ROUTE 1 CORRIDOR STUDY

PORT AQUIA DRIVE TO AUSTIN RUN BOULEVARD

STAFFORD COUNTY, VIRGINIA

FINAL REPORT

STARS VDOT

Route 1 Corridor Study

Port Aquia Drive to Austin Run Boulevard

Final Report

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Prepared for

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1 Introduction

1.1 Background

The Virginia Department of Transportation Fredericksburg District Office (VDOT), VDOT Transportation Mobility and Planning Division (TMPD), Stafford County, Virginia and the Fredericksburg Area Metropolitan Planning Organization (FAMPO) identified the need to evaluate existing and future conditions along the Route 1 corridor. This STARS corridor study focuses on evaluating the Route 1 corridor from Port Aquia Drive to Austin Run Boulevard, assessing measures to reduce congestion, and recommending possible spot improvements to address congestion and safety issues.

Route 1 is a critical north-south route in Stafford County and is a component of the Corridor of Statewide Significance Corridor K. This section of Route 1 also acts as an incident management alternative for I-95. Traffic in the subject area frequently operates in a congested state. Both AM and PM weekday peak periods are problematic, as are weekend peaks. The corridor has developed over the course of decades without a unifying plan to promote and preserve mobility and to control access, to the detriment of motorists, pedestrians and businesses.

The study corridor serves both local and regional travel and has eight signalized intersections and three unsignalized intersections. The Garrisonville Road and northbound I-95 off-ramp signalized intersections are particularly problematic during weekday AM and PM peak periods. The unsignalized intersection at Coachman Circle south also experiences significant delays. These operational challenges are expected to worsen moving into the future since traffic is projected to grow at an average annual growth rate of 1.6% through 2035. This traffic growth will cause continuing congested operating conditions and vehicle delay daily, which can be further exacerbated by traffic diverting from I-95 due to incidents or high weekend travel during the summer months and holidays.

Apart from the challenges presented by peak period traffic flows, access management to adjacent properties has evolved over time such that there are multiple driveways with direct access to Route 1. Accordingly, this study will examine current access to Route 1 and potentially recommend measures to improve the mobility and safety of people accessing properties and businesses along the corridor.

An analysis of safety-related conditions will also be an important element of this study. Crash data and field reviews will identify safety concerns, with mitigation strategies and actions to be recommended.

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 primarily during the PM peak hour, which are currently heavily utilized by passenger cars and some 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. During the recent five-year period, 465 crashes resulting in 1 fatality and 91 visible injuries, were reported within this corridor. The types of crashes frequently reported include rear-end, angle crashes, and sideswipe – same direction. These crash types are typically associated with recurring congestion and intersection conflict points along a corridor. Reduction in congestion along the corridor or reducing conflict points may have a corresponding safety benefit, in terms of reduction in number of crashes along the corridor.

Route 1 serves a mix of commercial, retail, residential and institutional uses. This study also intends to address access deficiencies 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) includes 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 Fredericksburg District Office and TMPD
- FAMPO
- Stafford County
- WSP Team

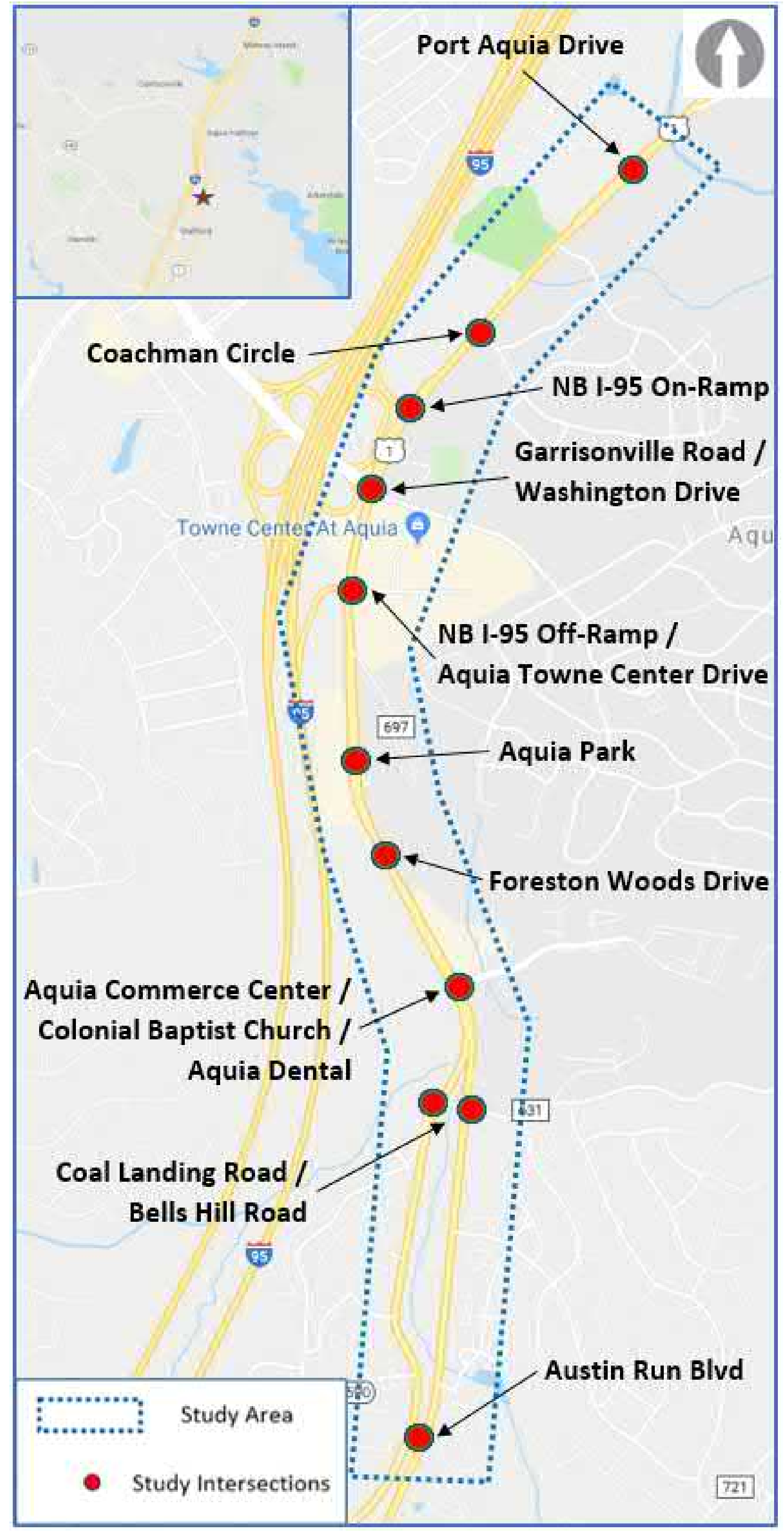
1.4 Study Area

This section of Route 1 is located within Stafford County, Virginia. This north-south corridor is approximately 2.3 miles in length and includes eleven (11) study intersections. These study intersections are listed below and shown in **Figure 1**.

Study Area Intersections

1. Route 1 and Port Aquia Drive
2. Route 1 and Coachman Circle (South)
3. Route 1 and NB I-95 On-Ramp
4. Route 1 at Garrisonville Road / Washington Drive
5. Route 1 at NB I-95 Off-Ramp / Aquia Towne Center Drive
6. Route 1 at Aquia Park
7. Route 1 at Aquia Commerce Center / Colonial Baptist Church / Aquia Dental
8. Route 1 at Foreston Woods Drive
9. Route 1 at Coal Landing Road / Bells Hill Road (two intersections at this location)
10. Route 1 at Austin Run Boulevard

Figure 1. Study Area Map



2 Existing Conditions

2.1 Existing Zoning and Future Land Use

A review of existing zoning and future land use plans was conducted for the areas adjacent to the Route 1 corridor. Existing zoning classifications primarily include suburban and urban residential and urban commercial. The Future Land Map in the County's Comprehensive Plan designates Route 1 as a commercial corridor with the Aquia Town Center planning area designated as a Priority Focus Area, with a mix of residential, office and commercial uses. Layouts showing the existing zoning and future land use are included in the **Appendix**. These layouts were obtained from the *Stafford County GIS Plans, Zoning and Development Application Gallery*.

2.2 Existing Roadway Network

An inventory of existing roadway conditions was prepared along Route 1 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 observations to capture:

- Roadway geometry to include lane configuration, lane/shoulder widths
- Pedestrian accommodations
- 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 eight (8) signalized intersections and three (3) unsignalized intersection as discussed in **Sections 2.2.1** through **2.2.4** below:

2.2.1 Route 1 Corridor

Route 1 in this portion of Stafford County from north of Port Aquia Drive to Austin Run Boulevard is classified as Other Principal Arterial Highway per *VDOT Functional Classification*. Within the study area, Route 1 is a 4-lane undivided roadway with a two-way left-turn lane throughout the corridor. The posted speed limit is 35 miles per hour along the corridor. Pedestrian facilities such as sidewalks and pedestrian crossing signals with ADA ramps are sporadic along the corridor. No dedicated bike facilities are present within the study corridor.

2.2.2 Intersection 1: Route 1 at Port Aquia Drive

The intersection of Route 1 at Port Aquia Drive is a 4-leg signalized intersection. The posted speed limit for Port Aquia Drive is 25 miles per hour. The northbound approach of Route 1 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Port Aquia Drive has one shared left-thru lane and one right-turn lane. The westbound approach has one shared left-thru lane and one right-turn lane. The signal operations include permitted-protected left turns for the northbound and southbound approaches and permitted phasing for the eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are not currently present at the intersection. **Figure 2** shows an aerial view of the intersection.

Figure 2: Route 1 at Port Aquia Drive

Source: Google Imagery

2.2.3 Intersection 2: Route 1 at Coachman Circle (South)

The intersection of Route 1 at Coachman Circle (South) is a 4-leg unsignalized intersection. The northbound and southbound approaches of Route 1 are free-flow, while the eastbound and westbound approaches of Business Drive and the Business Entrance are stop-controlled. The northbound approach of Route 1 has one two-way-left-turn-lane (TWLTL), two through lanes, and one right-turn lane. The southbound approach has one TWLTL, two through lanes and one shared thru-right lane. The eastbound approach of the Business Entrance has one shared left-thru-right lane. The westbound approach of Coachman Circle has one shared left-thru-right lane. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 3** shows an aerial view of the intersection.

Figure 3: Route 1 at Coachman Circle

Source: Google Imagery

2.2.4 Intersection 3: Route 1 at NB I-95 On-Ramp

The NB I-95 On-Ramp is classified as an Interstate Ramp per *VDOT Functional Classification.* The intersection of Route 1 at NB I-95 On Ramp is a 3-leg unsignalized intersection. There is no posted speed limit along NB I-95 On-Ramp. The northbound approach of Route 1 has one left-turn lane and two through lanes. The southbound approach has one shared right-thru lane and two through lanes. The NB I-95 On-Ramp is the third leg of the intersection and has one lane going onto NB I-95. The signal operations include permitted-protected left turns for the northbound approach. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 4** shows an aerial view of the intersection.

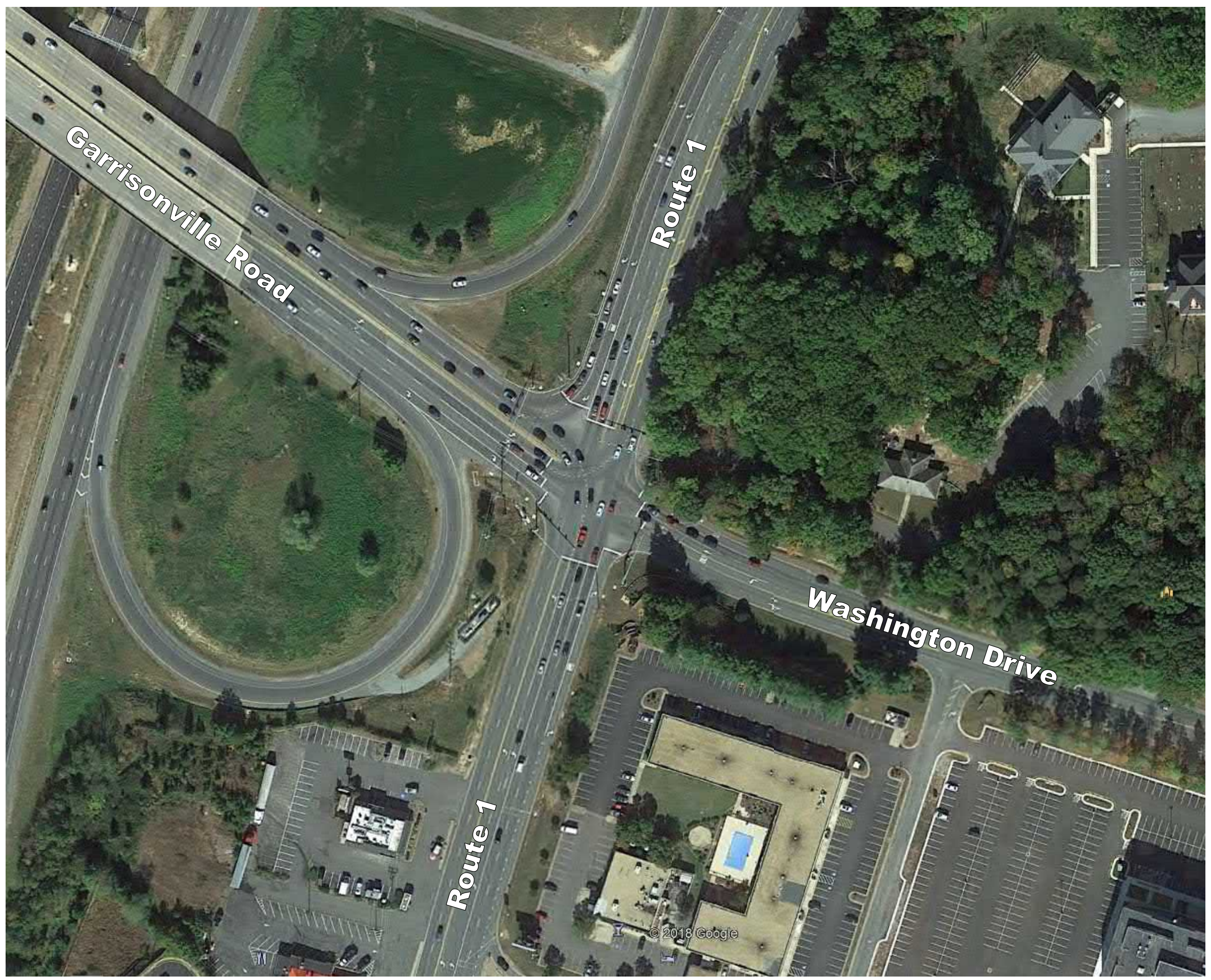
Figure 4: Route 1 at NB I-95 On-Ramp

Source: Google Imagery

2.2.5 Intersection 4: Route 1 at Garrisonville Road/Washington Drive

Garrisonville Road is classified as a Major Collector per *VDOT Functional Classification.* The posted speed limit along Garrisonville Road is 35 miles per hour and 25 miles per hour on Washington Drive. The northbound approach of Route 1 has two left-turn lanes, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and two right-turn lanes. The eastbound approach of Garrisonville Road has one left-turn lane, one shared left-thru lane, one through lane, one right-turn lane, and one lane for the on-ramp to NB I-95. The westbound approach of Washington Drive has one left-turn lane, two through lanes, and one right-turn lane. The signal operations include protected left turns for the northbound and southbound approaches and split phasing for the eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 5** shows an aerial view of the intersection.

Figure 5: Route 1 at Garrisonville Road/Washington Drive

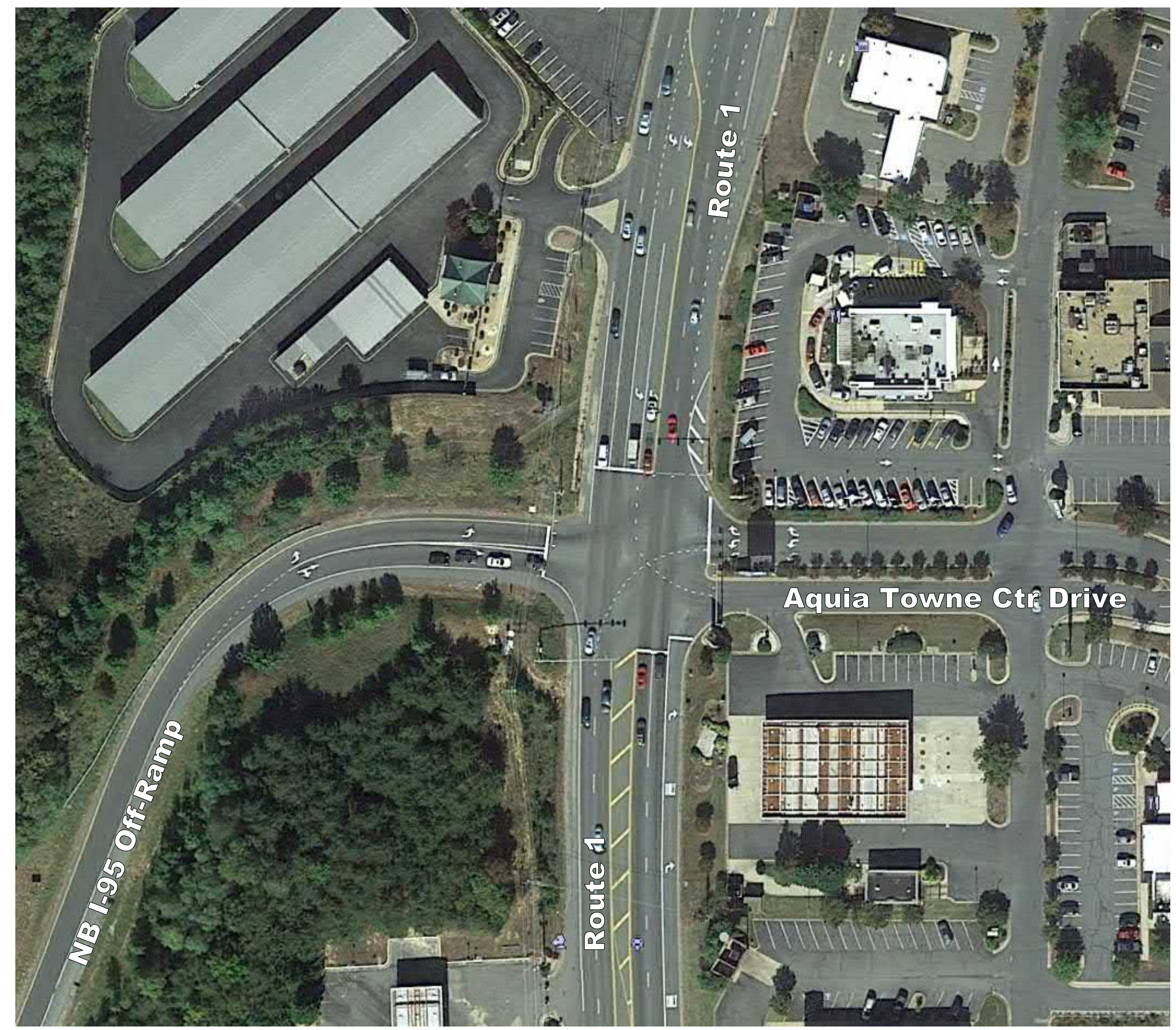


Source: Google Imagery

2.2.6 Intersection 5: Route 1 at NB I-95 Off-Ramp/Aquia Towne Center Drive

The NB I-95 Off-Ramp is classified as an Interstate Ramp per *VDOT Functional Classification.* The posted speed along NB I-95 Off-Ramp is 35 miles per hour. The northbound approach of Route 1 has two through lanes and one right-turn lane. The southbound approach has two left-turn lanes and two through lanes. The eastbound approach of the NB I-95 Off-Ramp has one left-turn lane and one shared thru-right lane. The westbound approach of Aquia Towne Center Drive has two left-turn lanes and one right-turn lane. The signal operations include protected left turns for the southbound, eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 6** shows an aerial view of the intersection.

Figure 6: Route 1 at NB I-95 Off-Ramp/Aquia Towne Center Drive



Source: Google Imagery

2.2.7 Intersection 6: Route 1 at Aquia Park Drive

The intersection of Route 1 at Aquia Park Drive is a 4-leg signalized intersection. There is no posted speed limit along Aquia Park Drive. The northbound approach of Route 1 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Aquia Park Drive has one shared left-thru lane and one right-turn lane. The westbound approach has one shared left-thru-right lane. The signal operations include permitted-protected left turns for the northbound and southbound approaches and split phasing for the eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian signals are present across the south, east and west legs of the intersection. **Figure 7** shows an aerial view of the intersection.

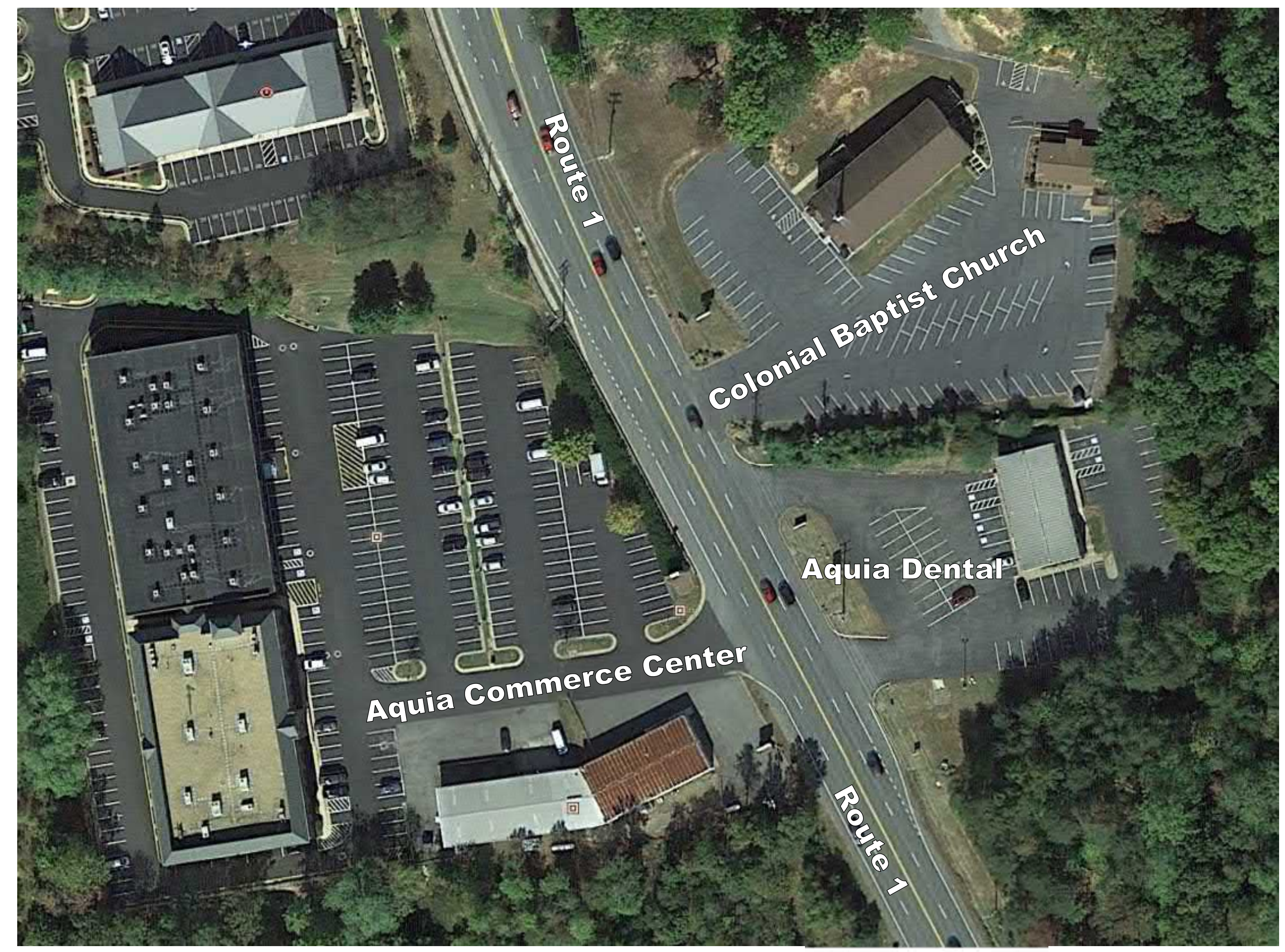
Figure 7: Route 1 at Aquia Park Drive

Source: Google Imagery

2.2.8 Intersection 7: Route 1 at Aquia Commerce Center/Colonial Baptist Church/Aquia Dental

The intersection of Route 1 at Aquia Commerce Center/Colonial Baptist Church/Aquia Dental is a 4-leg unsignalized intersection. There is no posted speed limit along either of the side streets. The northbound and southbound approaches of Route 1 are free-flow, while the eastbound and westbound approaches of Business Drive and the Business Entrance are stop-controlled. The northbound approach of Route 1 has one shared left-thru lane and one shared thru-right lane. The southbound approach has one shared left-thru lane, one through lane, and one right-turn lane. The eastbound approach of Aquia Commerce Center has one shared left-thru-right lane. The westbound approach has one shared left-thru-right lane. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 8** shows an aerial view of the intersection.

