately observed as one alternative ("Alternative 6 to RT 637 + Alternative 6 at RT 637" and ("Alternative 6 to RT 637 without fatality + Alternative 6 at RT 637")

A single fatality was observed in the study over the 5-year crash period. Alternative 6 is the only alternative proposing improvements along the road segment that included the fatality. As shown in Table 2, the potential reduction of future fatal crashes along this segment causes Alternative 6 to have a much greater cost savings than any of the other alternatives due to the societal costs associated with fatalities.

After further review it was observed that this fatality could be viewed as an outlier as it was a pedestrian related crash where the pedestrian was reported to have been standing in the roadway in an area not designated for pedestrian crossing. For comparison purposes, we have provided an additional alternative to show the reduction in crashes and associated costs savings without this fatality included.

8.3.3 Cost of Construction

The 2027 cost estimate for each alternative as summarized in Table 19 was used in the calculation of B/C ratios. The following equation was used to develop the B/C ratios:

Equation 6. Benefit/Cost Ratio (BCR)

$$BCR = PVB/PVC$$

Where,

PVB = Present Value of Combined Benefits = $PVB_D + PVB_S$

PVC = Present Value of Costs = 2027 cost estimates

Table 23 summarizes the calculated BCR for each of the improvement alternatives.

Table 23. BCR per Improvement Alternative

Alternative	Delay Reduction Benefit (PVB_D)	Safety Benefit (PVB_S)	Present Value of Costs (PVC)	Benefit-Cost Ratio (BCR)
Alternative 1A	$1,243,115.00	$1,952,664.88	$2,832,638.00	1.13
Alternative 1B	$1,160,948.00	$1,952,664.88	$7,404,300.77	0.42
Alternative 2 Option 1	-$378,652.00	$2,648,831.56	$255,923.43	8.87
Alternative 2 Option 2	$314,148.00	$4,284,583.50	$4,653,940.67	0.99
Alternative 3 Option 1	$0.00	$520,461.25	$46,092.42	11.29
Alternative 3 Option 2	-$37,852.00	$2,252,704.78	$1,474,392.39	1.50
Alternative 4	-$49,385.00	$1,522,141.34	$16,596.71	88.74
Alternative 5	-$11,452.00	$970,429.92	$121,615.30	7.89
Alternative 6	-$14,918.00	$853,469.01	$233,823.18	15.30
Alternative 7*	--	--	$110,692.12	--

* Alternative 7 primarily addresses access management issues along the corridor. These measures do not have direct benefit with delay reduction, hence, delay reduction values were not available. Similarly, FHWA's CMF Clearinghouse does not provide crash modification factors for access management in rural areas. Therefore, no BCR is available for Alternative 7.

8.3.4 Project Prioritization

Improvement projects should be prioritized at a regional level. The following factors should be considered while evaluating the proposed improvement alternatives to be advanced further for funding and construction:

- B/C Ratio: Typically, projects with B/C ratios greater than or equal to 1.00 indicate cost effectiveness of the improvements and are preferred by the Agencies;
- Safety Improvements and their Benefits;
- Geometric Improvements;
- No anticipated ROW Impacts: Projects that require additional right-of-way are typically costly, and are not preferred.

Table 24 summarizes these factors for each improvement alternative proposed by this study.

Table 24. Project Prioritization Criteria

Alternative	B/C Ratio	Safety Improvements	Geometric Improvements	No Anticipated ROW Impacts
Alternative 1A	1.13	✓	✓	
Alternative 1B	0.42	✓	✓	
Alternative 2 Option 1	8.87	✓	✓	✓
Alternative 2 Option 2	0.99	✓	✓	
Alternative 3 Option 1	11.29	✓		✓
Alternative 3 Option 2	1.50	✓	✓	✓
Alternative 4	88.74	✓		✓
Alternative 5	7.89	✓		✓
Alternative 6	15.30	✓	✓	✓
Alternative 7	--	✓		✓

✓ Indicates the criteria for the corresponding improvement alternative is fulfilled

Based on the review of the criteria, the following alternatives were identified that can potentially be submitted for SMART SCALE or other funding sources:

- Alternative 1A (US 460/US 19 Intersection)
- Alternative 2, Option 1 (US 460/US 19/SR 610 Intersection)
- Alternative 3, Option 2 (US 460/Claypool Hill Mall Road Intersection)
- Alternative 4 (US 460/US 19/Clay Drive Intersection)
- Alternative 5 (US 460/US 19/Cedar Creek Road Intersection)
- Alternative 6 (US 460/US 19/SR 637 Intersection)
- Alternative 7 (corridor-wide Access Management)

The District, in coordination with the localities may choose to advance some or all of these projects at their discretion.