Figure 8: Route 1 at Aquia Commerce Center/Colonial Baptist Church/Aquia Dental

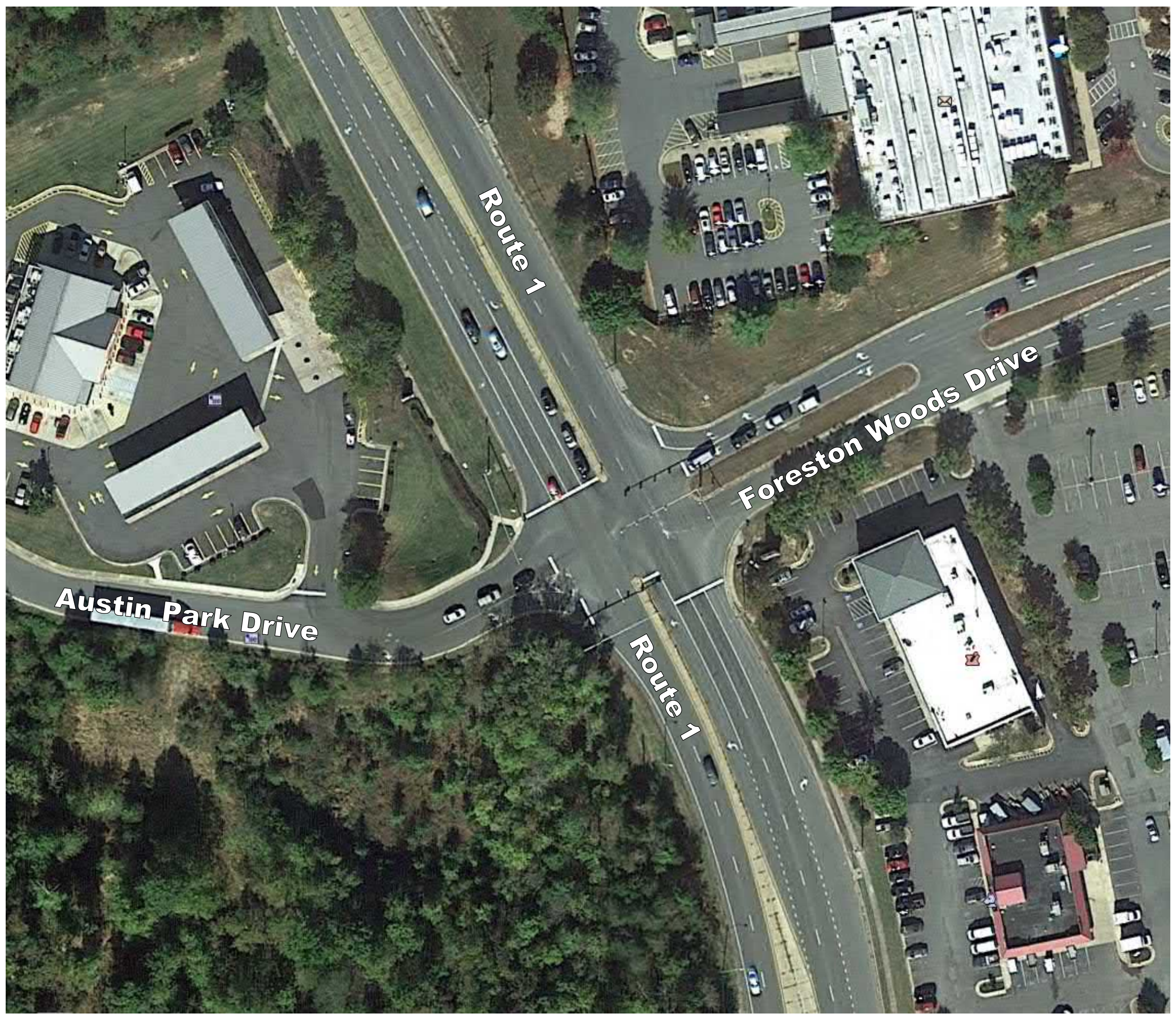


Source: Google Imagery

2.2.9 Intersection 8: Route 1 at Foreston Woods Drive

The intersection of Route 1 at Austin Park Drive/Foreston Woods Drive is a 4-leg signalized intersection. The posted speed along Foreston Woods Drive is 25 miles per hour. The northbound approach of Route 1 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Austin Park Drive has one shared left-thru lane and one right-turn lane. The westbound approach of Foreston Woods Drive has one shared left-thru lane and one right-turn lane. The signal operations include protected left turns for the northbound and southbound approaches and split phasing for the eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 9** shows an aerial view of the intersection.

Figure 9: Route 1 at Foreston Woods Drive



Source: Google Imagery

2.2.10 Intersection 9: Route 1 at Coal Landing Road/Bells Hill Road

Coal Landing Road is classified as a Minor Collector per *VDOT Functional Classification*. The posted speed along Coal Landing Road is 30 miles per hour and 35 miles per hour along Bells Hill Road. The northbound approach of Route 1 at Coal Landing Road has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach of Route 1 at Bells Hill Road has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Bells Hill Road at southbound Route 1 has one shared thru-right lane and one shared left-thru lane at northbound Route 1. The westbound approach of Coal Landing at northbound Route 1 has one shared thru-right lane and one shared left-thru lane at southbound Route 1. The signal operations include protected left turns for the northbound and southbound approaches and split phasing for the eastbound and westbound approaches. The northbound/southbound through movements are coordinated with adjacent signalized intersections. The signals at Coal Landing Road and Bells Hill Road have a shared traffic controller, suggesting the individual movements at the two intersections are controlled by one controller. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 10** shows an aerial view of the intersection.

Figure 10: Route 1 at Coal Landing Road/Bells Hill Road

Source: Google Imagery

2.2.11 Intersection 10: Route 1 at Austin Run Boulevard

The intersection of Route 1 at Austin Run Boulevard is a 3-leg unsignalized intersection. The posted speed along Austin Run Blvd is 30 miles per hour. The northbound approach of Route 1 has one shared left-thru lane, one through lane, one right-turn lane. The southbound approach has one left-turn lane and two through lanes. The eastbound approach at northbound Route 1 has one shared left-thru lane. The westbound approach at northbound Route 1 has one shared thru-right lane and has one left-turn lane at southbound Route 1. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 11** shows an aerial view of the intersection.

Figure 11: Route 1 at Austin Run Boulevard

2.3 Traffic Data

2.3.1 2019 Existing Traffic Volumes

Existing traffic volume data along the study corridor was collected in May 2019:

- 13-hour turning movement classification counts to include passenger cars, buses, pedestrians, and sub-classification of medium/large trucks were collected on a typical weekday from 6:00 am to 7:00 pm at the following intersections:
  - Route 1/Port Aquia Drive
  - Route 1/Coachman Circle (south)
  - Route 1/NB I-95 On-Ramp
  - Route 1/Garrisonville Road
  - Route 1/NB I-95 Off-Ramp/Aquia Town Center Drive
  - Route 1/Aquia Park
  - Route 1/Aquia Commerce Center/Aquia Dental Care
  - Route 1/Foreston Woods Drive
  - Route 1/Coal Landing Road/Bells Hill Road
  - Route 1/Austin Run Boulevard
- 13-hour turning movement classification counts to include passenger cars, buses, pedestrians, and sub-classification of medium/large trucks were collected on a Saturday from 6:00 am to 7:00 pm at the following intersection:
  - Route 1/Garrisonville Road
- 48-hour classification tube counts were collected at the following locations:
  - NB I-95 Off-Ramp
  - NB I-95 On-Ramp
  - Route 1 between I-95 Off-Ramp and Route 610
  - Route 1 between Port Aquia Drive and Coachman Circle (south)
  - Route 1 between Foreston Woods Drive and Cole Landing Road

The field counts are provided in the **Appendix**. The existing (2019) peak hour volumes are summarized in **Figures 12 and 13**.

2.3.2 Additional Data

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

- Queue length measurements at selected signalized study area intersections to be used in the calibration of the existing Synchro/SimTraffic model.
- Peak period travel time runs for the entire corridor.
- Crash data from the last five years to perform the crash analysis.
- Signal timing data from the VDOT District.

Figure 12. Existing 2019 Weekday AM (PM) Peak Hour Volumes

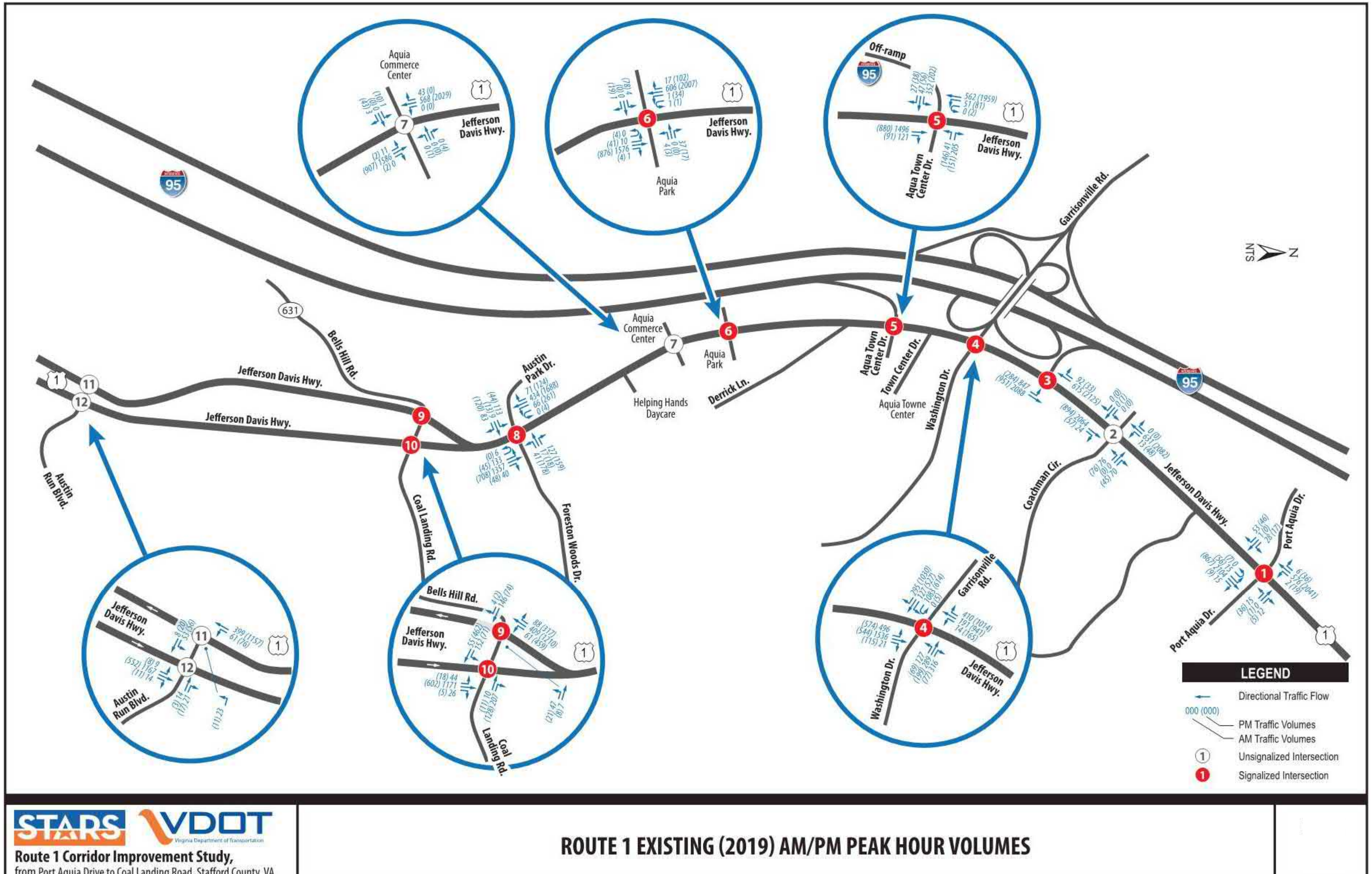
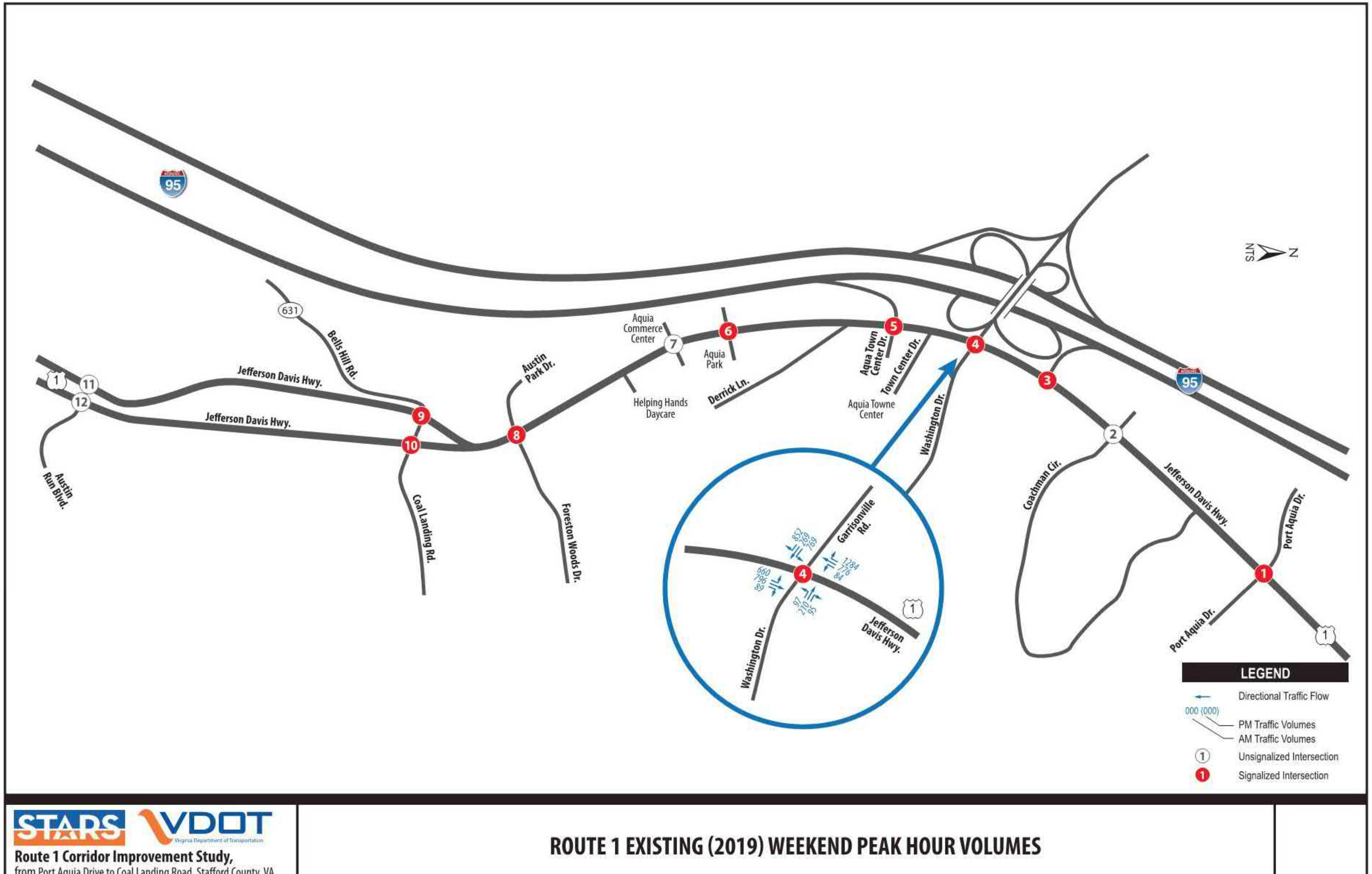


Figure 13. Existing 2019 Saturday Peak Hour Volumes



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 the current *VDOT Access Management Design Standards for Entrances and Intersections,* which is included as *Appendix F* of the *VDOT Roadway Design Manual*. This assessment involved an analysis of existing spacing of driveways and intersections and an evaluation of their 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 with a posted speed limit of 35 mph to 45 mph.

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

Highway Functional Classification	Minimum Centerline to Centerline Spacing (Feet)			
	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	1,320	1,050	565	305

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

A total of 52 access points are located within the study corridor of Route 1 between Port Aquia Drive and Austin Run Boulevard. Most of these access points are closely spaced and serve commercial and retail parcels, with a small percentage serving residential parcels. These access points are shown graphically in the **Appendix** and identified as **AP1** through **AP52**. The spacing of these access 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 Route 1

Roadway	Number of Access Points	Per VDOT Spacing Guidelines	
		Compliant	Non-Compliant
Route 1	52	15 Total: AP 1, AP 29-31, AP 38-42, AP 44, AP 48-52	37 Total: AP 2-28, AP 32-37, AP 43, AP 45-47

Note: Refer to the Appendix for graphical presentation of access points.

The spacing standards are not satisfied for 37 out of the 52 access point locations involving full/partial access driveways, entrances, median crossovers and intersections. The area serves urban/suburban land uses, with significant development along both sides of the roadway. Application of access management best practices would benefit corridor operations by reducing conflict points along the corridor.

3 EXISTING TRAFFIC OPERATIONAL ANALYSIS

3.1 Analysis Peak Periods

Weekday and Saturday peak periods were identified from the count data for the arterial segments and for each study intersection. Each study intersection is being analyzed in the weekday AM/PM peaks, while Garrisonville Road / Washington Drive is the only intersection analyzed in the Saturday peak. The common peak hours for the overall network were determined based on the hourly variations in traffic volumes at each intersection, travel patterns along the study corridor and percentage of traffic during the highest hour. Based upon a review of the traffic count data, the following peak hours were identified for this study:

- Weekday AM Peak: 6:45 AM – 7:45 AM
- Weekday PM Peak: 4:15 PM – 5:15 PM
- Weekend Saturday Peak: 11:30 AM – 12:30 PM.

Peak Hour Factors (PHFs) were calculated for each overall intersection for the weekday and Saturday peak hours using the turning movement count data. Similarly, heavy vehicle percentages were calculated for the peak hours for each movement at the study intersections.

The raw traffic counts were balanced throughout the network. Traffic volume balancing was required considering individual intersection peak hours and the resulting volume variations observed throughout the corridor. The peak hour traffic volumes were balanced using an iterative process of adjusting intersection approach and departure volumes until intersection volumes were within 10% for most movements. This 10% threshold was allowed to be exceeded for links with a significant number of access points (traffic generators or sinks) between the intersections.

3.2 Analysis Tools

Traffic operations analysis for the corridor was conducted using Synchro 9.0 (Version 9.2, build 914) analysis software*,* 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

Measures of Effectiveness (MOEs) are utilized in traffic operations analyses to quantify operational and safety objectives and provide 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 SimTraffic MOEs evaluated for the study corridor is presented below:

- 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, microsimulation delay is reported for individual intersection movements as well as 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 Intersection Delay

Signalized Intersection Delay Thresholds (sec/veh)	Unsignalized Intersection Delay Thresholds (sec/veh)	Measure of Congestion	Color
< 10	< 10	Slight Delay	Green
> 10 – 20	> 10 – 15	Slight Delay	Green
>20 – 35	>15 – 25	Moderate Delay	Yellow
>35 – 55	>25 – 35	Moderate Delay	Yellow
>55 – 80	>35 – 50	Significant Delay	Red
>80	>50	Significant Delay	Red

Source of Delay Thresholds: Highway Capacity Manual 2010

3.4 Base Model Development and Calibration

Weekday AM/PM and Saturday peak hour base Synchro models were developed using the data discussed under Section 2.3.1 and following the guidance in TOSAM. The SimTraffic input parameters were in accordance with *Section 7.6.1* of *VDOT TOSAM* and included one 60-minute seed interval and four 15-minute recording intervals, with the PHF applied to the third interval for weekday AM and PM peak analysis. The Saturday analysis included one 30-minute seed interval and four 15-minute recording intervals. To account for simulation variance, 10 simulation runs were conducted and averaged together. The simulation settings remained at the default settings, with the exception of the headway factor for northbound movements in the PM peak in order to fine-tune model calibration.

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

A summary of the volume, queue, and travel time calibration is provided in **Table 4**, with supporting documentation in the **Appendix**.

Table 4. Calibration Summary

Peak Period	Calibration Measure	Evaluation	Criteria	Total Number Evaluated	Total Number Met	Percent Met	Target Criteria	Target Met
AM	Volume (vph)	Turning Movements	Within ± 20% for < 100 vph Within ± 15% for ≥ 100 vph to < 300 vph Within ± 10% for ≥ 300 vph to < 1000 vph Within ± 5% for ≥ 1000 vph	96	82	85%	85%	Yes
	Queue Length	Turning Movements	Within ± 20% on oversaturated arterials	35	30	86%	85%	Yes
PM	Volume (vph)	Turning Movements	Within ± 20% for < 100 vph Within ± 15% for ≥ 100 vph to < 300 vph Within ± 10% for ≥ 300 vph to < 1000 vph Within ± 5% for ≥ 1000 vph	102	90	88%	85%	Yes
	Queue Length	Turning Movements	Within ± 20% on oversaturated arterials	41	37	90%	85%	Yes
Saturday	Volume (vph)	Turning Movements	Within ± 20% for < 100 vph Within ± 15% for ≥ 100 vph to < 300 vph Within ± 10% for ≥ 300 vph to < 1000 vph Within ± 5% for ≥ 1000 vph	12	12	100%	85%	Yes
	Queue Length	Turning Movements	Within ± 20% on oversaturated arterials	8	3	38	85%	No

3.4.1 Volume Calibration

The volume calibration results summary in **Table 4** shows that the calibration parameters are met for the AM, PM and Saturday models. The full SimTraffic volume calibration results tables are 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 peak hours. The tables show the difference and percentage difference between field counts and the average volumes from the simulation runs.

3.4.2 Queue Length Calibration

The queue calibration results summary in **Table 4** shows that the calibration parameters are met for the AM and PM models, whereas the calibration threshold is not achieved for the Saturday model. It should be noted that the Saturday analysis includes only one intersection of Route 1/Garrisonville Road, with total of 8 movements. The field queue data collection is usually done manually, with limitation for measurement of number of vehicles that accumulate at an approach during the observation period. The field measured queue data indicates that there were instances where a number of vehicles accumulated at eastbound and northbound approaches could not be accurately counted due to the queues exceeding observer's eyesight. Furthermore, there are a few locations in which the queue is less than four vehicles. In these locations, even a small difference in queued vehicles would result in a large percentage difference. For example, if a field-counted queue is four vehicles, but the SimTraffic resulting queue is two vehicles, the relative (percent) difference from the model to field data would be 50%, although the actual difference is only two vehicles. Therefore, to manage the percentage variation for low-volume queues, any difference of four or less vehicles (100 ft) between field counts and SimTraffic results can be considered reasonable. The SimTraffic average queue calibration results tables are shown in the **Appendix.**

3.4.3 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 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 these runs met the required tolerance error and confidence interval, with results included in the **Appendix**.

3.5 Intersection Operations: 2019 Existing Conditions

Traffic operations analyses were conducted using SimTraffic to evaluate overall performance of the study intersections and arterial segments within the corridor. SimTraffic run output reports provided a measure of movement delays and the maximum queues formed for each movement.

Microsimulation Delay in sec/veh was reported from SimTraffic for all the signalized and unsignalized intersections within the study area. Microsimulation delay includes the sum of the total delay per vehicle (sec/vehicle) plus the denied delay per vehicle (sec/vehicle) to account for any denied vehicles into the network.

Table 5 provides a summary of the weekday AM and PM peak hour delay for each movement for the study intersections along the study corridor. **Figure 7** presents the overall intersection delay graphically with color coding to represent the average overall intersection delay. SimTraffic output sheets are provided in the **Appendix**.

Table 6 provides a summary of the weekend/Weekend peak hour delay for each movement for the study intersections along the study corridor. **Figure 8** presents the overall intersection delay graphically with color coding to represent the average overall intersection delay. SimTraffic output sheets are provided in the **Appendix**.

The results from **Table 5** and **Table 6** suggest that the following signalized intersection operates with an overall delay value that exceeds a moderate delay level of 35 sec/veh, which is used as the threshold for the existing conditions evaluation because these delays have the potential to increase to unacceptable delays in the future year conditions.

Intersection 2 – Route 1 and Coachman Circle S

- Microsimulation delay of 133.5 sec/veh during the AM peak hour and 76.9 sec/veh during the PM peak hour

Intersection 4 – Route 1 and Garrisonville Road

- Microsimulation delay of 88.4 sec/veh for the AM peak hour, 69.3 sec/veh for the PM peak hour, and 109.4 sec/veh during the Saturday peak hour

Intersection 5 – Route 1 and NB I-95 Off-Ramp

- Microsimulation delay of 129.5 sec/veh for the AM peak hour

Intersection 6 – Route 1 and Aquia Park

- Microsimulation delay of 48.7 sec/veh for the AM peak hour

Intersection 9 – Route 1 and Bells Hill Road

- Microsimulation delay of 37.2 sec/veh for the AM peak hour

Table 5. Existing 2019 SimTraffic AM and PM Peak Hour Delay (sec/veh)

#	Intersection Number and Description	Type of Control	Lane Group	Eastbound AM Delay	Eastbound PM Delay	Westbound AM Delay	Westbound PM Delay	Northbound AM Delay	Northbound PM Delay	Southbound AM Delay	Southbound PM Delay	Overall AM	Overall PM
1	Route 1 and Port Aquia Drive			Port Aquia Drive		Port Aquia Drive		Route 1		Route 1			
		Signal	Uturn	--	--	--	--	0.0	49.3	--	--		
			Left	50.7	65.9	60.2	66.2	5.9	44.5	26.1	12.8	Delay	Delay
			Through	41.3	0.0	0.0	68.3	4.5	3.6	2.7	10.6		
			Right	8.6	11.2	37.2	34.0	2.3	1.7	5.1	5.8	5.2	10.4
			Approach	23.0	26.5	50.4	62.2	4.4	6.5	2.7	10.5		
2	Route 1 and Coachman Circle S					Coachman Circle S		Route 1		Route 1			
		Two Way Stop	Left	--	--	2395.1	1806.3	--	--	24.5	12.2	Delay	Delay
			Through	--	--	--	--	1.9	1.2	1.4	8.3		
			Right	--	--	2392.9	1751.3	2.1	1.2	--	--	133.5	76.9
			Approach	--	--	2394.1	1795.8	1.9	1.2	1.8	8.4		
3	Route 1 and NB I-95 On Ramp					--		Route 1		Route 1			
		Signal	Left	--	--	--	--	26.6	56.3	--	--	Delay	Delay
			Through	--	--	--	--	4.5	3.1	12.4	5.3		
			Right	--	--	--	--	--	--	11.9	5.7	11.1	9.1
			Approach	--	--	--	--	10.8	15.7	12.3	5.3		
4	Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1			
		Signal	Uturn	0.0	112.6	--	--	--	--	--	--		
			Left	116.5	120.3	83.7	64.9	39.2	69.7	54.1	94.6	Delay	Delay
			Through	58.3	104.7	88.5	70.8	46.0	30.0	44.6	61.3		
			Right	6.8	105.4	458.3	15.3	5.6	8.6	11.9	20.5	88.4	69.3
			Approach	89.0	109.4	254.0	57.0	43.9	46.8	23.1	44.4		
5	Route 1 and NB I-95 Off Ramp			I-95 Off Ramp		Aquia Town Center		Route 1		Route 1			
		Signal	Uturn	--	--	--	--	--	--	0.0	73.9		
			Left	51.6	63.5	543.2	63.9	--	--	66.7	73.0	Delay	Delay
			Through	35.9	65.1	--	--	83.4	7.1	15.8	22.3		
			Right	37.5	64.2	890.4	207.1	13.9	1.4	--	--	129.5	33.1
			Approach	48.8	63.9	837.5	137.8	78.2	6.6	20.1	24.4		
6	Route 1 and Aquia Park			Aquia Park Drive		Aquia Park Drive		Route 1		Route 1			
		Signal	Uturn	--	--	--	--	0.0	26.4	0.0	4.2		
			Left	81.6	68.5	68.6	64.0	41.6	28.7	17.0	10.5	Delay	Delay
			Through	--	--	--	--	66.1	10.3	3.0	7.2		
			Right	4.6	22.0	40.8	9.7	82.2	4.6	1.7	3.4	48.7	10.0
			Approach	50.8	59.6	46.3	15.1	66.0	11.2	3.1	7.0		

Table 5 Cont'd: Existing 2019 SimTraffic AM and PM Peak Hour Delay (sec/veh)

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	Route 1 and Aquia Comm Center			Aquia Comm Center		Aquia Comm Center		Route 1		Route 1			
		Two Way Stop	Left	0.0	--	--	--	23.9	18.1	--	--	Delay	Delay
			Through	0.0	63.4	--	--	24.6	5.8	1.6	3.4		
			Right	4.5	33.5	0.0	6.1	0.0	3.7	1.6	0.0	18.5	4.8
			Approach	4.6	40.3	0.0	6.9	24.6	5.8	1.6	3.4		
8	Route 1 and Foreston Woods Drive			Austin Park Drive		Foreston Woods Drive		Route 1		Route 1			
		Signal	Uturn	--	--	--	--	80.0	0.0	0.0	56.7	Delay	Delay
			Left	79.0	68.4	56.9	64.9	83.3	73.7	73.0	58.3		
			Through	78.6	61.1	49.8	68.1	19.0	31.1	8.9	28.4		
			Right	22.9	42.5	23.5	11.0	2.8	3.3	3.3	10.6	25.8	33.4
			Approach	55.6	50.0	33.3	41.0	24.4	32.0	15.4	31.2		
9	Route 1 and Bells Hill Road			Bells Hill Road		Bells Hill Road				Route 1			
		Signal	Left	--	--	2.9	58.2	--	--	81.0	42.9	Delay	Delay
			Through	63.0	66.2	3.3	64.2	--	--	32.7	15.5		
			Right	47.9	37.5	--	--	--	--	4.3	8.3	37.2	22.8
			Approach	62.5	64.9	2.9	57.8	--	--	33.6	20.6		
10	Route 1 and Coal Landing Road			Coal Landing Road		Coal Landing Road		Route 1		--			
		Signal	Left	37.6	7.2	--	--	66.1	79.1	--	--	Delay	Delay
			Through	40.8	7.0	54.2	62.9	29.8	33.1	--	--		
			Right	--	--	30.1	15.9	5.1	8.7	--	--	31.7	21.7
			Approach	38.9	7.0	31.4	19.8	30.5	34.0	--	--		
11	Route 1 and Austin Run Blvd SB			--		Austin Run Blvd				Route 1			
		One Way Stop	Left	--	--	6.2	8.0	--	--	2.4	1.9	Delay	Delay
			Through	--	--	--	--	--	--	1.4	2.2		
			Right	--	--	--	--	--	--	--	--	1.7	2.2
			Approach	--	--	6.2	8.9	--	--	1.5	2.1		
12	Route 1 and Austin Run Blvd NB			Austin Run Blvd		Austin Run Blvd		Route 1					
		Two Way Stop	Left	17.4	6.4	--	--	1.6	1.2	--	--	Delay	Delay
			Through	18.7	7.7	15.7	7.9	1.0	0.7	--	--		
			Right	--	--	6.9	3.1	2.6	3.4	--	--	2.0	1.6
			Approach	17.6	6.8	9.9	3.8	1.0	0.8	--	--		

Note – The delay values are an average of 10 simulation runs.

Table 6. Existing 2019 SimTraffic Saturday Peak Hour Delay (sec/veh)

Intersection Number and Description	Type of Control	Lane Group	Eastbound	Westbound	Northbound	Southbound	Overall
			Saturday	Saturday	Saturday	Saturday	
			Delay	Delay	Delay	Delay	Saturday
4 Route 1 and Garrisonville Road			Garrisonville Road	Washington Drive	Route 1	Route 1	
	Signal	Left	153.6	71.9	60.5	186.3	Delay
		Through	99.6	67.4	28.9	216.1	
		Right	90.3	17.6	6.9	744.8	109.4
		Approach	117.3	56.3	41.1	161.3	

Note – The delay values are an average of 10 simulation runs.

Figure 14. Existing 2019 AM (PM) Peak Hour Intersection Operations Results

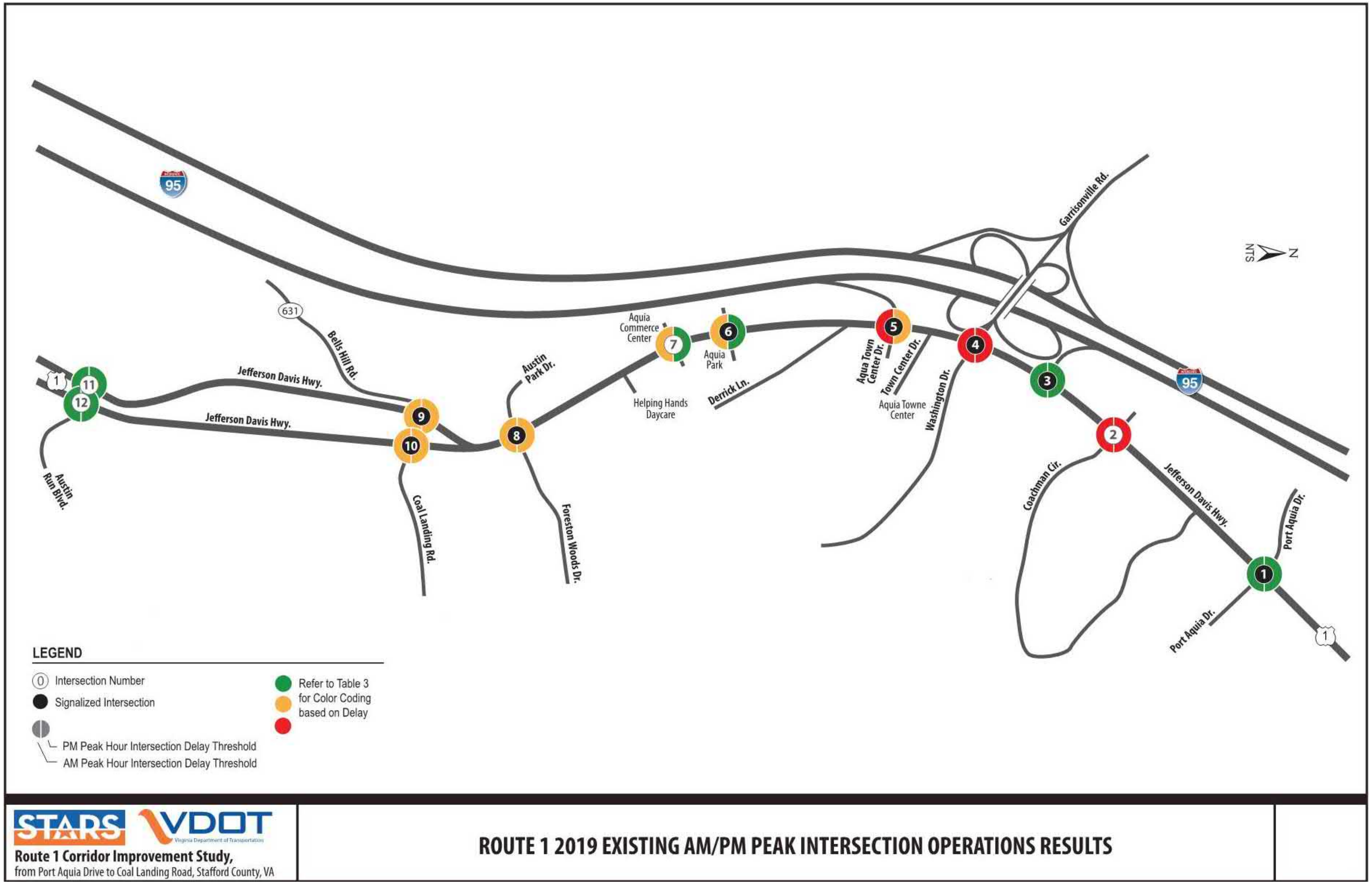
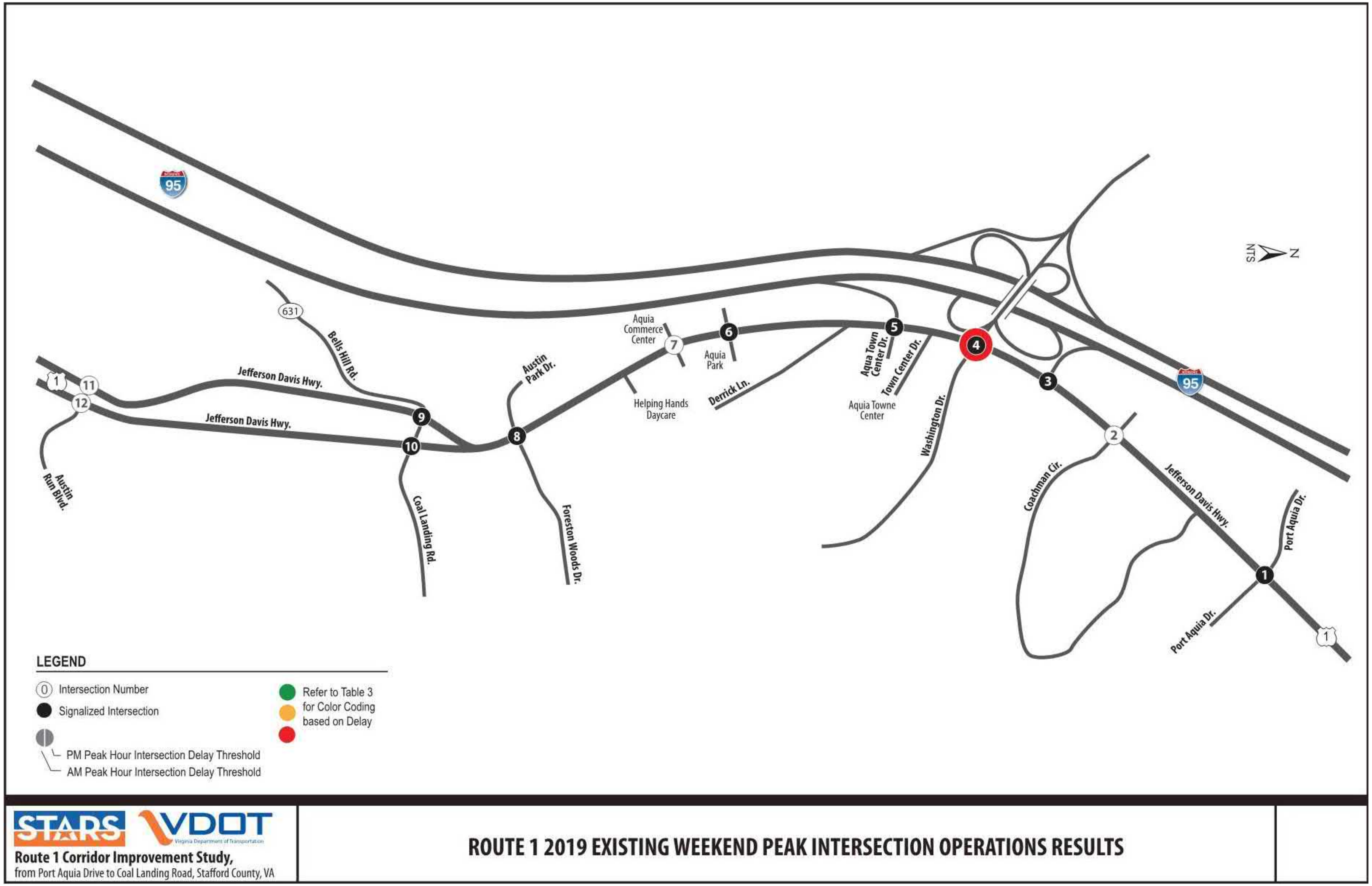


Figure 15. Existing 2019 Saturday Peak Hour Intersection Operations Results



95
631
Bells Hill Rd.
Jefferson Davis Hwy.
Jefferson Davis Hwy.
Austin Run Blvd.
Coal Landing Rd.
Austin Park Dr.
Foreston Woods Dr.
Aquia Commerce Center
Helping Hands Daycare
Aquia Park
Derrick Ln.
Aqua Town Center Dr.
Town Center Dr.
Aquia Towne Center
Washington Dr.
Coachman Cir.
Jefferson Davis Hwy.
Port Aquia Dr.
Port Aquia Dr.
NTS
N
LEGEND
Intersection Number
Signalized Intersection
PM Peak Hour Intersection Delay Threshold
AM Peak Hour Intersection Delay Threshold
Refer to Table 3 for Color Coding based on Delay
Route 1 Corridor Improvement Study,
from Port Aquia Drive to Coal Landing Road, Stafford County, VA
ROUTE 1 2019 EXISTING WEEKEND PEAK INTERSECTION OPERATIONS RESULTS

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 inappropriate phasing. A queuing analysis was completed for the study intersections during the 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 7** provides a summary of the maximum queue lengths during the weekday AM and PM peak hours as compared to the available storage bay lengths. The queue lengths in red and bold text in **Table 7** are the movements in which the reported maximum queue length value exceeds the storage length available for that turning movement. The SimTraffic output sheets including the maximum queue lengths are included in the **Appendix**.

Table 8 provides a summary of the maximum queue lengths during the Saturday peak hour as compared to the available storage bay lengths. The queue lengths in red and bold text in **Table 8** are the movements in which 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 the **Appendix**.

The movements in which the maximum queue exceeds the available storage bay length are summarized below:

Intersection 1 – Route 1 and Port Aquia Drive

- Westbound right-turning movement (existing storage bay length of 20 ft.) indicates the maximum queue length is 55 ft. in the AM peak and 29 ft. in the PM peak. The SimTraffic simulation indicated right-turn bay blockage due to traffic queued in the adjacent through lane.

Intersection 4 – Route 1 and Garrisonville Road

- Westbound right-turning movement (existing storage bay length of 295 ft.) indicates the maximum queue length reaches capacity in the AM peak. The queueing report indicates that the maximum queue reaches capacity but the SimTraffic model shows the queue extending past the turn bay blocking through vehicles due to heavy right turn demand.

- Southbound left-turning movement (existing storage bay length of 315 ft.) indicates the maximum queue length reaches capacity in the PM and weekend peaks. The SimTraffic simulation indicated extensive left-turn bay blockage due to heavy traffic in the adjacent through lanes.

Intersection 5 – Route 1 and NB I-95 Off-Ramp

- Eastbound thru-right turning movement (existing storage bay length of 245 ft.) indicates the maximum queue length reaches capacity in the AM peak. The SimTraffic simulation indicated extensive thru-right turn bay blockage due to heavy traffic in the adjacent left-turn lane.

- Westbound left-turning movement (existing storage bay length of 250 ft.) indicates the maximum queue length is 636 ft. in the AM peak. The SimTraffic simulation indicated extensive left-turn bay blockage due to heavy traffic in the adjacent right-turn lane.

Intersection 8 – Route 1 and Foreston Woods Drive

- Eastbound right-turning movement (existing storage bay length of 110 ft.) indicates the maximum queue length reaches capacity in the AM and PM peaks. The SimTraffic model and simulation results extensive right-turn bay blockage due to heavy traffic in the adjacent left-thru lane.

- Northbound left-turning movement (existing storage bay length of 250 ft.) indicates the maximum queue length reaches capacity in the AM peak. The queueing report indicates that the maximum queue reaches capacity but the SimTraffic model shows the queue extending past the turn bay blocking through vehicles due to heavy left turn demand in some instances but also shows extensive left-turn bay blockage due to heavy traffic in the adjacent through lanes.

- Southbound left-turning movement (existing storage bay length of 260 ft.) indicates the maximum queue length reaches capacity in the PM peak. The queueing report indicates that the maximum queue reaches capacity but the SimTraffic model shows the queue extending past the turn bay blocking through vehicles due to heavy left turn demand in some instances but also shows extensive left-turn bay blockage due to heavy traffic in the adjacent through lanes.

Intersection 9 – Route 1 and Bells Hill Road

- Southbound left-turning movement (existing storage bay length of 200 ft.) indicates the maximum queue length reaches capacity in the PM peak. The queueing report indicates that the maximum queue reaches capacity but the SimTraffic model shows the queue extending past the turn bay blocking through vehicles due to heavy left turn demand in some instances but also shows extensive left-turn bay blockage due to heavy traffic in the adjacent through lanes.

- Southbound right-turning movement (existing storage bay length of 270 ft.) indicates the maximum queue length reaches capacity in the PM peak. The SimTraffic simulation indicated extensive right-turn bay blockage due to heavy traffic in the adjacent through lanes.

Table 7. 2019 Existing Conditions: Summary of AM/PM Peak 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 Route 1 and Port Aquia Drive			Port Aquia Drive			Port Aquia Drive			Route 1			Route 1		
	Signal	Left	--	79	83	--	76	117	200	57	113	250	23	130
		Through	--			--			--	197	149	--	118	437
		Right	150	73	67	20	**55**	**29**	280	16	9	270	18	131
2 Route 1 and Coachman Circle S			--			Coachman Circle S			Route 1			Route 1		
	Two Way Stop	Left/Uturn	--			--			--	--	--	--	61	275
		Through	--	0	11	--	537	722	--	--	--	--	--	--
		Right	--			--			340	2	10	--	11	273
3 Route 1 and NB I-95 On Ramp						--			Route 1			Route 1		
	Signal	Left	--	--	--	--	--	--	365	358	345	--	--	--
		Through	--	--	--	--	--	--	--	419	141	--	201	229
		Right	--	--	--	--	--	--	--	--	--	--	274	307
4 Route 1 and Garrisonville Road			Garrisonville Road			Washington Drive			Route 1			Route 1		
	Signal	Left	985	406	398	225	206	150	640	370	394	315	41	**314**
		Through	--	182	377	--	1,338	181	--	644	248	--	144	572
		Right	--	140	416	295	**295**	77	910	214	81	575	148	464
5 Route 1 and NB I-95 Off Ramp			I-95 Off Ramp			Aquia Town Center			Route 1			Route 1		
	Signal	Left	--	463	292	250	**636**	200	--	--	--	290	83	271
		Through	--	**245**	220	--	--	--	--	1,455	211	--	194	436
		Right	245			--	639	499	565	554	46	--	--	--
6 Route 1 and Aquia Park			Aquia Park Drive			Aquia Park Drive			Route 1			Route 1		
	Signal	Left	--	26	153	--			300	192	93	270	30	43
		Through	--			--	83	50	--	720	279	--	126	254
		Right	--	18	51	--			145	45	31	290	27	46
7 Route 1 and Aquia Comm Center			Aquia Commerce Center			Aquia Commerce Center			Route 1			Route 1		
	Two Way Stop	Left	--			--			--	535	41	--	--	--
		Through	--	22	86	--	0	27	--	510	11	--	--	--
		Right	--			--			--	--	--	--	--	--
8 Route 1 and Foreston Woods Dr			Austin Park Drive			Foreston Woods			Route 1			Route 1		
	Signal	Left	--	309	198	--	138	320	250	**250**	217	260	144	**260**
		Through	--			--			--	367	339	--	142	549
		Right	110	**110**	**110**	--	152	120	340	183	160	400	55	326
9 Route 1 and Bells Hill Road			Bells Hill Road			Bells Hill Road						Route 1 (one way)		
	Signal	Left	--	--	--	--	27	86	--	--	--	200	186	**200**
		Through	--	251	143	--			--	--	--	--	278	618
		Right	--			--	--	--	--	--	--	270	166	**269**

Table 7 Cont'd. 2019 Existing Conditions: Summary of AM/PM Peak 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)
10 Route 1 and Coal Landing Road			Coal Landing Road			Coal Landing Road			Route 1 (one way)					
	Signal	Left	--	203	101	--	--	--	165	164	136	--	--	--
		Through	--			--	274	150	--	529	281	--	--	--
		Right	--	--	--	--			685	33	54	--	--	--
11 Route 1 and Austin Run Blvd SB			--			Austin Run Blvd						Route 1 (one way)		
	Two Way Stop	Left	--	--	--	--	35	32	--	--	--	--	0	0
		Through	--	--	--	--	--	--	--	--	--	--	0	0
		Right	--	--	--	--	--	--	--	--	--	--	0	0
12 Route 1 and Austin Run Blvd NB			Austin Run Blvd			Austin Run Blvd			Route 1 (one way)					
	Two Way Stop	Left	--	102	57	--	--	--	--	0	0	--	--	--
		Through	--			--	53	30	--	0	0	--	--	--
		Right	--	--	--	--			--	0	0	--	--	--

NOTE: The maximum queues in feet are obtained from 10 SimTraffic simulation runs averaged together.
'--' Storage Bay Length not provided or the movements do not exist.
Red and bold text indicates queue lengths that reach or exceed the available storage lengths OR indicates turn lane storage blockage.

Table 8. 2019 Existing Conditions: Summary of Saturday Peak Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound	
			Storage Bay Length	Saturday Queue (ft)	Storage Bay Length	Saturday Queue (ft)	Storage Bay Length	Saturday Queue (ft)	Storage Bay Length	Saturday Queue (ft)
4 Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1	
	Signal	Left	985	386	225	165	640	365	315	**315**
		Through	--	244	--	162	--	291	--	1,634
		Right	--	351	295	89	910	71	575	512

NOTE: The maximum queues in feet are obtained from 10 SimTraffic simulation runs averaged together.
'--' Storage Bay Length not provided or the movements do not exist.
Red and bold text indicates queue lengths that reach or exceed the available storage lengths OR indicates turn lane storage blockage.

4 FUTURE 2035 NO BUILD OPERATIONAL ANALYSIS

Operational analysis was performed at each of the study intersections for the Future 2035 No-Build Conditions using the methodology described in Section 3 of this report.

4.1 Future 2035 Traffic Volumes

Future Year 2035 traffic growth factors were derived using outputs from the Fredericksburg Area Metropolitan Planning Organization (FAMPO) regional travel demand forecasting model. FAMPO staff noted that this model accounts for the latest approved land use growth projections for North Stafford County. It also allows the study team to account for the potential effects of extending the I-95 Express lanes southward to Route 17. This was important because Route 1 and I-95 run parallel to one another and there can be significant interplay between the two depending on traffic levels on I-95. An examination of the FAMPO travel demand model outputs resulted in a projected average annual grow rate (AAGR) of 1.6% for the study corridor. This factor was applied to the 2019 peak period traffic counts to project traffic volumes to 2035.

The 2035 peak hour volume projections are presented in **Figures 16** and **17**.

Figure 16. Future 2035 AM (PM) Peak Hour Traffic Volumes

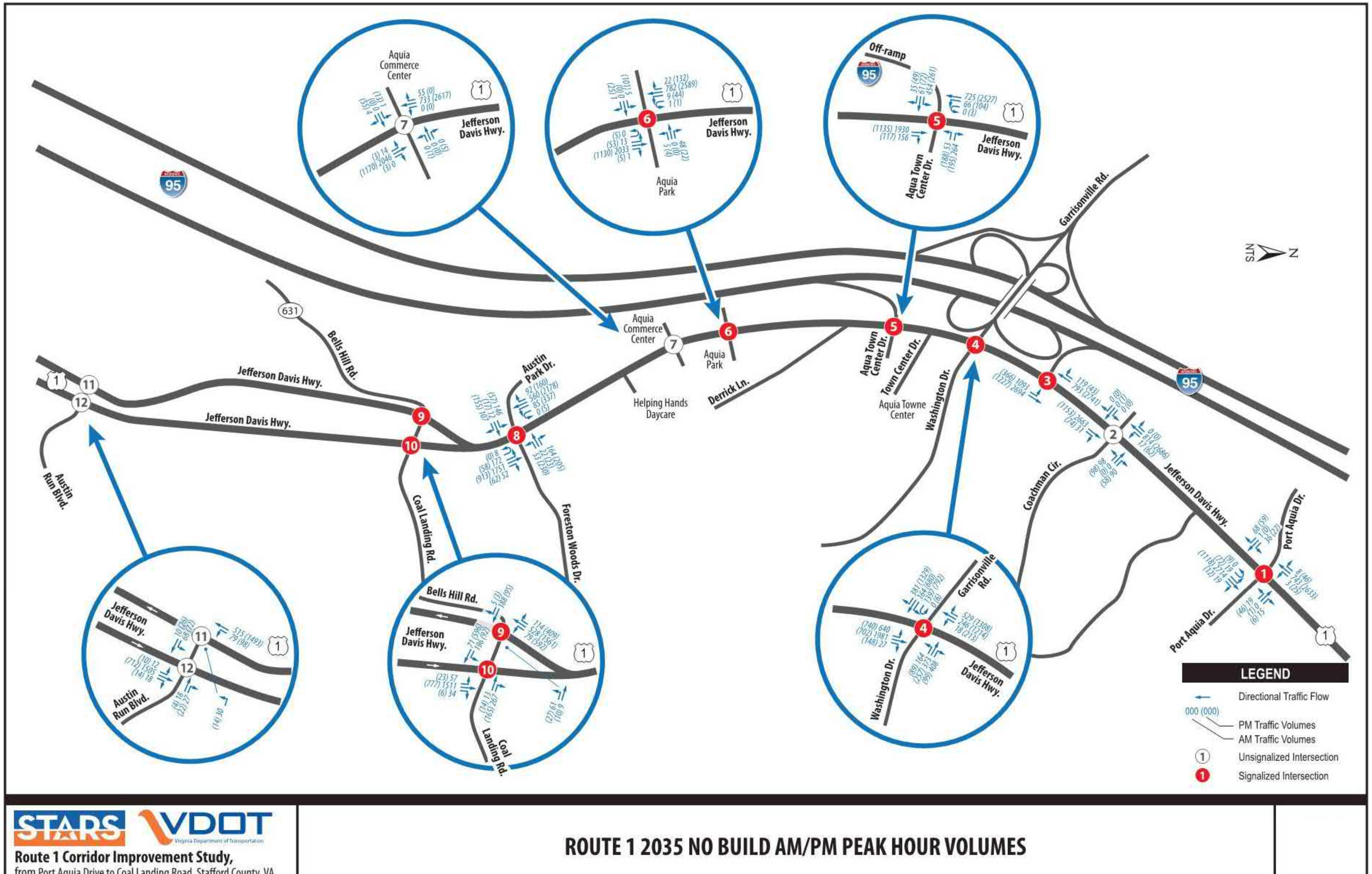
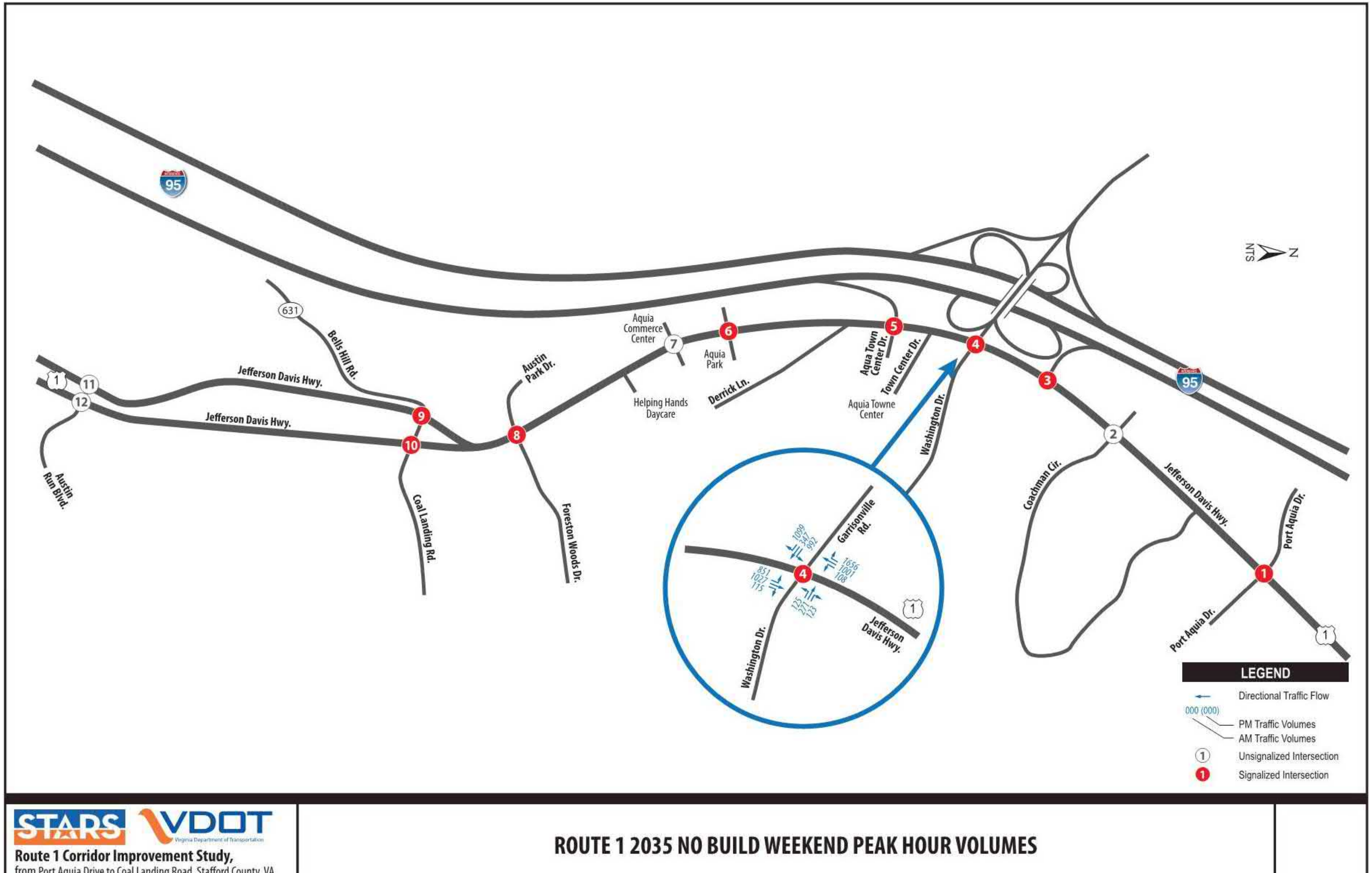


Figure 17. Future 2035 Saturday Peak Hour Traffic Volumes



4.2 Intersection Operations: Future 2035 No-Build Conditions

Operational analysis was performed at each of the study intersections for the Future 2035 No-Build Conditions scenario. **Tables 9** and **10** summarize the average peak hour delay and LOS during weekday and weekend peak hours respectively for the study intersections along the Route 1 corridor. **Figures 18** and **19** summarize the overall intersection delay graphically. SimTraffic output sheets are provided in the **Appendix**.