9 Conclusions And Recommendations

The STARS US 460/US 19 Corridor Study identifies operational, safety, access management and congestion issues along the corridor. This study also evaluates potential mitigation measures and improvement alternatives to address those issues. This study should be used as a planning level document to establish the next steps of planning, programming, designing and constructing the identified safety, operational and access management improvements within the corridor. Following are the specific steps that may be followed:

Gain Consensus and Prioritize Improvements

It is recommended to conduct outreach meetings with stakeholders who were not part of the SWG of this study to gain their consensus on the proposed candidate improvement alternatives. Prioritization of the improvements is suggested by considering the following factors:

- Benefit-Cost
- Local/District Preference
- Safety Benefits
- Geometric Improvements
- ROW Impacts

Prepare Projects for Advancement

Upon identifying and prioritizing the improvements at the regional level, the projects with the highest priority should be advanced to be included in the following plans:

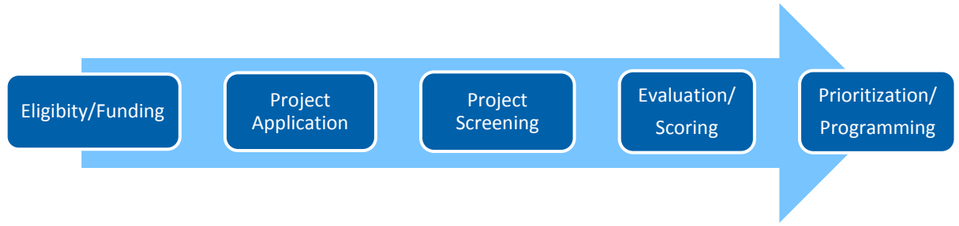
- Constrained Long Range Transportation Plan (CLRP)
- Transportation Improvement Plan (TIP)
- Statewide Transportation Improvement Plan (STIP)
- VDOT Six-Year Improvement Program (SYIP)

Secure Funding

There are several funding sources or revenue sharing programs that can be tapped into to fund the improvements identified in this study:

SMART SCALE

Virginia's SMART SCALE Process facilitates selecting the right transportation projects for funding and ensuring the best use of limited tax dollars. It includes five overreaching steps as depicted below:



Per the SMART SCALE Technical Guide, the scoring process evaluates, scores and ranks projects based on congestion mitigation, economic development, accessibility, safety, environmental quality and land use factors. The location of the project determines the weight of each of these scoring factors. For the projects in the Bristol District, the scoring factors with the highest weight are:

- Economic Development (35%)
- Safety (30%)

All the improvement alternatives identified in this study are candidate projects for SMART SCALE funding. Several of these projects can also be packaged together into one SMART SCALE application to achieve a better project score and to recognize cost savings associated with completing the projects concurrently.

The SMART SCALE funding may be accompanied by other sources of funding as listed below:

- Construction District Grants Program (DGP)
- High Priority Projects Program (HPPP)
- Congestion Mitigation and Air Quality Funding (CMAQ)
- Regional Surface Transportation Block Grant Program (RSTBG)
- Revenue Sharing
- Transportation Alternatives (TA) Set-Aside Funds
- Highway Safety Improvement Program (HSIP) and Other Safety Program Funds
- Tele-fees and Unpaved Road Related Funds
- State of Good Repair

SMART SCALE projects can be submitted by regional entities including counties, cities and towns that maintain their own infrastructure. Once the project has been screened, scored and selected for funding by the Commonwealth Transportation Board (CTB), it remains in the SYIP as a funding priority.

Project Completion

Once the funding is secured and improvements are ready for construction, the projects should be advanced and implemented with close coordination among the affected stakeholders in the region.