The results in **Table 9** suggest that, under Future 2035 No-Build conditions, the following intersections will operate at unacceptable delay values (LOS F with an overall intersection delay greater than 80 seconds/vehicle) during the AM and/or PM peak hours:

- Route 1 / Coachman Circle (S)
- Route 1 / Garrisonville Road
- Route 1 / NB I-95 off-Ramp
- Route 1 / Aquia Park
- Route 1 / Aquia Commerce Center
- Route 1 / Foreston Woods Drive
- Route 1 / Bells Hill Road
- Route 1 / Coal Landing Road
- Route 1 / Port Aquia Drive (PM Peak)
- Route 1 / NB I-95 on-Ramp (PM Peak)
- Route 1 / Austin Run Boulevard SB (AM Peak)
- Route 1 / Austin Run Boulevard NB (AM Peak)

The intersection of Route 1/Garrisonville Road was analyzed for the Future 2035 No-Build weekend conditions, which is expected to operate at an unacceptable level of delay at LOS F as shown in **Table 10**.

Queuing analysis was completed for the study intersections during the AM, PM, and weekend peak hours for 2035 No-Build conditions. SimTraffic Maximum Queue Lengths in feet were reported for each movement at study intersections. These queue lengths are based on an average of 10 simulation runs. **Tables 11** and **12** summarize the maximum queue lengths during the AM/PM and weekend peak hours, respectively. Queue results show significant northbound and southbound queuing during both the AM and PM peaks at every intersection in the study area.

Table 9. Future 2035 No-Build SimTraffic AM and PM Peak Hour Delay (veh/sec)

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 Route 1 and Port Aquia Drive			Port Aquia Drive		Port Aquia Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	53.2	--	--		
		Left	60.8	64.1	63.1	62.6	7.7	44.9	16.7	422.8	Delay	Delay
		Through	89.1	--	--	81.3	5.0	4.5	3.3	415.3		
		Right	8.8	9.8	35.6	35.9	2.6	2.1	4.4	384.4	5.9	338.3
		Approach	27.0	24.8	49.5	59.9	5.0	6.8	3.4	414.7		
2 Route 1 and Coachman Circle S			Coachman Circle S		Coachman Circle S		Route 1		Route 1			
	Two Way Stop	Left	--	--	3219.7	4473.7	--	--	28.2	80.5	Delay	Delay
		Through	--	412.2	--	--	1.8	1.1	1.8	89.1		
		Right	--	--	3249.6	4495.2	2.1	1.4	--	--	238.8	278.8
		Approach	--	412.10	3235.8	4480.8	1.8	1.1	2.3	88.9		
3 Route 1 and NB I-95 On Ramp					--		Route 1		Route 1			
	Signal	Left	--	--	--	--	37.2	742.2	--	--	Delay	Delay
		Through	--	--	--	--	5.5	22.5	16.7	131.4		
		Right	--	--	--	--	--	--	18.7	142.0	15.3	142.1
		Approach	--	--	--	--	14.7	177.7	16.9	131.6		
4 Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1			
	Signal	Uturn	--	1333.3	--	--	--	--	--	--		
		Left	128.7	420.7	911.4	77.6	47.6	252.9	56.7	229.1	Delay	Delay
		Through	64.2	163.1	934.9	85.8	62.9	378.5	41.1	180.8		
		Right	21.3	116.4	1468.5	655.2	5.3	17.1	14.5	32.2	280.9	179.1
		Approach	102.0	204.3	1183.2	218.3	58.7	289.4	23.9	15.9		
5 Route 1 and NB I-95 Off Ramp			I-95 Off Ramp		Aquia Town Center		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	--		139.0		
		Left	59.6	1659.2	1797.3	1461.7	--	--	60.4	83.4	Delay	Delay
		Through	39.2	1490.2	--	--	100.3	223.7	15.4	33.2		
		Right	40.7	1505.3	2296.4	2159.7	18.1	19.9	--	--	336.3	480.6
		Approach	56.1	1610.0	2220.9	1851.6	94.4	205.7	18.9	35.7		
6 Route 1 and Aquia Park			Aquia Park Drive		Aquia Park Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	280.3	--	--		
		Left	53.0	279.4	61.9	229.5	144.9	292.8	18.3	28.6	Delay	Delay
		Through	--	--	--	--	177.4	409.9	3.8	25.3		
		Right	5.4	76.4	57.2	242.7	125.1	215.1	1.8	15.3	125.0	140.3
		Approach	45.1	239.0	58.7	251.1	177.1	404.0	4.0	24.9		

Table 9 Continued. Future 2035 No-Build SimTraffic AM and PM Peak Hour Delay (veh/sec)

Intersection Number and Description	Type of Control	Lane Group	Eastbound AM Delay	Eastbound PM Delay	Westbound AM Delay	Westbound PM Delay	Northbound AM Delay	Northbound PM Delay	Southbound AM Delay	Southbound PM Delay	Overall AM	Overall PM
7 Route 1 and Aquia Comm Center			Aquia Comm Center		--		Route 1		Route 1			
	Two Way Stop	Left	66.8	1287.7	--	179.8	283.9	587.6	--	--	Delay	Delay
		Through	--	--	--	--	276.4	414.3	1.9	20.6		
		Right	2.9	1198.9	--	761.1	--	243.7	2.0	--	200.3	176.7
		Approach	16.2	1238.3	--	791.0	276.3	414.3	1.9	20.6		
8 Route 1 and Foreston Woods Drive			Austin Park Drive		Foreston Woods Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	130.2	--	--	123.2	Delay	Delay
		Left	771.1	279.6	85.0	209.5	114.3	114.8	75.1	113.6		
		Through	806.6	243.1	35.7	197.3	74.9	113.9	32.1	82.6		
		Right	686.5	180.7	--	216.6	13.5	9.2	12.2	49.8	137.9	118.6
		Approach	737.3	210.3	51.1	211.8	76.7	108.2	34.9	84.7		
9 Route 1 and Bells Hill Road			Bells Hill Road		Bells Hill Road		Route 1		Route 1			
	Signal	Left	--	--	2.9	57.7	--	--	1021.9	127.6	Delay	Delay
		Through	2965.4	244.0	4.9	44.8	--	--	125.7	23.6		
		Right	2964.6	215.3	--	--	--	--	77.6	13.0	819.6	55.9
		Approach	2964.6	244.8	3.2	54.4	--	--	224.9	44.7		
10 Route 1 and Coal Landing Road			Coal Landing Road		Coal Landing Road		Route 1		--			
	Signal	Left	301.8	43.7	--	--	1047.0	286.6	--	--	Delay	Delay
		Through	324.8	25.8	234.8	222.1	760.0	284.6	--	--		
		Right	--	--	226.8	123.1	565.9	278.4	--	--	655.0	195.7
		Approach	305.0	28.3	227.2	192.5	765.5	284.3	--	--		
11 Route 1 and Austin Run Blvd SB			--		Austin Run Blvd		Route 1		Route 1			
	One Way Stop	Left	--	--	--	7.5	--	--	774.4	5.1	Delay	Delay
		Through	--	--	--	--	--	--	5.3	2.2		
		Right	--	--	--	--	--	--	--	--	102.2	2.3
		Approach	--	--	--	7.5	--	--	105.1	2.2		
12 Route 1 and Austin Run Blvd NB			Austin Run Blvd		Austin Run Blvd		Route 1		Route 1			
	Two Way Stop	Left	759.7	10.9	--	--	275.3	4.8	--	--	Delay	Delay
		Through	492.4	6.8	1398.2	9.3	289.6	12.0	--	--		
		Right	--	--	1358.3	13.7	266.7	10.9	--	--	321.5	7.4
		Approach	289.2	6.8	746.8	11.7	1373.1	13.1	--	--		

Note – The delay values are an average of 10 simulation runs.

Table 10. Future 2035 No-Build SimTraffic Weekend Peak Hour Delay (sec/veh)

Intersection Number and Description	Type of Control	Lane Group	Eastbound	Westbound	Northbound	Southbound	Overall
			Weekend	Weekend	Weekend	Weekend	
			Delay	Delay	Delay	Delay	AM
4 Route 1 and Garrisonville Road			Garrisonville Road	Washington Drive	Route 1	Route 1	
	Signal	Left	239.3	291.1	921.9	1096.8	Delay
		Through	159.4	295.8	591.5	1151.1	
		Right	181.6	116.6	568.4	1054.4	722.0
		Approach	201.6	252.7	741.8	1092.0	

Note – The delay values are an average of 10 simulation runs.

Table 11. Future 2035 No-Build Conditions: Summary of AM/PM Peak 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 Route 1 and Port Aquia Drive			Port Aquia Drive			Port Aquia Drive			Route 1			Route 1		
	Signal	Left	--	91	101	--	90	143	200	33	99	250	31	227
		Through	--			--			--	225	127	--	153	488
		Right	150	67	92	20	**54**	**30**	280	18	12	270	35	**270**
2 Route 1 and Coachman Circle S			Coachman Circle S			Coachman Circle S			Route 1			Route 1		
	Two Way Stop	Left/Uturn	--	543	32	--	2	714	--	--	--	--	73	1,456
		Through	--			--			--	--	2	--	--	--
		Right	--			--			340		14	--	34	1,459
3 Route 1 and NB I-95 On Ramp						--			Route 1			Route 1		
	Signal	Left	--	--	--	--	--	--	365	**365**	**365**	--	--	--
		Through	--	--	--	--	--	--	--	629	882	--	265	1,144
		Right	--	--	--	--	--	--	--	--	--	--	357	1,133
4 Route 1 and Garrisonville Road			Garrisonville Road			Washington Drive			Route 1			Route 1		
	Signal	Left	985	408	395	225	221	208	640	639	**640**	315	52	**315**
		Through	--	170	407	--	1,562	895	--	977	1,048	--	181	926
		Right	--	168	412	295	**295**	**295**	910	298	**910**	575	193	**918**
5 Route 1 and NB I-95 Off Ramp			I-95 Off Ramp			Aquia Town Center			Route 1			Route 1		
	Signal	Left	--	634	909	250	**631**	**612**	--	--	--	290	80	289
		Through	--	**245**	**245**	--	--	--	--	1,658	1,631	--	188	692
		Right	245			--	639	627	565	554	552	--	--	--
6 Route 1 and Aquia Park			Aquia Park Drive			Aquia Park Drive			Route 1			Route 1		
	Signal	Left	--	33	366	--	120	166	300	**300**	**300**	270	32	187
		Through	--			--			--	1,091	1,079	--	140	852
		Right	--	12	147	--			145	28	101	290	20	216

Table 11 Cont'd. Future 2035 No-Build Conditions: Summary of AM/PM Peak 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)
7 Route 1 and Aquia Comm Center			Aquia Commerce Center			Aquia Commerce Center			Route 1			Route 1		
	Two Way Stop	Left	--			--			--	1,738	1,617	--	--	420
		Through	--	24	404	--	--	98	--	1,750	1,618	--	--	420
		Right	--			--			--	--	24	--	10	--
8 Route 1 and Foreston Woods Dr			Austin Park Drive			Foreston Woods			Route 1			Route 1		
	Signal	Left	--	384	408	--	224	488	250	**250**	249	260	179	**260**
		Through	--			--			--	396	377	--	366	1,321
		Right	110	**110**	**110**	--	240	468	340	**340**	308	400	157	365
9 Route 1 and Bells Hill Road			Bells Hill Road			Bells Hill Road						Route 1 (one way)		
	Signal	Left	--	--	--	--	41	96	--	--	--	200	**200**	**200**
		Through	--	458	195	--			--	--	--	--	782	816
		Right	--			--	--	--	--	--	--	270	246	268
10 Route 1 and Coal Landing Road			Coal Landing Road			Coal Landing Road			Route 1 (one way)					
	Signal	Left	--	212	186	--	--	--	165	**165**	144	--	--	--
		Through	--			--	490	377	--	3,578	2,244	--	--	--
		Right	--	--	--	--			685	**685**	164	--	--	--
11 Route 1 and Austin Run Blvd SB						Austin Run Blvd						Route 1 (one way)		
	Two Way Stop	Left	--	--	--	--	33	33	--	--	--	--	262	--
		Through	--	--	--	--	--	--	--	--	--	--	885	--
		Right	--	--	--	--	--	--	--	--	--	--	--	--
12 Route 1 and Austin Run Blvd NB			Austin Run Blvd			Austin Run Blvd			Route 1 (one way)					
	Two Way Stop	Left	--	155	76	--	--	--	--	375	132	--	--	--
		Through	--			--	266	38	--	375	129	--	--	--
		Right	--	--	--	--			--	100	--	--	--	--

NOTE: The maximum queues in feet are obtained from 10 SimTraffic simulation runs averaged together.
'--' Movement is a full lane (No storage bay) or the movement does not exist.
Red and bold text indicates queue lengths that reach or exceed the available storage lengths OR indicates turn lane storage blockage.

Table 12. Future 2035 No-Build Conditions: Summary of Saturday Peak Maximum Queues (feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound	
			Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)
4 Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1	
	Signal	Left	985	383	225	**228**	640	**640**	315	**315**
		Through	--	324	--	654	--	1,883	--	1,827
		Right	--	349	295	270	910	75	575	575

Figure 18. Future 2035 No-Build AM(PM) Peak Intersection Operations Results

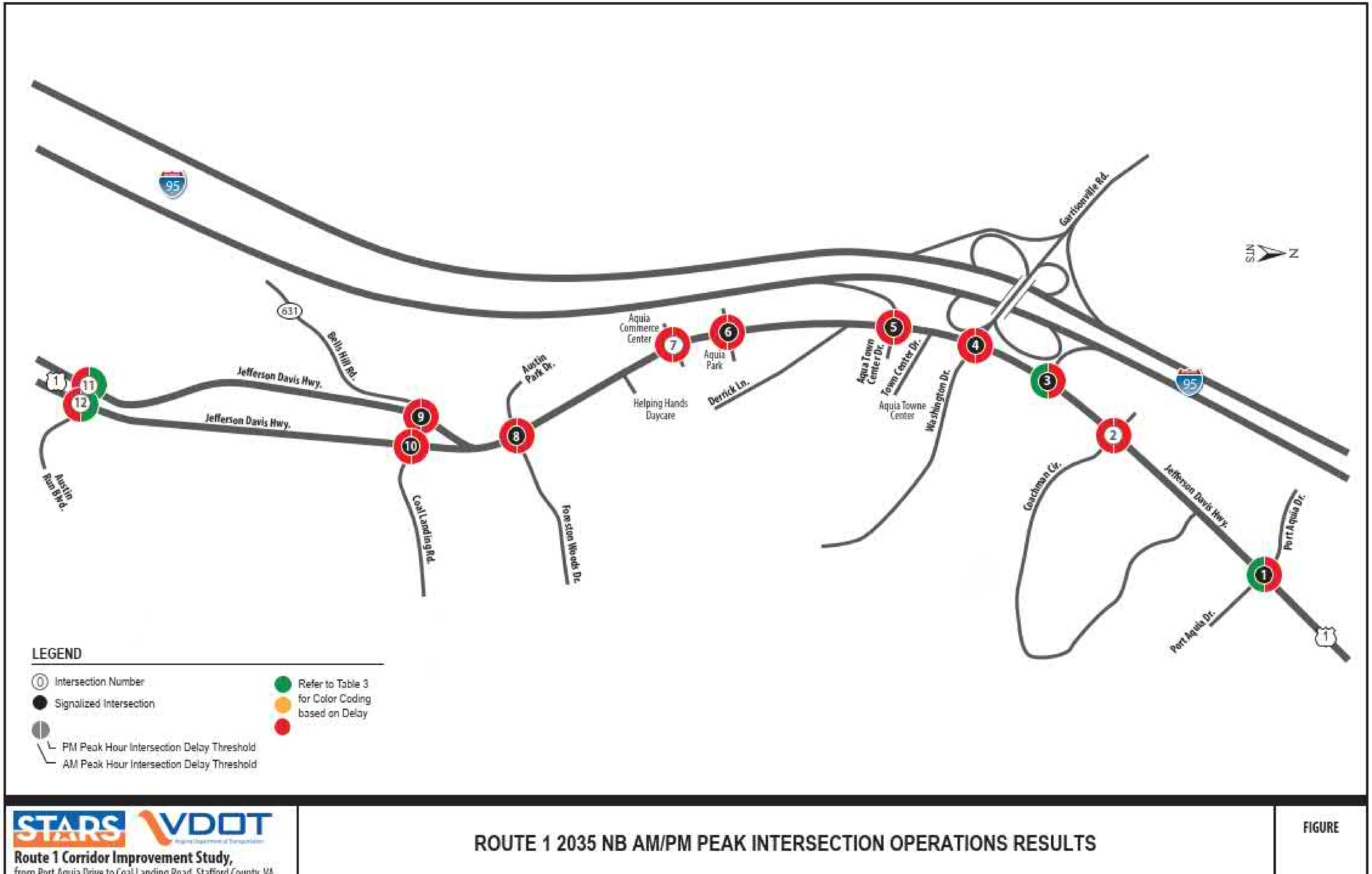
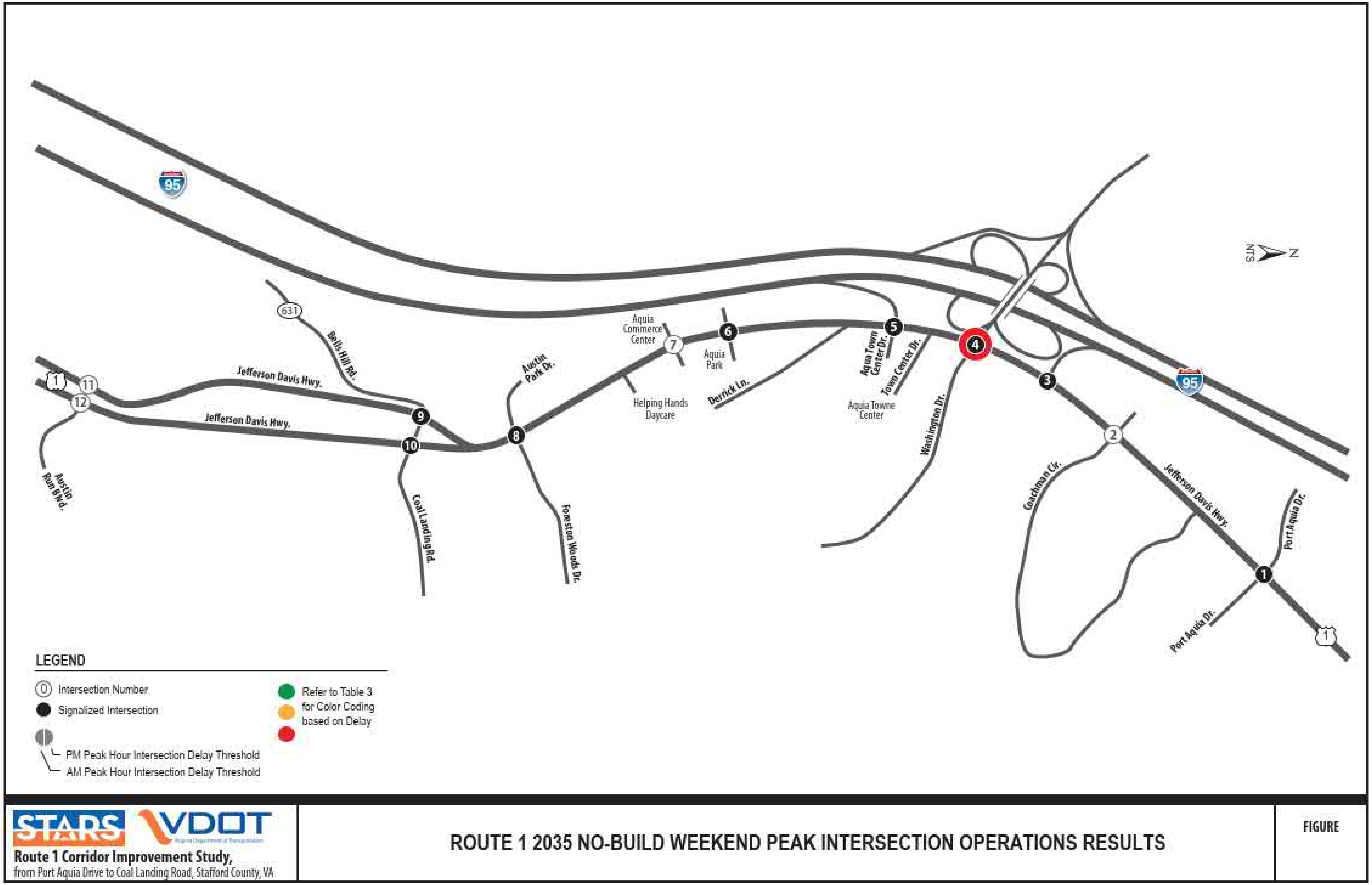


Figure 19. Future 2035 No-Build Weekend Peak Intersection Operations Results



5 CRASH ANALYSIS

Crash data for the most recent five (5) years (September 1, 2013 through August 31, 2018) were obtained from VDOT's *Crashtools* Database. The crash data were evaluated to identify crash locations and patterns, the severity of crashes, and likely causes for crashes. As part of the crash analysis, crash histograms illustrating all crashes by year were developed and are included in the **Appendix.** The crash data was 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 based on the crash data obtained from the database. Field reviews were conducted, which included the observations during the AM and PM peak hours (6:45AM to 7:45AM; 4:15PM to 5:15PM), 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.

5.1 Findings and Recommendations

The findings for the project area are separated by Crash Data Analysis findings and Field Review findings. The Crash Data Analysis findings describe trends in the data regarding the year, time of day, type of crash, and roadway condition. The Field Review findings describe the field observations and discuss how those observations may relate to trends identified in the crash data. The findings and recommendations are provided in the following sections.

5.2 Crash Data Analysis

5.2.1 Crashes by Year

A total of 465 crashes occurred along Route 1 from Port Aqua Drive to Austin Run Boulevard between September 1, 2013 and August 31, 2018, as shown in **Figure 20**. Note that the 2013 and 2018 bars are striped since the data does not include a full calendar year. The AADT values were used to associate the traffic volume with crashes per year, as shown in **Figure 20** (orange trend line). The AADT values remained steady from 2013 to 2017 with an increase in traffic in 2018. Generally, the total number of crashes fluctuated over the 5-year study period with a general, slight decline in crashes. **Figure 23** is a crash heat map used to illustrate areas experiencing the highest density of crashes over the course of the 5-year study period.

Figure 20. Number of Crashes per Year

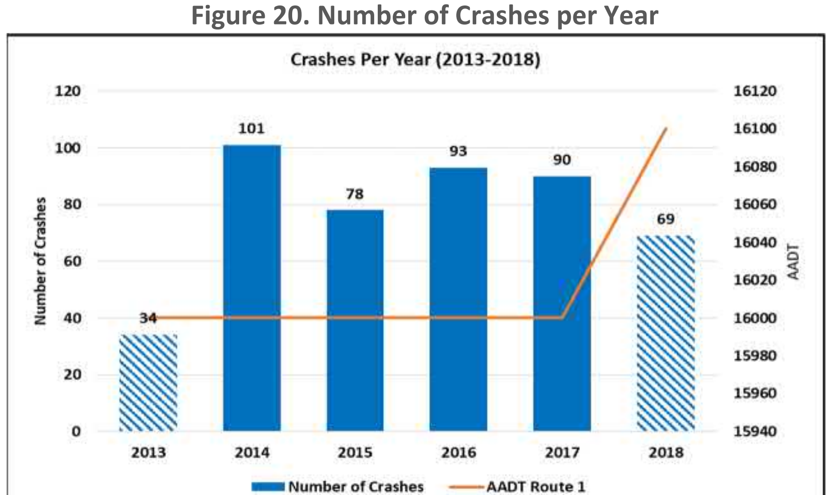


Figure 21. Crashes by Severity

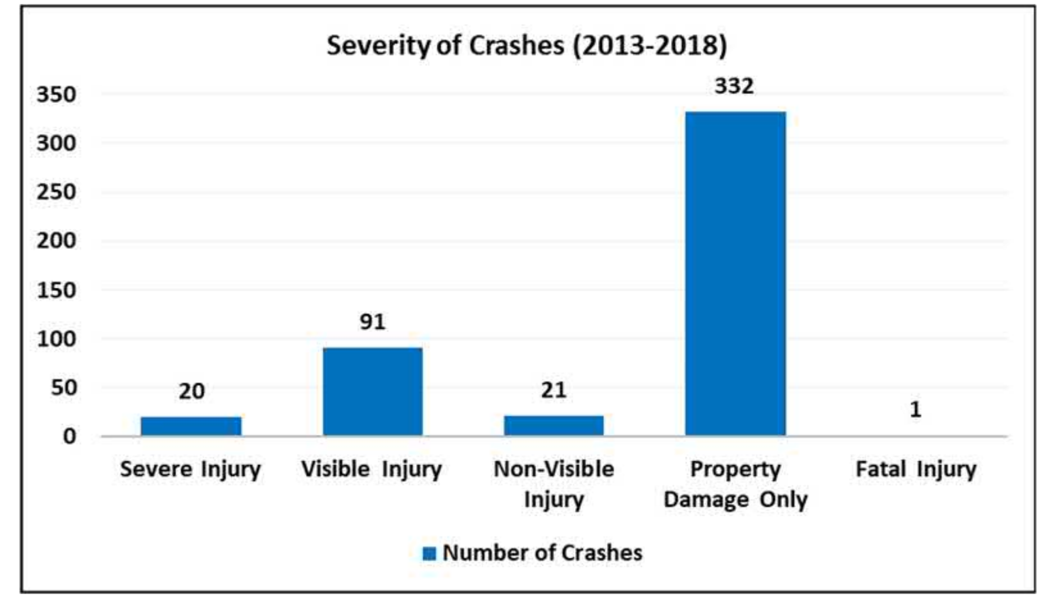


Figure 21 shows that 1 fatal injury (<1%), 20 severe injuries (4%), 21 no-visible injuries (5%), and 91 visible injuries (20%) occurred in the study area within the five-year period. Most crashes that occurred were property damage, which accounted for 71% of all crashes. **Figure 22** displays the severity of crashes for which the highest percentage of crashes were PDO (O) (71%) followed by B+C (24%) and then K+A (5%).

Figure 22. Crashes by Injury Severity

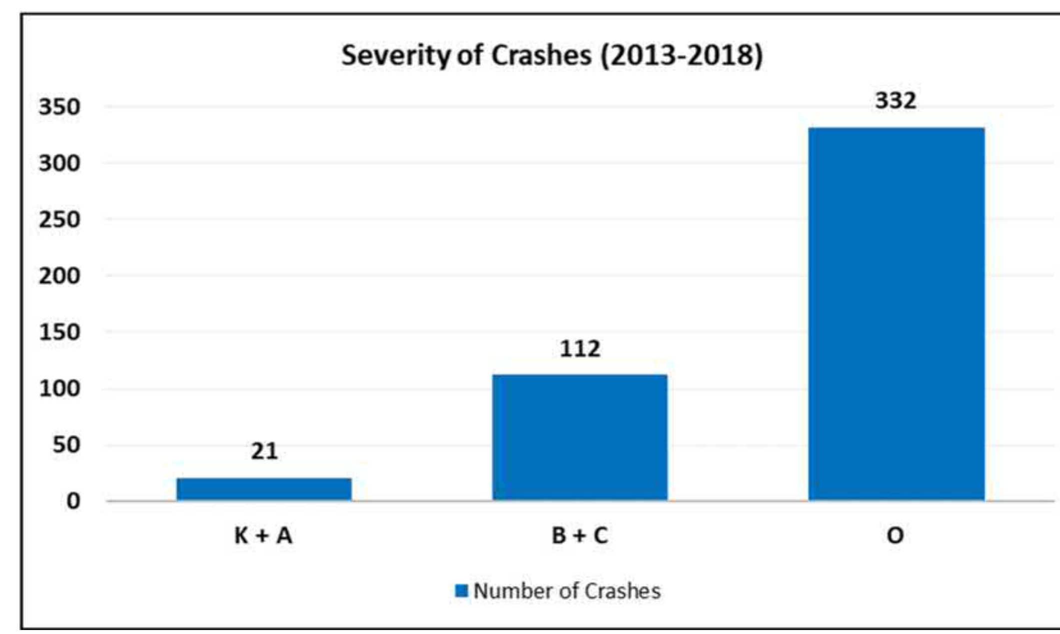
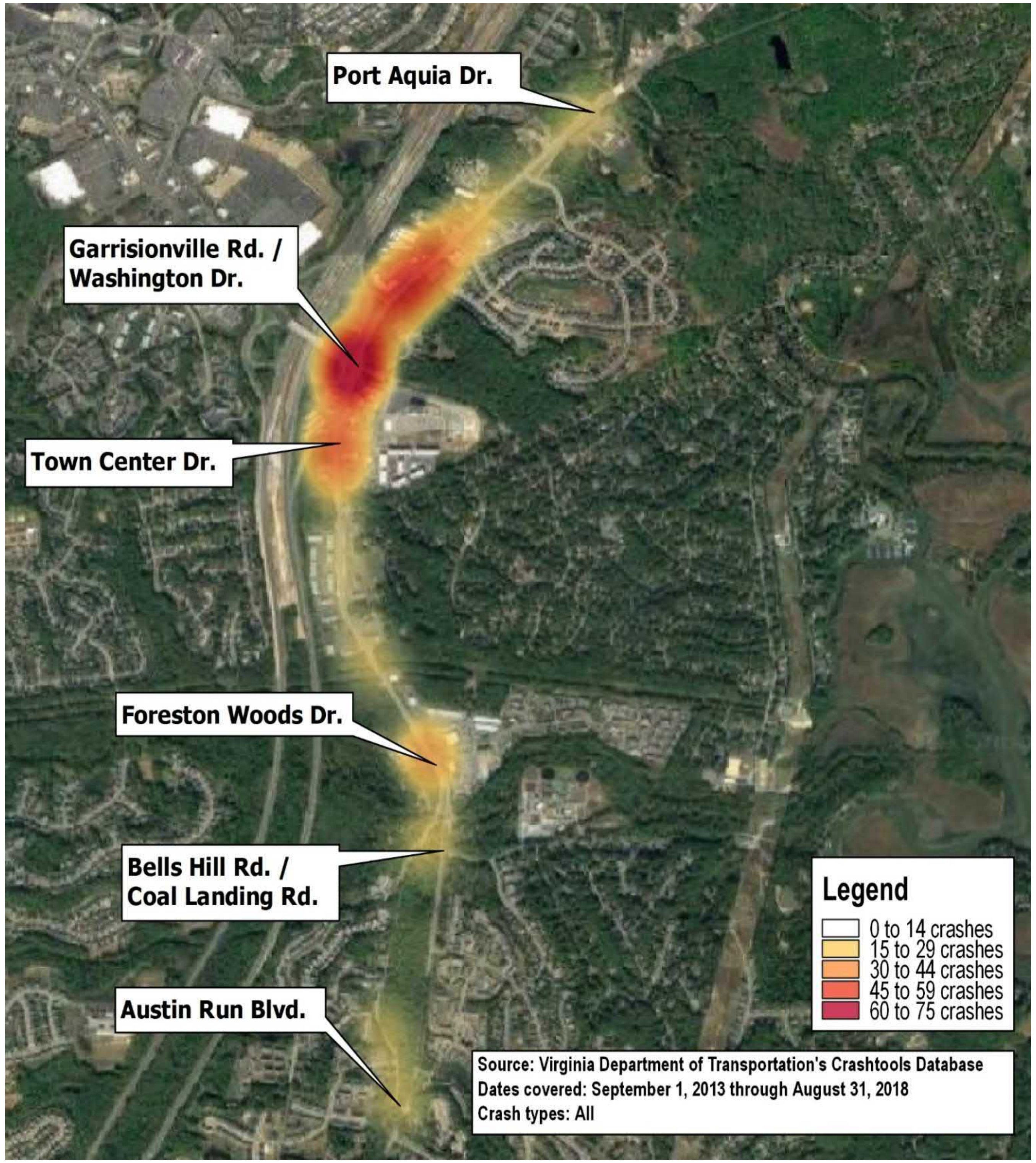


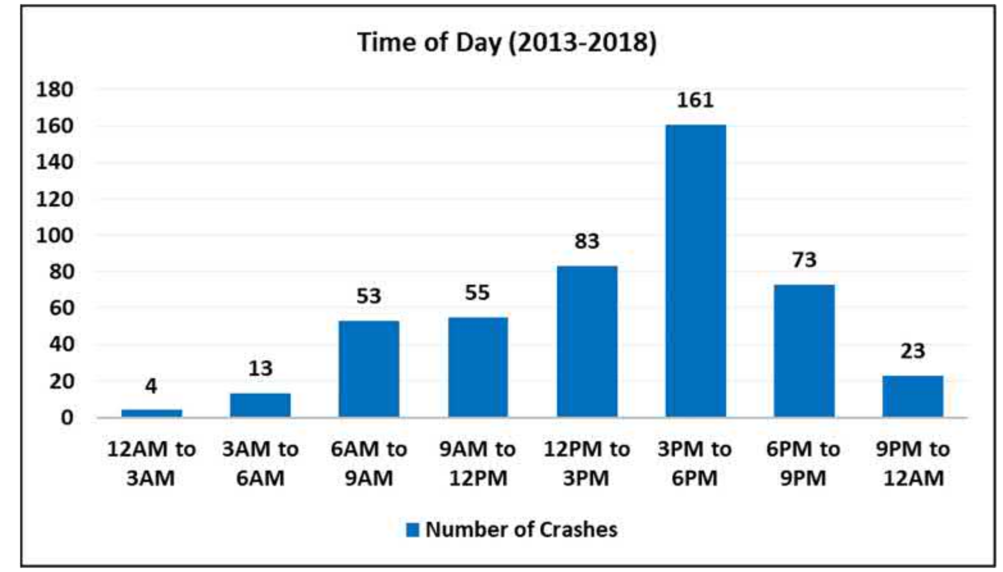
Figure 23. Crash Heat Map Route 1 (Jefferson Davis Highway) from September 2013 through August 2018



5.2.2 Crashes by Time of Day

Figure 24 displays the number of crashes that occurred by the time of day, presented in 3-hour increments. The highest frequency of crashes occurred from 3PM–6PM (35%), from 12PM–3PM (18%), from 6PM–9PM (16%), from 9AM-12PM (12%), and from 6AM–9AM (11%).

Figure 24. Number of Crashes by Time of Day



5.2.3 Crashes by Type

As shown in **Figure 25**, the majority of crashes that occurred were rear-end crashes (50%), followed by angle crashes (28%), then side-swipe same direction crashes (8%), followed by Fixed Object – Off Road (7%); the remaining crash types each accounted for less than 6% of the overall crashes.

Figure 25. Number of Crashes by Type of Crashes

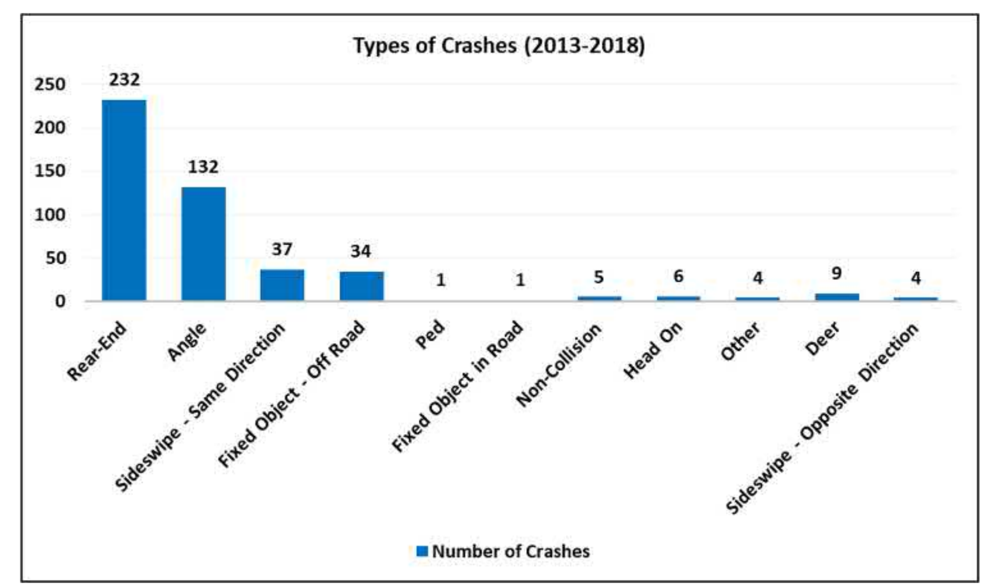


Table 13 includes the most prominent crashes along the route. Note that for the purposes of analyzing the most frequent crashes, not all crashes are included in the crash pattern analysis and thus the total crashes within **Table 13** does not equal the total crashes observed over the five-year study period for the corridor.

Table 13. Crash Patterns along Corridor 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 %)
Route 1 between Coachmen Circle Roads	NB Lanes	Rear-end	1 Ped	2014-2017	12 Total (41% rear-end; 8% pedestrian)
Route 1 at Coachmen Circle (South)	Intersection	Angle	N/A	2013-2015; 2017-2018	12 Total (75% angle)
Route 1 at Extra Storage Space Driveway	Intersection	Angle	N/A	2014; 2016-2018	8 Total (100% angle)
Route 1 at Hampton Inn Driveway	Intersection	Angle	N/A	2013-2018	28 Total (89% angle)
	SB Approach	Rear-end	N/A	2013; 2016; 2018	6 Total (86% rear-end)
Route 1 at I-95 On-Ramp	Intersection	Angle	N/A	2013; 2015; 2017-2018	19 Total (100% angle)
	SB Approach	Rear-end	N/A	2014; 2016	8 Total (88% rear-end)
	NB Approach	Rear-end	N/A	2013-2018	8 Total (88% rear-end)
Route 1 at Garrisonville Road	Intersection	Angle	N/A	2014-2018	19 Total (78% angle)
	EB Approach	Rear-end	N/A	2013-2018	23 Total (78% rear-end)
	NB Approach	Rear-end	N/A	2014-2018	26 Total (69% rear-end
Route 1 at I-95 NB Off-Ramp	Intersection	Angle	N/A	2014-2018	15 Total (53% angle)
	NB Approach	Rear-end	N/A	2014-2018	20 Total (95% rear-end)
Route 1 at Aquia Park Shopping Center	Intersection	Angle	N/A	2014; 2016; 2018	5 Total (100% angle)
Route 1 at Austin Park Drive	Intersection	Angle	N/A	2014; 2016; 2018	7 Total (71% angle)
	SB Approach	Rear-end	N/A	2013-2018	13 Total (77% rear-end)
Route 1 at Bells Hill Road	Intersection (West Intersection)	Angle	N/A	2015-2017	6 Total (83% angle)
Route 1 between Bells Hill Road and Carnaby Street	SB Lanes	Fixed Object Off-Road	N/A	2014-2018	20 Total (50% fixed object off-road)
Route 1 between Carnaby Street and Austin Run Boulevard	SB Lanes	Fixed Object Off-Road	N/A	2014-2016; 2018	8 Total (75% fixed object off-road)

5.2.4 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 16% of crashes.

Figure 26. Number of Crashes by Roadway Surface Condition

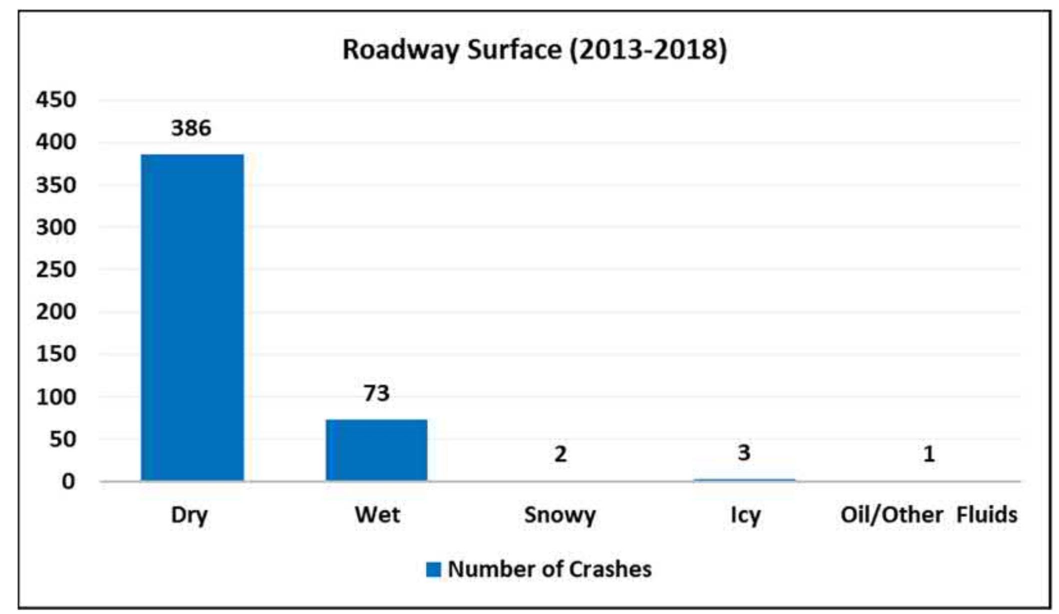
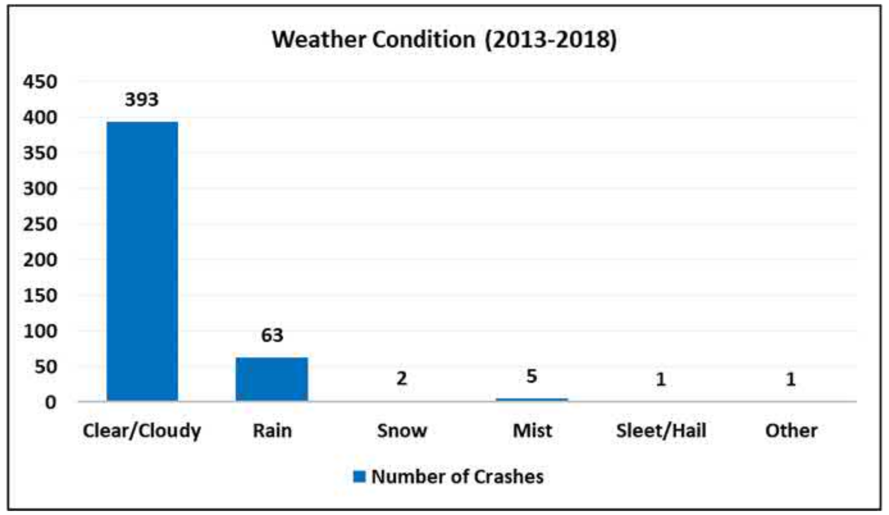


Figure 27 shows that most of the collisions occurred under clear/cloudy weather conditions (85%), followed by rainy weather conditions (14%).

Figure 27. Number of Crashes by Weather Conditions



5.2.5 Crash Density by Half mile

Crash density bi-directional histograms were developed in ½ mile increments to provide a visual representation of crashes along the corridor based on crash type, crash severity, time-of-day, and roadway conditions, and are provided in **Appendix**.

5.2.6 Crash Rate (by intersection and segment)

The crash rates were calculated utilizing the rate calculations described in the *Highway Safety Manual*. Crash rates were calculated by using the road segment equation and intersection equation. The intersections and roadway segments were broken up on the study route to better identify and target high crash rate areas. These areas are provided in **Table 14** and **Table 15**. **Table 15** also compares the crash rates to the statewide averages on comparable road segments ("Urban Other Principal Arterials; Connecting Links of Other Rural Principal Arterial") for the most recent year data are available (2016).

Table 14. Crash Rates (Intersections)

Intersection	Total Crash Rate (Per MEV)	Fatal Crash Rate (Per MEV)	Injury Crash Rate (Per MEV)	PDO Crash Rate (Per MEV)
Port Aquia Drive	0.31	0.00	0.12	0.19
Coachman Circle (South)	0.37	0.00	0.12	0.25
I-95 NB On-Ramp	0.88	0.00	0.25	0.63
Garrisonville Road	0.98	0.00	0.28	0.70
I-95 NB Off-Ramp	0.51	0.00	0.21	0.30
Aquia Park Shopping Center	0.15	0.00	0.08	0.07
Austin Park Drive	0.40	0.00	0.14	0.26
Bells Hill Road	0.20	0.02	0.05	0.14
Austin Run Boulevard	0.28	0.00	0.05	0.23

Table 15. Crash Rates (Segments)

Segment	Total CR (Per 100 MVM)		SW Average (2016)	Fatal CR (Per 100 MVM)		SW Average (2016)	Injury CR (Per 100 MVM)		SW Average (2016)	PDO CR (Per 100 MVM)		SW Average (2016)
Port Aquia Drive to Coachman Circle (South)	168.67	≤	173.33	0.00	≤	0.53	42.17	≤	58.64	126.50	≥	114.15
Coachman Circle (South) to I-95 NB On-Ramp	635.35	≥	173.33	0.00	≤	0.53	144.90	≥	58.64	490.44	≥	114.15
I-95 NB On-Ramp to Garrisonville Road	200.43	≥	173.33	0.00	≤	0.53	18.22	≤	58.64	182.21	≥	114.15
Garrisonville Road to I-95 NB Off-Ramp	293.64	≥	173.33	0.00	≤	0.53	67.76	≥	58.64	225.88	≥	114.15
I-95 NB Off-Ramp to Aquia Park Shopping Center	116.43	≤	173.33	0.00	≤	0.53	37.05	≤	58.64	79.39	≤	114.15
Aquia Park Shopping Center to Austin Park Drive	87.47	≤	173.33	0.00	≤	0.53	25.92	≤	58.64	61.55	≤	114.15
Austin Park Drive to Bells Hill Road	61.29	≤	173.33	0.00	≤	0.53	7.66	≤	58.64	53.63	≤	114.15
Bells Hill Road to Austin Run Boulevard	113.43	≤	173.33	0.00	≤	0.53	30.25	≤	58.64	83.18	≤	114.15
	Exceeds the state average crash rate											

NOTES:

- *CR = Crash Rate, SW = Statewide*
- *Crash rate values from 2016 VDOT averages for Urban Other Principal Arterials (Primary Roads).*

5.2.7 Crash Data Summary

The following observations were made for crashes that occurred during the five (5) year period from Port Aquia Drive to Austin Run Boulevard:

- One (1) fatal crash occurred as a result of a collision involving a fixed object off-road and occurred during dusk (6PM to 9PM).
- One (1) crash involved a pedestrian.
- Thirty-four (34) crashes involved fixed-objects off-road.
- Sixteen (16) crashes involved drivers under the influence of alcohol.
- Seventy-seven (77) crashes involved distracted drivers.

5.3 Field Review

Field observations were conducted at the project study area from Tuesday, March 26, 2019 through Thursday, March 28, 2019 during the AM and PM peak periods to assess traffic operations, roadway geometrics, safety, queuing, vehicle interaction conflicts, and existing signage. 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)), American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide and IESNA standards were used to guide the recommendations. It should be noted, that while histograms were utilized to determine crash patterns and areas of focus within the field, other recommendations and/or observations were noted that may not be directly related to crash patterns. However, it was important to record all field recommendations and/or observations since they could represent potential improvements that can promote safer conditions for road users.

The same or very similar field observations were made multiple times across various locations along the study route; **Table 16** lists these common observations/recommendations 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 16**.

Table 16. Common Field Observations/Recommendations and the Associated Standards

Observation/Recommendation	Associated Standard
Tactile domes do not comply with standards and should be updated	VDOT RBS; ADA Section 705.1
The stop bar is missing or faded and should be refurbished	MUTCD Section 3B.16
Stop sign is not present and should be installed; Stop sign is not MUTCD compliant	MUTCD Section 2B.10
Pedestrian facilities are not up to standards	MUTCD Section 3B.18 and MUTCD Chapter 4E
Overhead roadway lighting is not present and should be installed	IESNA RP-8-05 Reaffirmed
Pavement markings are faded and should be refurbished.	MUTCD Section 3B
Pavement markings are not present and should be installed	MUTCD Section 3B

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.

5.3.1 Route 1 (Jefferson Davis Highway) General Corridor Comments

1. Pavement markings along the northbound and southbound lanes as well as eastbound and westbound approaches are faded. *(See Recommendation A3)*
2. Pedestrian facilities (ramps, tactile domes, pedestrian signals, crosswalks) are discontinuous and sporadic throughout the corridor. Pedestrians were observed utilizing the shoulder(s) of Route 1 and grass paths along the road in order to proceed northbound and southbound along the corridor, as shown in **Figure 28** and **Figure 29**. Additionally, pedestrians were observed crossing mid-block throughout the corridor in order to access the east or west sides of Route 1. Based on the crash data, one pedestrian crash occurred along the corridor, and the existing conditions could have contributed to this crash. *(See Recommendation A4)*

Figure 28. Non-Continuous sidewalk along east side of Route 1 between Foreston Woods Drive and Aquia Park Shopping

Figure 29. Pedestrians using grass pathway along east side of Route 1

5.3.2 Route 1 (Jefferson Davis Highway) at Coachman Circle (North)

3. Pavement markings are faded along all approaches of the intersection. *(See Recommendation A3)*

5.3.3 Route 1 (Jefferson Davis Highway) at Coachman Circle (South)

4. Pavement markings are faded along all approaches of the intersection. *(See Recommendation A3)*
5. Due to high volumes of traffic along the northbound and southbound lanes, westbound left-turning vehicles were having difficulty proceeding southbound. During peak hour conditions, vehicles were observed making dangerous turn movements resulting in near-miss situations with northbound and southbound proceeding traffic. Based on the crash data, crashes were prominent at this intersection, and the existing conditions could be contributing to these crashes.

5.3.4 Route 1 (Jefferson Davis Highway) from Coachman Circle (South) to I-95 On-Ramp Intersection

6. The Hampton Inn/Valero Driveway (unsignalized intersection) eastbound approach, left sight distance, is obstructed due to vegetation along the southbound approach. Based on the crash data, angle crashes were prominent at this intersection, and the existing conditions could be contributing to these crashes. *(See Recommendation A5)*
7. A stop bar is not present at the eastbound approach of the Hampton Inn/Valero Driveway (unsignalized intersection). *(See Recommendation A3)*
8. Northbound left turning vehicles at the Hampton Inn/Valero Driveway (unsignalized intersection) were observed making difficult and dangerous turn maneuvers, often resulting in near-miss situations with the southbound proceeding vehicles. Based on the crash data, angle crashes were prominent at this intersection, and the existing conditions could be contributing to these crashes.

5.3.5 Route 1 (Jefferson Davis Highway) at I-95 On-Ramp Intersection

9. The signals for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the crash data, rear-end crashes were prominent along the northbound and southbound approaches. *(See Recommendation A2)*
10. During the peak hours, southbound queues from the intersection of Garrisonville Road/Washington Drive were observed extending north into the intersection and blocking northbound left-turn movements from proceeding to I-95, as shown in **Figure 30**.
11. During the peak hour conditions, heavy congestion was observed along the southbound left and middle lanes which extended north through the intersection. Despite this congestion, the southbound right lane, which acts as a thru-right lane, was often free flowing during the green cycle. Congestion from the southbound left and middle lanes caused sight distance issues for northbound left-turning vehicles. As a result, northbound vehicles were observed making dangerous left-turns which resulted in near-miss incidents involving the southbound right lane thru proceeding vehicles, as shown in **Figure 30**. The crash data show that angle crashes were prominent at this intersection, and the existing conditions could be contributing to these crashes. *(See Recommendation A7)*

Figure 30 . Southbound approach view of NB left-turning vehicle

5.3.6 Route 1 (Jefferson Davis Highway) from I-95 On-Ramp Intersection to Garrisonville Road/Washington Drive

12. During the peak hours, heavy congestion was observed along the southbound approach, and extended north into the I-95 On-Ramp Intersection.

5.3.7 Route 1 (Jefferson Davis Highway) at Garrisonville Road/Washington Drive

13. Pavement markings are faded along all approaches of the intersection. *(See Recommendation A3)*
14. Currently, the "Garrisonville" guide sign and "I-95" state route shield signs along the east side of the northbound approach are obstructed due to vegetation, as shown in **Figure 31**. *(See Recommendation A8)*
15. Currently, vegetation is obstructing the view of the signals along the westbound approach. *(See Recommendation A9)*
16. During the PM peak hour, heavy congestion was observed extending back (east) from the intersection of Stafford Market Place/Salisbury Drive along the west leg and into the intersection which caused delays and blockages for other approaches (northbound left-turning vehicles, westbound thru vehicles, and southbound right-turning vehicles), as shown in **Figure 32**.

Figure 31. East Side of NB Approach

17. During the PM peak hour, northbound left-turning vehicles were observed unable to make it through in one cycle. Vehicles were observed extending outside of the left turn lanes and into the southbound left-turn lanes at the intersection of Town Center/I-95 off-ramp. Additionally, vehicles were observed extending outside of the left-turn storage bays into the northbound thru lanes, which blocked northbound thru-proceeding vehicles.
18. During the AM peak hour, westbound left-turning and right-turning vehicles were observed extending outside of the storage bays and into the thru lanes. This ultimately caused blockages for westbound thru proceeding vehicles. Additionally, during the AM peak hour, vehicles were observed unable to make it through the light in one cycle.
19. During the AM and PM peak hours, heavy congestion was observed along the eastbound approach. Vehicles were observed extend back west of the intersection and caused blockages for vehicles merging from the I-95 southbound ramp to eastbound Garrisonville Road. Vehicles were observed waiting multiple cycles in order to proceed through the intersection, as shown in **Figure 33**.

Figure 32. WB Approach

Figure 33 . SE corner view of the EB Approach

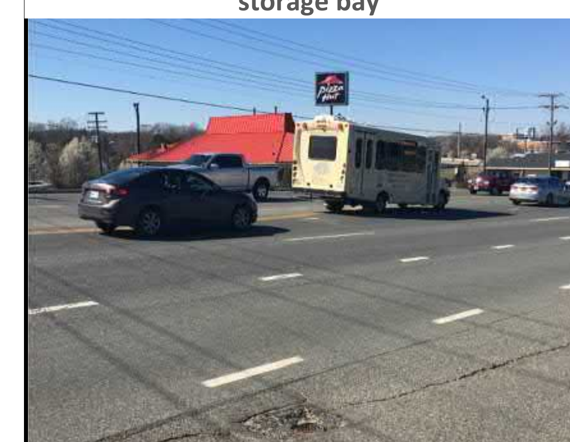
5.3.8 Route 1 (Jefferson Davis Highway) from Garrisonville Road/Washington Drive to Town Center Drive/I-95 Off-Ramp

20. During the peak hour, heavy congestion was observed extending back (south) along the northbound approach from the intersection of Garrisonville Road/Washington Drive into the intersection and causing blockages for northbound and eastbound proceeding vehicles, as shown in **Figure 34**.

5.3.9 Route 1 (Jefferson Davis Highway) at Town Center Drive/I-95 Off-Ramp

21. The signals for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the crash data, rear-end crashes were prominent along the northbound approach. *(See Recommendation A2)*
22. Pavement markings are faded along all approaches of the intersection. *(See Recommendation A3)*

Figure 34 . NB left-turning vehicles outside storage bay



23. Overhead street name signs are not provided on the mast arms for any approach. Currently, a street name sign post is provided at the southeast corner of the intersection; however, is illegible for all approaches due to commercial signs, vegetation, and utility poles. *(See Recommendation A1)*
24. A street post sign is provided on the southeast corner of the intersection; however, commercial signs and vegetation are obstructing the view for northbound proceeding vehicles. *(See Recommendation A10)*
25. The eastbound left-sight distance is obstructed due to the mast arm pole and the fence along the west side of the southbound approach. *(See Recommendation A11)*
26. The eastbound approach sight distance to the signal is obstructed due to the horizontal alignment of the roadway. *(See Recommendation A12)*

5.3.10 Route 1 (Jefferson Davis Highway) at Derrick Lane

27. The westbound left and right sight distances are obstructed due to the alignment of the roadway as it intersection Route 1. During and outside peak hours, westbound left-turning vehicles were observed waiting for extended periods of time in order to proceed southbound. In some instances, vehicles attempted the turn movement dangerously with a few resulting near-miss incidents. *(See Recommendation A13)*

5.3.11 Route 1 (Jefferson Davis Highway) from Derrick Lane to Aquia Park Shopping Center

28. A portion of this segment of corridor provides no buffer space between the center double yellow lines. Based on the crash data, one head-on collision occurred along this segment in 2018. *(See Recommendation A14)*
29. An acceleration lane is provided for westbound right-turning vehicles proceeding northbound from the Fairfield Inn & Suites Driveway; however, no merge condition pavement markings or signage is provided. *(See Recommendation A15)*

5.3.12 Route 1 (Jefferson Davis Highway) at Aquia Park Shopping Center

30. The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A2)*
31. Pavement markings are faded along the northbound and southbound approaches of the intersection. *(See Recommendation A3)*
32. The intersection provides pedestrian signals; however, does not provide a countdown timer. *(See Recommendation A16)*

5.3.13 Route 1 (Jefferson Davis Highway) from Aquia Park Shopping Center to Foreston Woods Drive/Austin Park Drive

33. An acceleration lane is provided for eastbound right turning vehicles at the Aquia Park Professional Centre right-in-right-out entrance/exit; however no merge condition pavement markings or signage is provided. Based on the crash data, rear-end crashes and sideswipe (same side) crashes occurred along this portion of the corridor and the existing conditions could be contributing to these crashes. *(See Recommendation A17)*
34. A portion of this segment provides no buffer space between the center double yellow lines. Based on the crash data, one head-on collision occurred along this segment in 2014. *(See Recommendation A18)*

5.3.14 Route 1 (Jefferson Davis Highway) at Foreston Woods Drive/Austin Park Drive

35. The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A2)*
36. Pavement markings are faded along the northbound and southbound approaches of the intersection. *(See Recommendation A3)*
37. Overhead street name signs are not provided on the mast arms for any approach. Currently, a street name signpost is provided at the southeast corner of the intersection; however, it is illegible for all approaches due to commercial signs, vegetation, and utility poles. *(See Recommendation A1)*
38. The northbound right-turn lane left sight distance is obstructed due to the location of the northbound left turn, as shown in **Figure 35**. Vehicles were observed rolling past the stop bar in order to verify left-sight clearance to proceed eastbound. *(See Recommendation A19)*
39. The westbound right-turn lane is a terminating lane; however, no "Right Lane Must Turn Right" (R3-7R) sign panel is present. *(See Recommendation A20)*
40. An acceleration lane exists along the north leg of the intersection; however, no merge condition pavement markings or signage is provided. Based on the crash data, rear-end crashes and sideswipe (same side) crashes have occurred along this segment of corridor, and the existing conditions could be contributing to these crashes. *(See Recommendation A21)*
41. During the PM peak hour, heavy congestion was observed along the southbound lanes. Vehicle queues were observed extending north and blocking approaches at the intersection of Route 1 at Aquia Park Shopping Center, as shown in **Figure 36**.

Figure 35 . NB Left Sight Distance

Figure 36 . SB PM Congestion queues from Foreston Woods Drive to Port Aquia Shopping Center

5.3.15 Route 1 (Jefferson Davis Highway) at Bell Hills Road/Coal Lansing Road

42. The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A2)*
43. Pavement markings are faded along the northbound and southbound approaches of the intersection. *(See Recommendation A3)*
44. The sight distance to the signal along the southbound approach is obstructed due to the horizontal alignment of the roadway. Currently, two (2) signal ahead (W3-3) sign panels are in place prior to the signal approximately 300 feet north along the southbound approach; however, are not spaced sufficiently with the existing speed limit per MUTCD standards, as shown in **Figure 37**. Based on the crash data, rear-end crashes occurred along the northbound approach and the existing conditions could be contributing to these crashes. *(See Recommendation A22)*

Figure 37 . SB Approach

45. Pavement arrows are not present along any approaches of the intersection. *(See Recommendation A3)*

5.3.16 Route 1 (Jefferson Davis Highway) from Bell Hills Road/Coal Landing Road to Austin Run Boulevard

46. No overhead lighting is present along the segment of the corridor. The horizontal alignment of the roadway is difficult to gauge with the absence of overhead lighting. Based on the crash data, run-off-road crashes were prominent along this segment of corridor, and the existing conditions could be contributing to these crashes. *(See Recommendation A23)*
47. Along the southbound lanes, approximately 300 feet north of the intersection of Route 1 at Twin Brook Lane (unsignalized intersection), advanced curve warning sign (W1-5) sign panel and advisory speed limit (W13-1P) sign panel (40 mph) are present along the west side of the road. Despite the advisory speed signs and advanced warning signs present, vehicles were observed to be traveling faster than the post speed limit as they proceeded southbound. *(See Recommendation A24)*
48. Advanced warning chevrons (W1-8) sign panels are present along the curves throughout this segment of the corridor; however, are difficult to see with flowing southbound traffic. Based on the crash data, run-off-road crashes were prominent along this segment of corridor, and the existing conditions could be contributing to these crashes. *(See Recommendation A25)*
49. The sight distance along the southbound lanes for the intersection of Route 1 at Carnaby Street (unsignalized intersection) is obstructed due to the horizontal alignment of the roadway. Additionally, the eastbound left sight distance at the intersection of Route 1 at Carnaby Street (unsignalized intersection) is obstructed due to the horizontal alignment of the roadway. Vehicles were observed making dangerous right turns and merging with some near-miss incidents. Based on the crash data, crashes (rear-end, sideswipe, and run-off-road) were prominent along this segment of the corridor, and the existing conditions could be contributing to these crashes. *(See Recommendation A26)*
50. At the intersection of Route 1 at Twin Brook Lane (unsignalized intersection), no stop bar is present along the eastbound approach. *(See Recommendation A3)*
51. At the intersection of Route 1 at Twin Brook Lane (unsignalized intersection), a street name sign is present at the northwest corner of the intersection; however, is obstructed due to the vegetation on the northwest corner. *(See Recommendation A27)*
52. At the intersection of Route 1 at Jason Lane (unsignalized intersection), no stop bar is present along the eastbound approach. *(See Recommendation A3)*
53. At the intersection of Route 1 at Allatoona Lane (unsignalized intersection), a stop sign is present along the westbound approach; however, is small and not MUTCD compliant. *(See Recommendation A28)*
54. At the intersection of Route 1 at Allatoona Lane (unsignalized intersection), no stop bar is present along the westbound approach. *(See Recommendation A3)*
55. At the intersection of Route 1 at Austin Run Boulevard (unsignalized intersection), no stop bar is present along the westbound approach. *(See Recommendation A3)*
56. At the intersection of Route 1 at Austin Run Boulevard (unsignalized intersection), no pavement markings (center line and stop bars) are present within the median area. *(See Recommendation A3)*
57. At the intersection of Route 1 at Austin Run Boulevard (unsignalized intersection), a street name sign is present at the southeast corner of the intersection; however, is obstructed due to vegetation. *(See Recommendation A29)*

5.4 Recommendations

Note: Recommendations provided below are intended to be short-term, low-cost improvements strictly based on field observations. These recommendations are not intended to represent final improvement options for the corridor study. These recommendations/maintenance type projects can be implemented in the field at the discretion of VDOT and/or Stafford County.

5.4.1 Route 1 (Jefferson Davis Highway) General Recommendations

A1. Consider installing overhead street name signs on the mast arms for all intersection approaches per standards outlined in MUTCD.

A2. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A3. Consider refurbishing and/or installing pavement markings along respective areas, per standards outlined in **Table 16**.

A4. Consider installing pedestrian facilities (i.e., crosswalk, ramps, tactile domes, pedestrian signals) per standards outlined in **Table 16** at applicable intersections throughout the corridor. Should pedestrian facilities be implemented at signalized intersections, consider installing “Turning Vehicles Yield to Pedestrians” sign panels (R10-15) on the mast arms/poles for all applicable approaches. Additionally, consider evaluating the needs for continuous sidewalk where applicable to provide refuge for existing and future pedestrian volumes.

5.4.2 Route 1 (Jefferson Davis Highway) from Coachman Circle (South) to I-95 On-Ramp Intersection

A5. Consider trimming the vegetation along the west side of the southbound approach at the Hampton Inn driveway (unsignalized intersection).

A6. Consider installing pavement marking arrows along the right turn lane.

5.4.3 Route 1 (Jefferson Davis Highway) at I-95 On-Ramp Intersection

A7. Consider updating the current phasing of the northbound left-turn signal to protective only during peak hour conditions. Restricting vehicles from permissive turn-movements during peak hour conditions could mitigate the angle crashes that are more prominent at the intersection currently.

5.4.4 Route 1 (Jefferson Davis Highway) at Garrisonville Road/Washington Drive

A8. Consider trimming the vegetation along the east side of the northbound approach.

A9. Consider trimming the vegetation along the westbound approach.

5.4.5 Route 1 (Jefferson Davis Highway) at Town Center Drive/I-95 Off-Ramp

A10. Consider relocating the street name signpost from behind the commercial signs closer to the northbound approach.

A11. Consider relocating the thru-right lane stop bar closer to the intersection.

A12. Consider installing advanced warning signal ahead (W3-3) sign panels along the eastbound approach per standards outlined in Chapter 2C of the MUTCD.

5.4.6 Route 1 (Jefferson Davis Highway) at Derrick Lane

A13. Consider restricting westbound left-turn movements.

5.4.7 Route 1 (Jefferson Davis Highway) from Derrick Lane to Aquia Park Shopping Center

A14. Consider installing centerline rumble strips where centerline buffer space is not provided along this segment of corridor.

A15. Consider installing merge condition (W4-2) sign panel and pavement markings per standards outline in chapter 2C of the MUTCD.

5.4.8 Route 1 (Jefferson Davis Highway) at Aquia Park Shopping Center

A16. Consider updating pedestrian signal heads per standards outlined in chapter 4E of the MUTCD.

5.4.9 Route 1 (Jefferson Davis Highway) from Aquia Park Shopping Center to Foreston Woods Drive/Austin Park Drive

A17. Consider installing merge condition (W4-2) sign panel and pavement markings per standards outline in chapter 2C of the MUTCD.

A18. Consider installing centerline rumble strips where centerline buffer space is not provided along this segment of corridor.

5.4.10 Route 1 (Jefferson Davis Highway) at Foreston Woods Drive/Austin Park Drive

A19. Consider relocating the northbound right-turn lane stop bar closer to the intersection.

A20. Consider installing “right lane must turn right” (R3-7R) sign panel along the north side of the westbound approach.

A21. Consider installing merge condition (W4-2) sign panel and pavement markings per standards outline in chapter 2C of the MUTCD.

5.4.11 Route 1 (Jefferson Davis Highway) at Bell Hills Road/Coal Lansing Road

A22. Consider relocating the existing signal ahead (W3-3) sign panels further south per standards outlined in chapter 2C of the MUTCD.

5.4.12 Route 1 (Jefferson Davis Highway) from Bell Hills Road/Coal Landing Road to Austin Run Boulevard

A23. Consider evaluating the need for overhead lighting through this segment of the corridor per standards outlined in **Table 16**.

A24. Consider conducting a horizontal alignment curve evaluation to confirm or revise the existing advisory speed limits along the southbound lanes.

A25. Consider evaluating the existing advanced warning signage and signage locations per standards outlined in chapter 2C of the MUTCD.

A26. Consider installing advanced warning sign (W1-4) sign panel, advisory speed limit (W13-1P) sign panel, and “watch for turning vehicles” sign panel south of the intersection of Route 1 at Twin Brook Lane per standards outlined in chapter 2C of the MUTCD.

A27. Consider trimming the vegetation on the northwest corner of the intersection of Route 1 at Twin Brook Lane.

A28. Consider replacing the existing stop sign (R1-1) sign panel with a MUTCD compliant stop (R1-1) sign panel per standards outlined in **Table 16**.

A29. Consider trimming the vegetation on the southeast corner of the intersection of Route 1 at Austin Run Boulevard.

6 Improvement Alternatives

The proposed improvements along Route 1 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 observations, review of prior studies/recommendations, as well as coordination with VDOT Fredericksburg District, Stafford County, and the Fredericksburg Area Metropolitan Planning Organization (FAMPO). An in-person Alternatives Development Workshop was held on August 27, 2019 at the VDOT Fredericksburg Residency Conference Room.

Based on the existing and 2035 No-Build conditions traffic operations and safety analysis, the following intersection locations were identified as the key locations which would benefit from improvements:

- Route 1 / Garrisonville Road
- Route 1 / NB I-95 on-Ramp (PM Peak)
- Route 1 / Aquia Park
- Route 1 / Aquia Commerce Center
- Route 1 / Foreston Woods Drive
- Route 1 / Bells Hill Road
- Route 1 / Coal Landing 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.

6.1 Preliminary Innovative Intersection Analysis to Determine Alternatives

Both traditional intersection improvements and innovative intersection concepts were considered in the development of potential improvement alternatives. Incorporating innovative intersections and interchanges into the transportation network is one strategy that VDOT is using to improve safety and mobility for congested corridors. Preliminary screening for innovative intersections was performed using VDOT Junction Screening Tool (VJuST)[1]. This tool assists engineers and planners to screen a number of innovative intersection and interchange ideas by evaluating the Critical Lane Volume (CLV) and identifies innovative intersection and interchange concepts that have potential to address congestion and safety issues. Congestion results are based on user inputs such as turning movement volumes, number of lanes and lane configurations. Safety results are based on conflict points—any points where roadway users' paths can cross with other roadway users. The screened concepts can then be analyzed further for their suitability considering site specific data such as potential right-of-way and utility impacts, potential impacts to adjacent business access points, and impacts to the pedestrian movements. **Figure 38** shows a screen capture of an example of VJuST screening at the intersection of Route 1/Garrisonville Road/Washington Street.

Figure 38. VJuST Analysis: Route 1/Garrisonville Road/Washington Street

Intersection Results

Type	Dir	Congestion: Maximum V/C	Pedestrian: Accommodation Compared to Conventional	Safety: Weighted Total Conflict Points	Notes
Conventional	-	1.06		48	Assumed EB Free flow RTL
Bowtie	-	3.10	+	24	V/C too high
Center Turn Overpass	-	1.47	+	32	
Echelon	-	0.78	+	28	Proximity of I-95 bridge makes it diificult
Full Displaced Left Turn	-	0.91	-	40	Too many site restrictions
Median U-Turn	-	1.55	+	20	Too heavy left turns
Partial Displaced Left Turn	-	0.98	-	44	Site restrictions identified
Partial Median U-Turn	-	1.55	+	28	Too heavy left turns
Quadrant Roadway	S-E	1.47		40	
Restricted Crossing U-Turn	-	2.67		20	
Single Loop	-	0.94	-	28	Not feasible for the area
Split Intersection	-	1.59		36	

Information

Congestion	The maximum v/c ratio represents the worst v/c of all zones that make up an intersection.
Pedestrian	Compares the potential of each design to accommodate pedestrians based on safety, wayfinding, and delay. Potential is qualitatively defined as better (+), similar (blank cell), or worse (-) than a conventional intersection or traditional diamond interchange.
Safety	Weighted Total = (2 x Crossing Conflicts) + Merging Conflicts + Diverging Conflicts

Several preliminary improvement alternatives were presented based on the operational, safety and VJuST analysis results. The improvement alternatives were vetted and screened by the Study Work Group (SWG) and a list of "Screened Alternatives" were selected to move forward for the Future 2035 Build Analysis. A complete list of alternatives that were tested is summarized in **Table 17**.

[1] VDOT Innovative Intersections and Interchanges: Junction Screening Tool, Version 1.02

Table 17. Preliminary Screened Improvement Alternatives

Location/Alternative	Potential Improvements			
	Option 1	Option 2	Option 3	Option 4
RT 1 and Garrisonville Road / Washington Drive	1. Change eastbound right-turn lane to free flow condition into added southbound through lane along S Route 1, which merges south of Town Center Dr. 2. Change the northbound outside lane from right only to through, and add a right turn lane. 3. Add a northbound through lane along north Route 1 and drop it at Coachman Circle S as a trap lane.	**Southeast Quadrant Roadway Intersection (QRI) Layout:** 1. All improvements identified in Option 1. 2.Relocate SB left turns to Town Center Dr left turns. 3. Relocate WB left and thru movements to WB left turns and right turns, respectively, at Town Ctr Dr. 4. Allow only westbound free-flow right turns along Washington Dr into added northbound lane that drops at Coachman Circle S. 5. Single lane roundabout at the intersection of Town Center Dr/Aquia Town Center Dr. 6. Revise the lane configuration and signal phasing at Route 1 /Town Center Dr/I-95 off-ramp intersection	**Realign Washington Drive with Town Center Dr:** 1. All improvements identified in Option 1 and 2. 2. Permanently detour westbound left and thru traffic to realigned Washington Dr.	**I-95 Interchange Ramp Swap:** 1. Redesign the I-95/Garrisonville Rd interchange to swap the ramps to the north and south of the intersection. 2. The existing I-95 NB on-ramp north of Garrisonville intersection will designated as I-95 NB off-ramp. 3. The existing I-95 off-ramp south of Garrisonville intersection will be designated as I-95 NB on-ramp. 4. Proposes to construct a new CD road along NB I-95.
RT 1 and I-95 NB On-Ramp	1. Change the northbound left turn phasing from pm+pt (flashing yellow) to protected only. 2. Implement access management along SB approach. Reroute left-out vehicles from Hampton Inn and Extra Space Storage as SB U-turns at the intersection.	No improvements identified.	No improvements identified.	No improvements identified.
RT 1 and Foreston Woods Drive/Austin Park Drive	1. Widen EB approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU, 1 RTL. 2. Widen WB approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU, 1 RTL Add second SB LTL (dual lefts) Extend the raised median along north RT 1 to Aquia Park 5. Refurbish pavement marking and add a cross walk across WB and NB approaches.	No improvements identified.	No improvements identified.	No improvements identified.
RT 1 and Coal Landing Rd/Bells Hill Road	1. Extend SB left-turn storage to 350 ft. 2. Relocate existing W3-3 sign further north to be in advance of the horizontal curvature. Supplement the signs with flashing beacons.	1. Realign southbound left turn only with the east intersection of NB RT 1/Coal Landing Road.	1. Prohibit eastbound left turns and through movements from Bells Hill Road, making it RI/RO out only. 2. Relocate the left-turns further south to Austin Run Blvd as U- turns via Carnaby Street. 3. Change the intersection control at Austin Run Blvd to signalized. 3. Prohibit westbound through movements from Coal Landing Rd and reassign the left-turns as NB U-turns at Foreston Woods Dr. 4. Prohibit northbound lefts at Coal Landing Rd and assign them as NBU at Foreston Woods Dr.	No improvements identified.
RT 1 Coachman Circle (South)	1. Prohibit WB left turns and reassign them to right turns. 2. Construct a new node north of Coachman Circle (S) intersection for the U-turns.	No improvements identified.	No improvements identified.	No improvements identified.
Corridor-wide	1. Construct shared-use path (SUP) along east side of Route 1 corridor per the Stafford County Bicycle and Pedestrians Facilities Plan.	No improvements identified.	No improvements identified.	No improvements identified.

6.2 Preferred Alternatives

The screened alternatives listed in **Table 17** were further tested for traffic operations improvements, safety improvements, as well potential cost. The results of testing were shared with the SWG via an Alternatives Evaluation Workshop webinar held on October 31, 2019. The results of the analysis as well pros and cons of each of the screened alternatives were discussed among the SWG. The main objective of this discussion was to select a concise list of improvement alternatives to be advanced further for submitting applications for funding. The agreed-upon list of preferred alternatives is shown in **Table 18**, which includes several low-cost, medium-cost and high-cost improvements. The alternatives requiring significant geometric modifications, such as addition of lanes, are considered as high-cost, while those involving signal re-timing, re-striping, traffic control devices upgrade are considered as low-cost.

Figures 39 through **45** present the conceptual design of the preferred alternatives that involve geometric modifications.

Table 18. Preferred Alternatives

Alternative	Location	Preferred Improvements
1	**Route 1 and I-95 NB On-Ramp**	1. Change the northbound left turn phasing from permitted + protected (flashing yellow) to protected only. 2. Implement access management along southbound approach. Reroute left-out vehicles from Hampton Inn and Extra Space Storage as southbound U-turns at the intersection.
2	**Route 1 and Garrisonville Road / Washington Drive**	Southeast Quadrant Roadway Intersection (QRI) Layout: 1. Relocate southbound left turns to Town Center Dr left turns. 2. Relocate westbound left and thru movements to westbound left turns and right turns, respectively, at Town Center Dr. 3. Allow only westbound free-flow right turns along Washington Dr into added northbound lane that drops at Coachman Circle S. 4. Change eastbound right-turn lane to free flow condition into added southbound through lane that merges south of Town Center Dr. 5. Change the northbound outside lane from right only to thru and add a right turn lane 6. Construct a single lane roundabout at the intersection of Town Center Dr/Aquia Town Center Dr. 7. Revise the lane configuration and signal phasing at Route 1/Town Center Dr/I-95 off-ramp intersection as the following: - Eastbound: 2-LT, 1-Thru+RT - Westbound: Change the WBR to free flow movement - Change the eastbound/westbound signal phasing from protected only to split
3	**Route 1 and Foreston Woods Drive/Austin Park Drive**	1. Widen EB approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU, 1 RTL. 2. Widen WB approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU+LTL, 1 RTL 3. Add second SB LTL (dual lefts) 4. Extend the raised median along north RT 1 to Aquia Park 5. Refurbish pavement marking and add a cross walk across WB and NB approaches.
4	**Route 1 and Coal Landing Rd / Bells Hill Road**	1. Prohibit eastbound left turns and through movements from Bells Hill Road, making it Right-In/Right-out only. 2. Relocate the eastbound left-turns further south to Austin Run Blvd as U- turns via Carnaby Street. 3. Change the intersection control at Austin Run Blvd to signalized. 4. Prohibit westbound through movements from Coal Landing Rd and reassign the left-turns as northbound U-turns at Foreston Woods Dr. 5. Prohibit northbound lefts at Coal Landing Rd and assign them as northbound U-turns at Foreston Woods Dr.
5	**Corridor-wide**	1. Construct shared-use path (SUP) along east side of Route 1 corridor per the Stafford County Bicycle and Pedestrians Facilities Plan.

Figure 39. Preferred Alternative 1 – Route 1 / I-95 On-Ramp Intersection

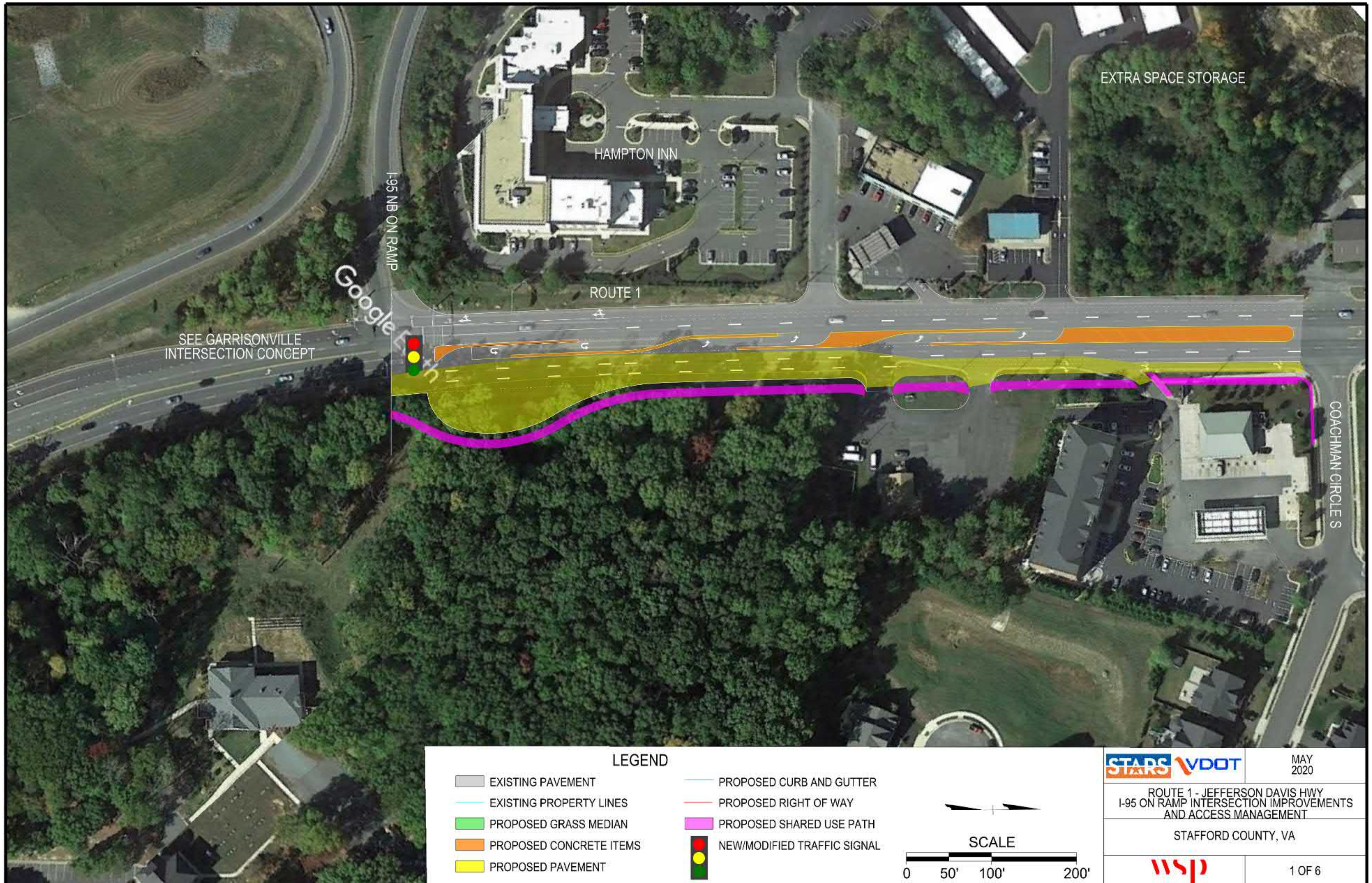


Figure 40. Preferred Alternative 2 – Route 1/ Garrisonville Rd/Washington Dr – SE Quadrant Intersection

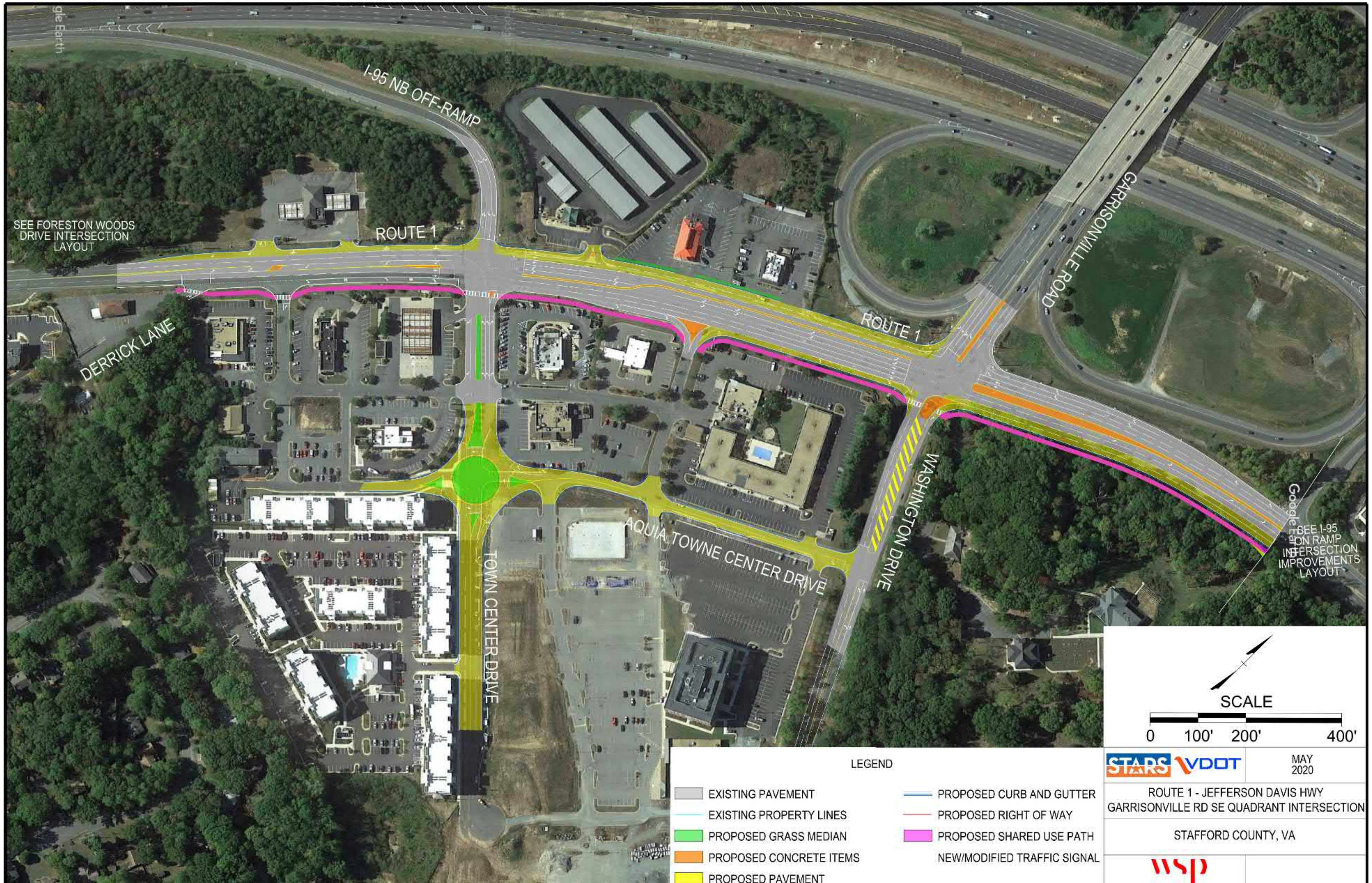


Figure 41. Preferred Alternative 3 - Route 1 / Foreston Woods Drive /Austin Park Drive

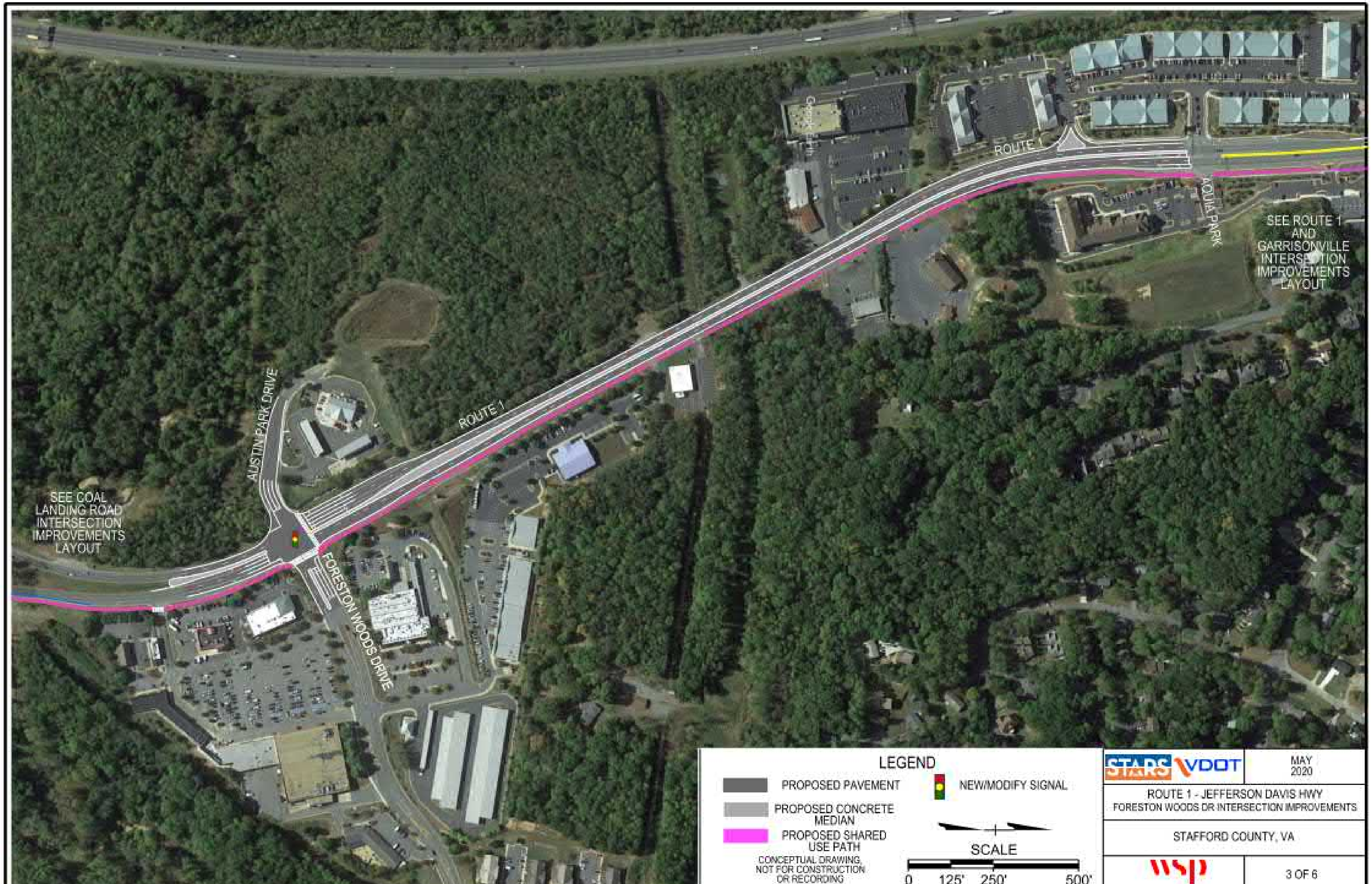


Figure 42. Preferred Alternative 4 (Part 1 of 2) - Route 1 / Coal Landing Rd / Bells Hill Road

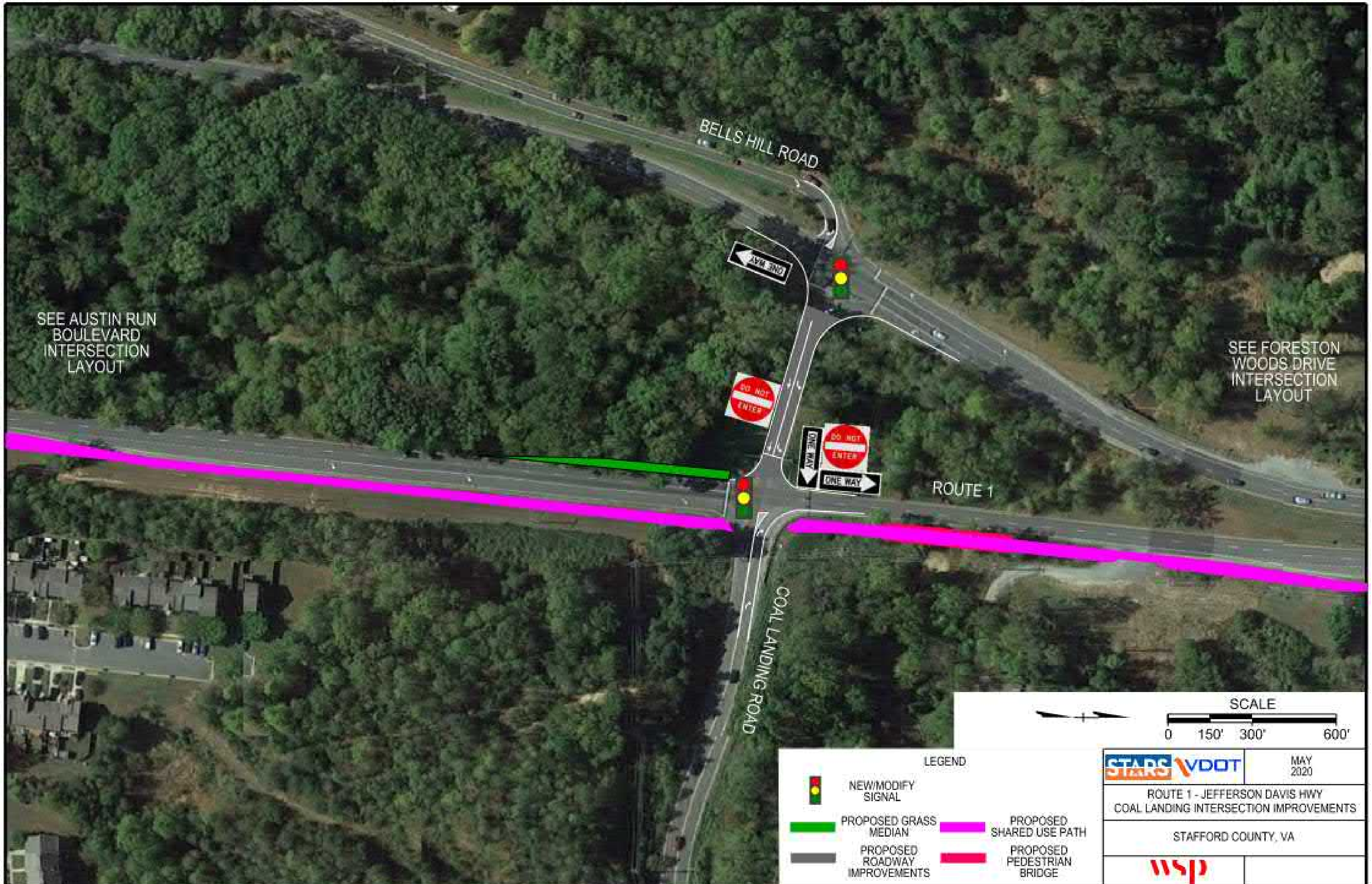
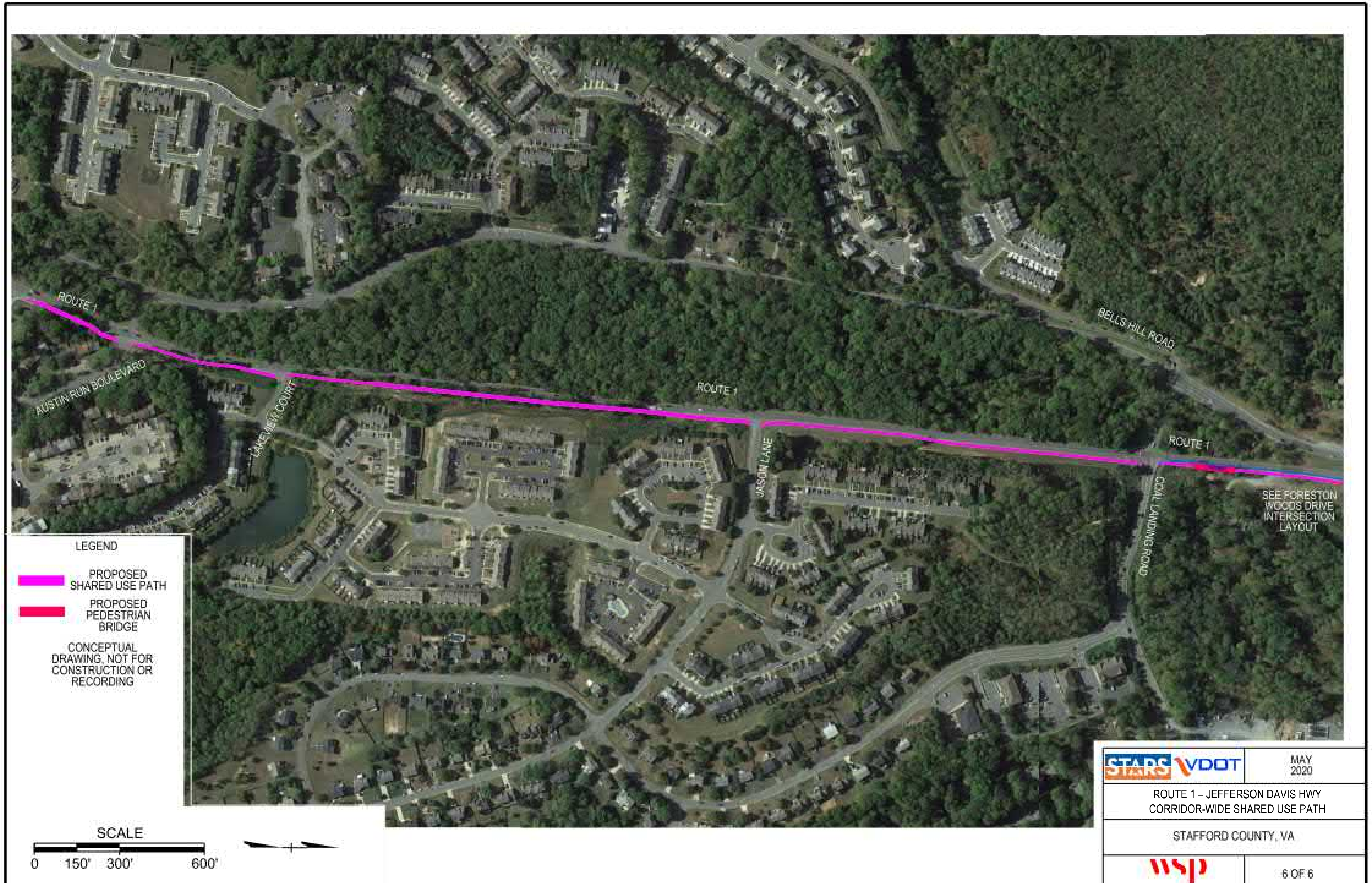


Figure 43. Preferred Alternative 4 (Part 2 of 2) – Route 1 / Austin Run Blvd

Figure 44. Preferred Alternative 5 – Corridor-wide Shared Use Path



7 FUTURE 2035 BUILD PREFERRED ALTERNATIVE OPERATIONAL ANALYSIS

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. The preferred alternative at each intersection was modeled together into one Synchro (SimTraffic) model to determine results for the entire corridor. These alternatives were evaluated using SimTraffic for the Future 2035 Build condition traffic operations.

7.1 2035 Build Volumes

The AM and PM peak hour volumes for 2035 Build conditions accounted for the changes in geometry, traffic reassignment with the innovative intersection layouts and lane assignments at intersections. **Figure 45** shows the final traffic volumes for the 2035 Build condition. Traffic reassignment was implemented in accordance with the following assumptions:

Intersection 4 – Route 1 and Garrisonville Road/Washington Drive (Reassignment of westbound traffic to Town Center Drive)

- Prohibit westbound left and through movements at the main intersection and reassign these movements to the westbound approach of Town Center Drive (via Aquia Towne Center Drive) ;
- Prohibit southbound lefts at the main intersection and reassign these movements to the intersection at Town Center Drive
- Install an additional SB through lane from Garrisonville Road to Derrick Lane
- Install a roundabout at the Town Center Drive and Aquia Towne Center Drive intersection and improve the pavement along Aquia Towne Center Drive to accommodate the increased volume of traffic.

Intersection 8 – Route 1 and Foreston Woods Drive (Conventional Improvements)

- Widen the eastbound approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU, 1 RTL.
- Widen the westbound approach to add third lane. Proposed lane configuration – 1 LTL, 1 THRU+LTL, 1 RTL
- Add a second southbound LTL (dual lefts)
- Extend the raised median along north Route 1 to Aquia Park; Refurbish pavement marking and add a cross walk across westbound and northbound approaches.

Intersection 9 – Route 1 and Bells Hill Road (Modified Through-Cut intersection layout)

- Prohibit westbound left and through movements along Coal Landing Road;
- Prohibit northbound lefts;
- Westbound left and through movements reassigned as right-turns at the Coal Landing/Route 1 intersection and U-turns at Foreston Woods Drive intersection;
- Northbound lefts reassigned as U-turns at Foreston Woods Drive intersection.

Intersection 10 – Route 1 and Coal Landing Road (Modified Through-Cut intersection layout)

- Prohibit eastbound left and through movements at the main intersection;
- Eastbound left and through movements reassigned as U-turns at Austin Run Boulevard intersection.

7.2 2035 Build Traffic Operations

Operational analysis was performed at each of the study intersections for the 2035 Future Build Condition. **Table 19** summarizes the average AM and PM peak hour weekday delay for each movement for the study intersections along the corridor, while **Table 20** provides a summary of the weekend operations at the intersection of Route 1 / Garrisonville Road/Washington Drive. **Table 21** summarizes the maximum queue lengths during the weekday AM and PM peak hours. **Table 22** summarizes the queuing at the intersection of Route 1/Garrisonville Road/Washington Drive during the weekend peak hour. The SimTraffic outputs can be found in the **Appendix**. **Figure 46** shows the weekday intersection delay and LOS for the preferred alternatives graphically, while **Figure 47** presents weekend delay results graphically.

The results from **Tables 19 and 20** indicate that the average weekday AM, PM and weekend peak hour delays reported during 2035 Build conditions are significantly lower compared to the 2035 No-Build conditions at every intersection in the corridor. The intersection of Route 1/Garrisonville Road/Washington Drive significantly improves from a very poor LOS F during AM and PM peaks for No-Build 2035 conditions to a LOS D and a better LOS F during AM and PM peaks for Build 2035 conditions. These results suggest that the proposed innovative intersection improvements at this intersection will be effective in alleviating the recurring peak hour congestion, since this intersection is heavily traveled and acts as a traffic bottleneck along the Route 1 study corridor. Congestion relief at this intersection will be beneficial for the entire corridor. With the proposed improvements, the following intersections are expected to operate at LOS D or better during both weekday peak hours:

- Route 1/I-95 Northbound off-ramp
- Route 1/Foreston Woods Drive/Austin Park Drive
- Route 1/Bells Hill Road
- Route 1/Austin Run Blvd (northbound and southbound intersections)

The change to signal phasing/access management roadway changes increases the delay at the intersection of Route 1 / I-95 On-ramp.

The queuing analysis shows improved Build conditions as compared to No-Build, however there will still be significant queuing during both weekday peaks at the I-95 northbound on-ramp and at Garrisonville Rd.

Figure 45. Future 2035 Build Preferred Alternative AM(PM) Peak Traffic Volumes

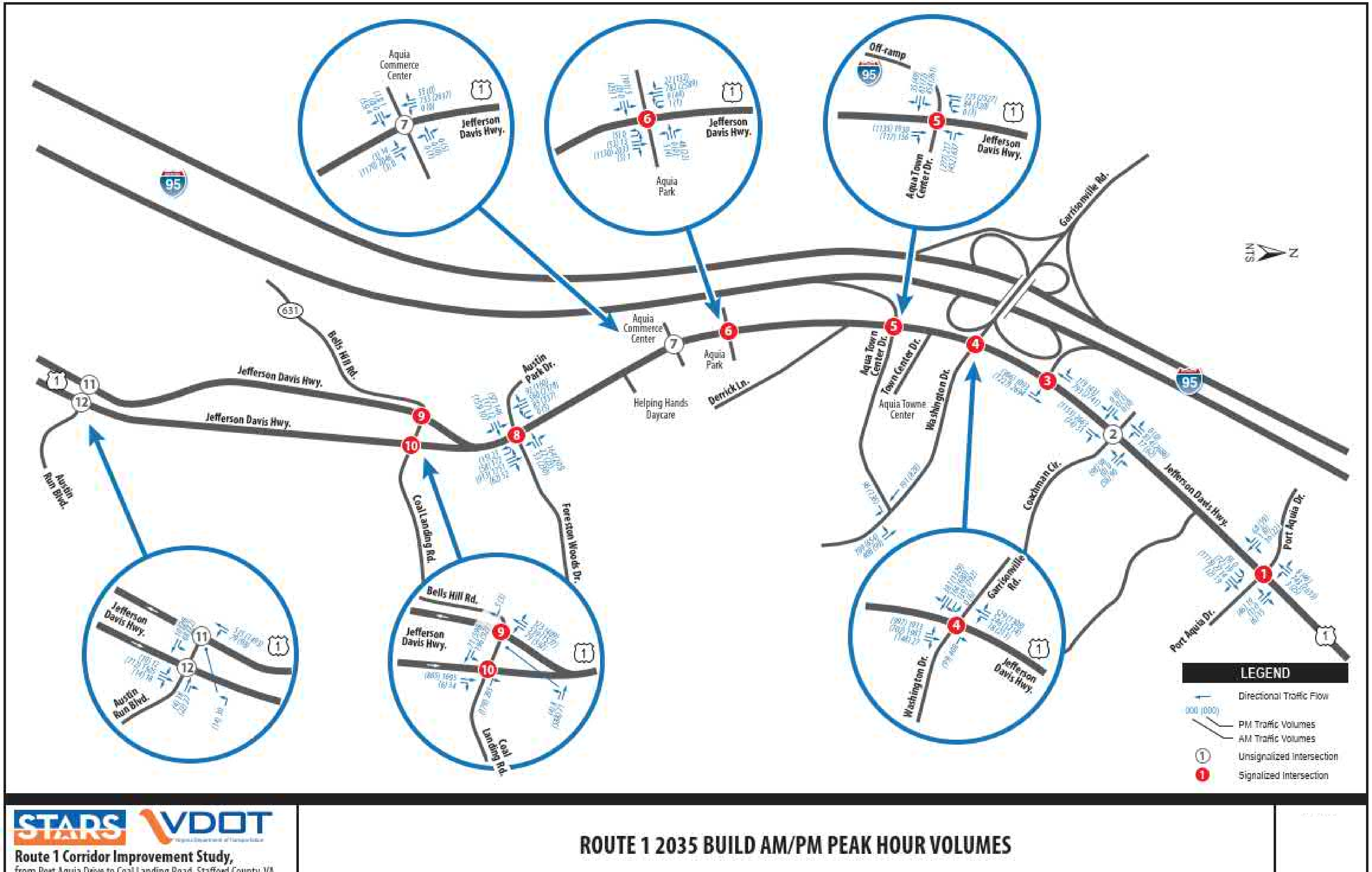


Table 19. Future 2035 Build Preferred Alternative: SimTraffic AM(PM) Peak Hour Delay (veh/sec)

Intersection Number and Description	Type of Control	Lane Group	Eastbound AM Delay	Eastbound PM Delay	Westbound AM Delay	Westbound PM Delay	Northbound AM Delay	Northbound PM Delay	Southbound AM Delay	Southbound PM Delay	Overall AM	Overall PM
1 Route 1 and Port Aquia Drive			Port Aquia Drive		Port Aquia Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	55.6	--	--	Delay	Delay
		Left	56.2	72.8	56.3	79.8	7.6	57.8	54.4	401.9		
		Through	55.4	0.0	0.0	198.9	6.0	1.9	2.4	445.9		
		Right	8.8	12.5	49.8	42.8	3.5	1.1	4.6	421.0	6.3	334.7
		Approach	25.2	27.7	53.2	78.5	6.0	5.9	2.5	445.0		
2 Route 1 and Coachman Circle S					Coachman Circle S		Route 1		Route 1			
	Two Way Stop	Left	--	--	4994.1	4450.5	--	--	103.2	95.0	Delay	Delay
		Through	--	--	--	--	3.5	0.9	189.1	110.6		
		Right	--	216.40	4917.7	4327.0	0.5	0.3	--	--	281.0	298.2
		Approach	--	216.40	4959.9	4361.0	3.5	0.9	183.9	110.2		
3 Route 1 and NB I-95 On Ramp							Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	--	170.3	166.9	Delay	Delay
		Left	--	--	--	--	30.3	56.5	--	--		
		Through	--	--	--	--	7.5	2.1	351.9	134.5		
		Right	--	--	--	--	--	--	675.7	171.4	84.4	97.8
		Approach	--	--	--	--	14.1	14.8	386.9	135.3		
4 Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	--	--	--	Delay	Delay
		Left	44.8	126.1	--	--	55.7	184.6	--	--		
		Through	47.6	121.6	--	--	39.5	23.4	32.5	138.7		
		Right	0.9	4.5	1.0	0.4	15.8	11.5	8.8	18.6	38.7	85.8
		Approach	45.5	67.2	1.0	0.4	44.8	110.3	17.1	82.7		
5 Route 1 and NB I-95 Off Ramp			I-95 Off Ramp		Aquia Town Center		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	--	--		Delay	Delay
		Left	44.8	51.9	56.4	60.3	--	--	67.1	84.5		
		Through	66.9	79.9	0.6	--	67.5	110.1	7.4	17.0		
		Right	51.0	63.2	2.3	0.7	9.9	6.9	--	--	43.5	47.9
		Approach	47.6	58.9	15.8	24.0	63.4	100.9	2.3	24.7		
6 Route 1 and Aquia Park			Aquia Park Drive		Aquia Park Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	--	--	0.0	0.0	Delay	Delay
		Left	54.1	79.7	67.8	87.3	59.1	208.6	30.9	20.8		
		Through	--	--	--	--	77.1	224.0	2.4	15.0		
		Right	6.7	27.5	42.9	52.5	24.1	169.5	1.7	7.6	55.6	84.6
		Approach	47.3	69.3	44.9	56.2	77.0	223.4	2.7	14.7		

Table 19 Continued. Future 2035 Build Preferred Alternative: SimTraffic AM(PM) Peak Hour Delay (veh/sec)

Intersection Number and Description	Type of Control	Lane Group	Eastbound AM Delay	Eastbound PM Delay	Westbound AM Delay	Westbound PM Delay	Northbound AM Delay	Northbound PM Delay	Southbound AM Delay	Southbound PM Delay	Overall AM	Overall PM
7 Route 1 and Aquia Comm Center			Aquia Comm Center		--		Route 1		Route 1			
	Two Way Stop	Left	25.2	1719.3	--	--	37.6	175.0	--	--	Delay	Delay
		Through	--	--	--	--	46.0	137.6	1.4	5.5		
		Right	4.2	1199.0	--	--	--	60.2	1.5	--	33.9	76.6
		Approach	7.7	1261.3	--	--	45.9	137.6	1.4	5.5		
8 Route 1 and Foreston Woods Drive			Austin Park Drive		Foreston Woods Drive		Route 1		Route 1			
	Signal	Uturn	--	--	--	--	71.3	97.2		63.1	Delay	Delay
		Left	52.9	67.0	52.7	68.8	70.9	100.4	64.6	78.6		
		Through	44.9	60.2	49.2	75.6	39.5	28.4	16.3	15.9		
		Right	11.5	44.5	1.7	2.3	7.7	6.1	3.3	4.0	34.5	29.8
		Approach	35.4	51.4	17.8	40.2	41.5	32.3	20.2	23.4		
9 Route 1 and Bells Hill Road			Bells Hill Road		Bells Hill Road				Route 1			
	Signal	Left	--	--	--	--	--	--	13.3	17.5	Delay	Delay
		Through	--	--	--	--	--	--	0.9	3.6		
		Right	3.0	3.6	--	--	--	--	1.3	4.1	2.2	6.7
		Approach	3.0	3.0	--	--	--	--	2.2	6.7		
10 Route 1 and Coal Landing Road			Coal Landing Road		Coal Landing Road		Route 1					
	Signal	Left	80.1	23.6	--	--	--	--	--	--	Delay	Delay
		Through	115.2	30.3	--	--	87.8	20.5	--	--		
		Right	--	--	42.2	12.5	47.2	11.3	--	--	81.7	22.4
		Approach	110.5	30.2	42.2	12.5	87.0	20.4	--	--		
11 Route 1 and Austin Run Blvd SB			--		Austin Run Blvd				Route 1			
	One Way Stop	Left	--	--	12.7	21.5	--	--	17.5	4.4	Delay	Delay
		Through	--	--	--	--	--	--	12.8	3.1		
		Right	--	--	--	--	--	--	--	--	14.4	3.5
		Approach	--	--	12.7		--	--	14.4			
12 Route 1 and Austin Run Blvd NB			Austin Run Blvd		Austin Run Blvd		Route 1					
	Two Way Stop	Left	27.4	8.7	--	--	8.2	5.7	--	--	Delay	Delay
		Through	29.3	9.6	14.3	8.2	9.0	5.3	--	--		
		Right	--	--	7.8	3.4	4.3	4.7	--	--	11.6	5.8
		Approach	27.4		10.2		8.9		--	--		

Table 20. Future 2035 Build Preferred Alternative: SimTraffic Weekend Peak Hour Delay (veh/sec)

Intersection Number and Description	Type of Control	Lane Group	Eastbound Weekend Delay	Westbound Weekend Delay	Northbound Weekend Delay	Southbound Weekend Delay	Overall AM
4 Route 1 and Garrisonville Road			Garrisonville Road	Washington Drive	Route 1	Route 1	
	Signal	Left	113.0	--	328.0	--	Delay
		Through	77.4	--	21.7	114.7	
		Right	9.4	11.6	7.0	68.3	**101.8**
		Approach	61.6	11.6	180.7	86.8	

Table 21. Future 2035 Build Preferred Alternative SimTraffic AM(PM) Peak Hour Max Queues

Intersection Number and Description	Type of Control	Lane Group	Eastbound Storage Bay Length	Eastbound AM Queue (ft)	Eastbound PM Queue (ft)	Westbound Storage Bay Length	Westbound AM Queue (ft)	Westbound PM Queue (ft)	Northbound Storage Bay Length	Northbound AM Queue (ft)	Northbound PM Queue (ft)	Southbound Storage Bay Length	Southbound AM Queue (ft)	Southbound PM Queue (ft)
1 Route 1 and Port Aquia Drive			Port Aquia Drive			Port Aquia Drive			Route 1			Route 1		
	Signal	Left	--	95	68	--	97	140	200	56	155	250	28	**249**
		Through	--			--			--		95	--	103	500
		Right	150	71	76	20	**59**	**49**	280	203	3	270	28	**270**
2 Route 1 and Coachman Circle S			--			Coachman Circle S			Route 1			Route 1		
	Two Way Stop	Left/Uturn	--	530	24	--	281	540	--	--	--	--	99	50
		Through	--			--			--	--		--	--	--
		Right	--			--			--	273		--	1,258	900
3 Route 1 and NB I-95 On Ramp						--			Route 1			Route 1		
	Signal	Left	--	--	--	--	--	--	365	**836**	**370**	--	--	--
		Through	--	--	--	--	--	--	--	908	52	--	1,119	1,154
		Right	--	--	--	--	--	--	--	--	--	--	1,133	1,134
4 Route 1 and Garrisonville Road			Garrisonville Road			Washington Drive			Route 1			Route 1		
	Signal	Left	985	409	399	--	--	--	640	388	552	--	--	--
		Through	--	149	314	--	--	--	--	1,042	1,072	--	183	887
		Right	--	0	3	295	0	0	910	201	85	575	103	**904**
5 Route 1 and NB I-95 Off Ramp			I-95 Off Ramp			Aquia Town Center			Route 1			Route 1		
	Signal	Left	--	306	264	250	167	233	--	--	--	290	117	226
		Through	--	313		--	--	--	--	603	585	--	114	1,086
		Right	245	193	181	--	0	84	565	554	554	--	--	--
6 Route 1 and Aquia Park			Aquia Park Drive			Aquia Park Drive			Route 1			Route 1		
	Signal	Left	--	31	217	--	103	70	300	247	**300**	270	40	183
		Through	--			--			--	949	1,092	--	119	528
		Right	--	18	47	--			145	14	**145**	290	27	218

Table 21 Continued. Future 2035 Build Preferred Alternative SimTraffic AM(PM) Peak Hour Max Queues

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)
7 Route 1 and Aquia Comm Center			Aquia Commerce Center			Aquia Commerce Center			Route 1			Route 1		
	Two Way Stop	Left	--			--			--	777	1,118	--	--	--
		Through	--	22	382	--	--	43	--	750	1,128	--	--	381
		Right	--			--			--	--	56	--	2	--
8 Route 1 and Foreston Woods Dr			Austin Park Drive			Foreston Woods			Route 1			Route 1		
	Signal	Left	--	215	123	--	75	259	250	250	234	260	107	232
		Through	--	50	219	--	134	285	--	378	359	--	193	487
		Right	110	87	110	--	0	42	340	305	252	400	76	366
9 Route 1 and Bells Hill Road			Bells Hill Road			Bells Hill Road						Route 1 (one way)		
	Signal	Left	--	--	--	--	--	--	--	--	--	200	46	375
		Through	--	--	--	--	--	--	--	--	--	--	66	346
		Right	--	35	35	--	--	--	--	--	--	270	30	45
10 Route 1 and Coal Landing Road			Coal Landing Road			Coal Landing Road			Route 1 (one way)					
	Signal	Left	--	180	216	--	--	--	--	--	--	--	--	--
		Through	--			--	--	--	--	1,046	318	--	--	--
		Right	--	--	--	--	312	139	685	293	26	--	--	--
11 Route 1 and Austin Run Blvd SB			--			Austin Run Blvd						Route 1 (one way)		
	Signal	Left	--	--	--	--	53	59	--	--	--	270	147	--
		Through	--	--	--	--	--	77	--	--	--	--	165	--
		Right	--	--	--	--	--	--	--	--	--	--	--	--
12 Route 1 and Austin Run Blvd NB			--			Austin Run Blvd			Route 1 (one way)					
	Signa	Left	--	250	100	--	--	--	--	152	--	--	--	--
		Through	--	202	69	--	50	86	--	--	--	--	--	--
		Right	100	41	32	--			--	--	--	--	--	--

Table 22. Future 2035 Build SimTraffic Weekend Peak Hour Max Queues

Intersection Number and Description	Type of Control	Lane Group	Eastbound		Westbound		Northbound		Southbound	
			Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)	Storage Bay Length	Weekend Queue (ft)
4 Route 1 and Garrisonville Road			Garrisonville Road		Washington Drive		Route 1		Route 1	
	Signal	Left	985	378	--	--	640	640	--	--
		Through	--	365	--	--	--	1,796	--	1,811
		Right	--	58	295	82	910	70	575	575

Figure 46. Future 2035 Build Preferred Alternative AM/PM Peak Intersection Operations Results

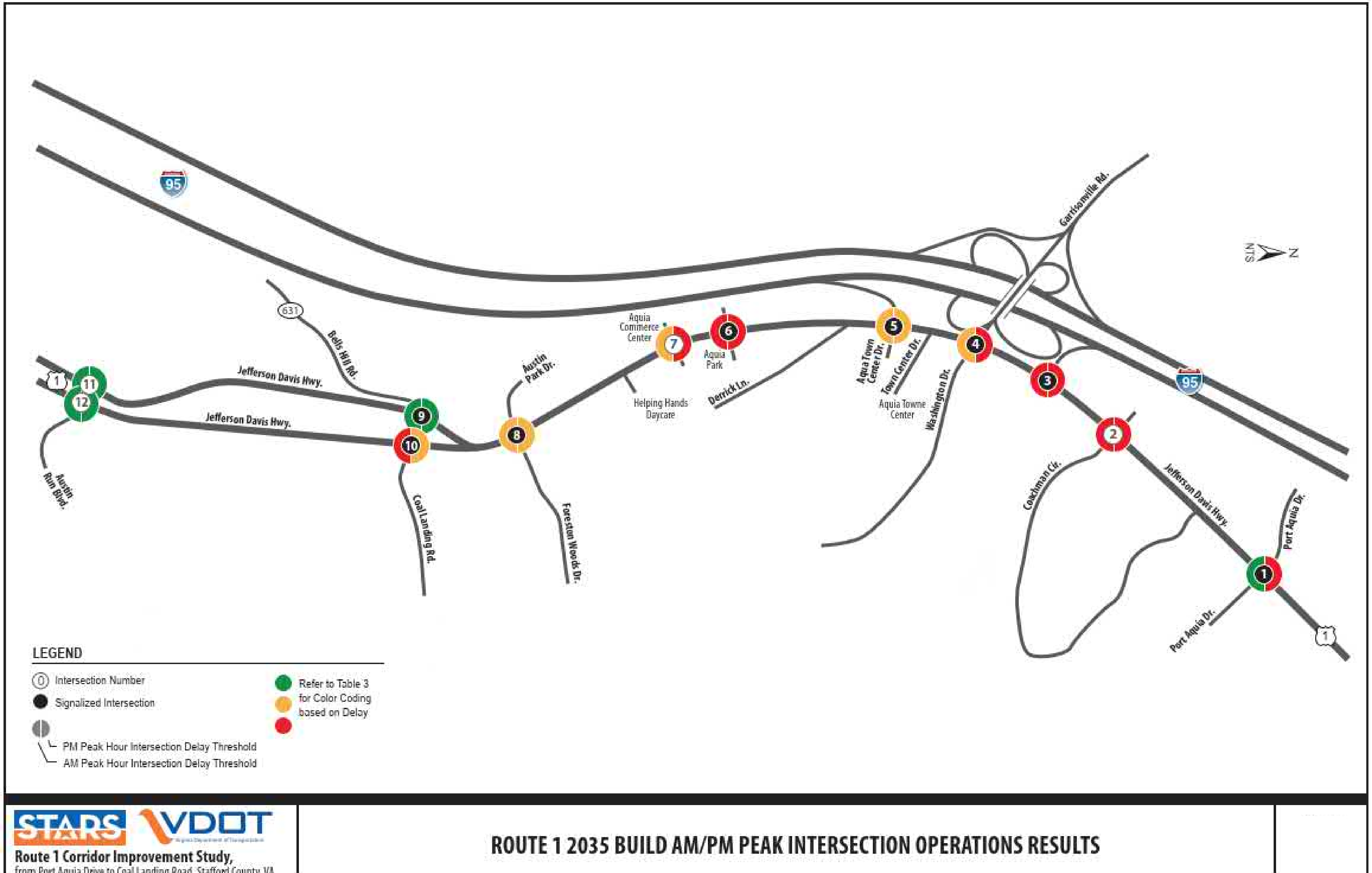
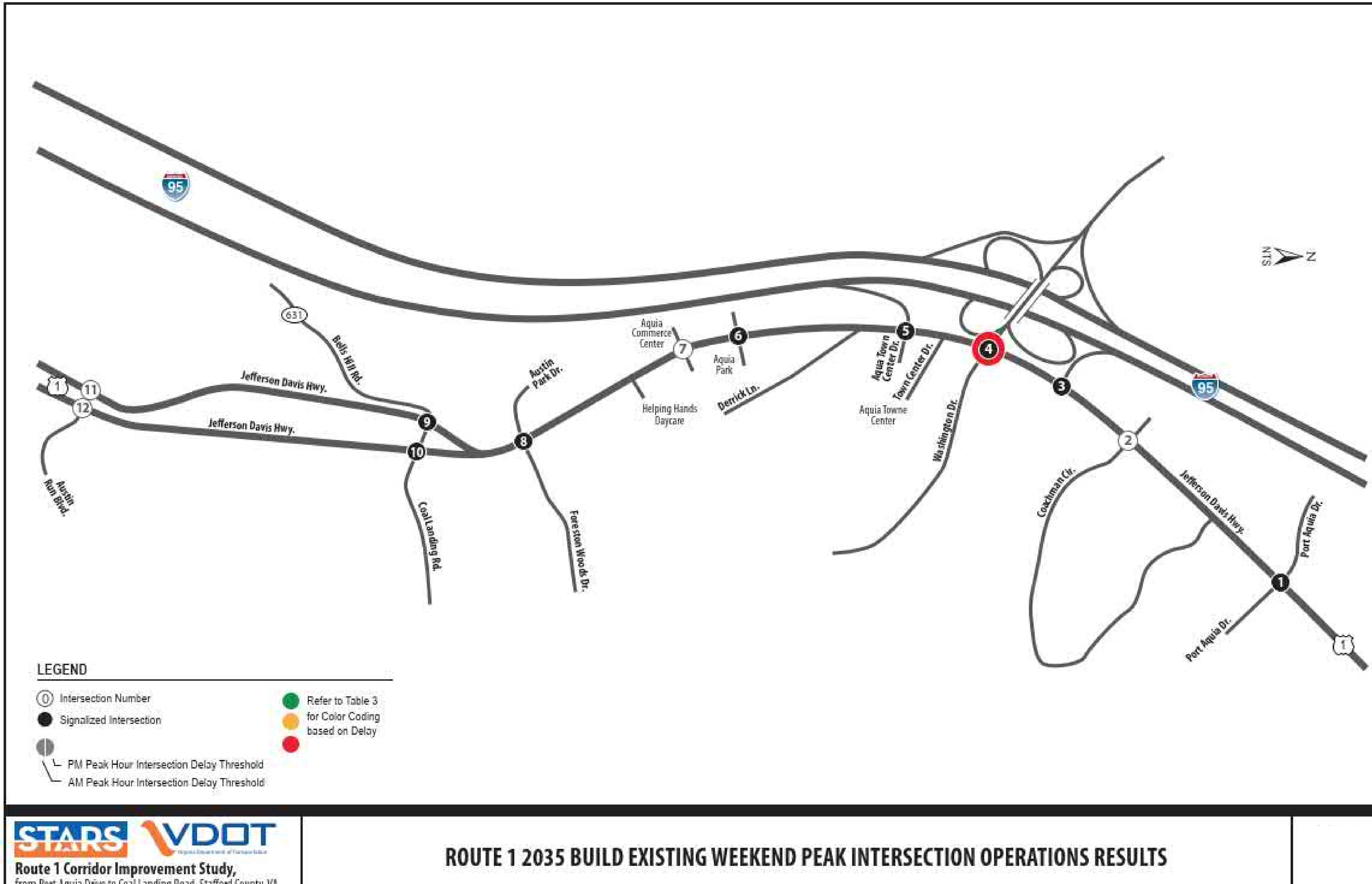


Figure 47. Future 2035 Build Weekend Peak Intersection Operations Results



8 Crash Reduction Analysis

A crash reduction analysis was conducted for Route 1 (Jefferson Davis Highway). As part of the crash reduction methodology, the *Crash Modification Factor Clearinghouse*[2] and *FHWA Desktop Reference for Crash Reduction Factors*[3] were utilized to calculate the Crash Reduction Factors (CRFs) associated with each proposed improvement along Route 1 in Fredericksburg, Virginia. The CRFs were applied to the expected 2035 crashes, based on historic crash data, from the *VDOT Crashtools Database*[4] to determine the expected number of crashes and the percent reduction in crashes per alternative. The proposed future alternative includes the addition of signalized intersections.

Expected crashes were projected to the year 2035 (base build year) and then projected over a 20-year life cycle to 2055. The expected crashes were then utilized to compare the *No Build* and *Build* conditions based on the 20-year projection to evaluate the efficacy of the proposed alternatives.

8.1 Analysis Methodology

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

8.1.1 Proposed Roadway Modifications and CRFs

The CRFs were selected based on the improvements designated for the *2035 Build* conditions. CRFs were selected based on factors such as quality and applicability. Though CRFs may exist, these studies that were conducted to generate the CRF are extremely site specific, and thus must match all factors (i.e., volume, number of lanes, number of approaches, etc.) from the Route 1 improvement in order to be applicable. Additionally, each CRF provides a level of star quality or standard error, which was also used a factor in the selection. The **Appendix** includes the following: 1) the countermeasures proposed, 2) categories of countermeasures obtained from the *CMF Clearinghouse* and/or *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 Crash Modification Factor Clearinghouse or 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.

In some instances, CRF values were applicable to the intersection or segment as a whole and often involved multiple CRF values. To accurately calculate CRFs for some alternatives, a composite CRF was calculated using **Equation 1**. Some alternatives required combined CRFs and/or individual CRFs, depending on the specific improvements.

Equation 1. Composite CRF Calculation

$$Composite\ CRF = 1 - [(1 - CRF_1) * (1 - CRF_2) * \dots * (1 - CRF_i)]$$

8.1.2 Applicable Crash Calculations

To properly determine how the improvements impact the 2035 and 2055 expected crashes, a detailed evaluation of historical crash data (2013-2018) was conducted. Not every crash at a specific location would be reduced due to an improvement. For example, when implementing a two-phase pedestrian cross walk, pedestrian related crashes would be expected to reduce. Therefore, the CRF should only be applied to the specific crashes that may be affected by the improvement. 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 (2013-2018). Then, the percent of applicable crashes (i.e., number of applicable crashes across the five calendar years divided by the total number of crashes) was determined for each improvement with a known CRF, as shown in **Equation 2**.

Equation 2. Percentage of Applicable Crashes Calculation

$$Percentage\ of\ Applicable\ Crashes = \frac{Number\ of\ Applicable\ Crashes}{Total\ Number\ of\ Crashes} * 100$$

8.1.3 Crash Reduction Evaluation

Based on the 2013-2018 crash data within the *VDOT Crashtools Database*, the average number of property damage only (PDO or O), visible and non-visible injury (B+C), and fatal or ambulatory injury (K+A) crashes over the most recent five years were calculated. The existing average crashes were then projected into 2035 (i.e., 16-year projection based on the 1.6% growth along Route 1) to which a base build year was established. These estimates were then projected out to the year 2055 (i.e., 20-year projection) to estimate the expected number of (PDO or O), (B+C), and (K+A) crashes for the *Build* conditions over the 20-year life cycle, based on the 1.6% growth rate for Route 1.

To calculate the expected number of (PDO or O), (B+C), and (K+A) crashes for the *Build* conditions where 100% of the crashes were applicable, the appropriate composite CRFs were implemented where improvements were proposed, as shown in **Equation 3**.

Equation 3. Expected Crashes for the 2035 Build Conditions (100% Applicable Crashes)

$$2035\ Build\ Expected\ Crashes = 2035\ No\ Build\ Expected\ Crashes - [2035\ No\ Build\ Expected\ Crashes * (CRF)]$$

[2] Federal Highway Administration. (2017). Crash Modification Factors Clearinghouse. Washington, DC. Retrieved from http://www.cmfclearinghouse.org/.
[3] Federal Highway Administration. (2014). *Desktop Reference for Crash Reduction Factors*. Washington, DC. Retrieved from https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/.
[4] Virginia Department of Transportation. (2017). *Crash Analysis Tool*. Retrieved from https://public.tableau.com/profile/tien.simmons#!/vizhome/Crashtools8_2/Main.

To calculate the expected number of (PDO or O), (B+C), and (K+A) crashes for the *Build* conditions where only a portion of the crashes were applicable, the appropriate composite CRFs were implemented where improvements were proposed, as shown in **Equation 4**.

Equation 4. Expected Crashes for the 2035 Build Conditions (<100% Applicable Crashes)

$$2035\ Build\ Expected\ Crashes =$$
$$2035\ No\ Build\ Expected\ Crashes - [2035\ No\ Build\ Expected\ Crashes * \%\ Applicable\ Crashes * (CRF)]$$

The percent reduction in (PDO or O), (B+C), and (K+A) crashes between the *2055 No-Build* and *Build* conditions per alternative was calculated for each intersection/segment for Route 1 over the 20-year cycle life.

Another level of our analysis was accounting for vehicle diversions as a result of future restricted movements. For example, at the intersection of Route 1 at Coal Landing Road, the preferred alternative proposes to remove the northbound thru and left-turn movements. These restrictions would require vehicles to divert to adjacent intersections. As a result of the vehicle diversions, existing approaches are subjected to potentially higher crash statistics which need be accounted for in the crash analysis. For the purposes of our analysis, projected increased percentages in vehicular volumes per the affected approach were calculated and applied to existing crash statistics in order to project the overall increase in crash rates. **Equations 5** and **6** below further illustrate the analysis approach.

Equation 5. Percent Volume Increase

$$Percent\ Volume\ Increase = \frac{[Existing\ Approach\ Volume + Diverted\ Volume]}{Existing\ Volume}$$

Equation 6. Percent Crash Increase

$$Percent\ Crash\ Increase = \left\{\frac{[Existing\ Approach\ Crashes * Percent\ Volume\ Increase]}{5}\right\} - \left\{\frac{[Existing\ Approach\ Crashes]}{5}\right\}$$

Projected crashes and crash reductions to the base build year (2035) are provided in the **Appendix**. This base condition was then projected each year over the 20-year life cycle to determine the crash reductions through 2055.

8.1.4 General Assumptions

Clearinghouse

- CRFs having studies with 3 stars or better were used for application.
- Only applicable and relevant CRF factors were utilized for respective countermeasures. If no applicable category was found, the FHWA Desktop Reference was used. If an applicable CRF was not provided in either source, a CRF of 0 (zero) or N/A was utilized.
- Multiple CRF values applying to either whole segment countermeasures were combined and applied.

FHWA Desktop Reference for Crash Reduction Factors

- Only applicable and relevant CRF factors were utilized for respective countermeasures. If no applicable category was found, countermeasure CRFs were considered to be 0 (zero) or N/A.
- Categories providing multiple CRF factors were combined to find an average CRF factor.
- Multiple CRF values applying to either whole segment or intersection countermeasures were combined and applied.
- In some countermeasures, CRF factors were applied to only applicable crashes vs. the entire interchange or segment being analyzed.
- Based on the overall setting and city, it was assumed this area was urban.

Crash Reduction Analysis

- Projected crash growths were calculated as an average over a 5 year period (2013-2018) based on existing crash data along the corridor in *VDOT Crashtools Database.*
- Projected crash rates were based on a 1.6% growth rate.
- Projected crash rates for build conditions were calculated for 2035 and 2055.
- Estimated crash reduction factors remained the same over the entirety of the 20-year projections.
- Crashes are expected to increase as a result of vehicles diverting to adjacent intersections.
- 2035 is assumed to be the base build year.
- Cost savings were based on the difference in crash reductions between 2035 and 2055.
- Crashes are random and thus results and benefits may vary over time.

8.2 Analysis Results

The total crash reduction values over the 20-year cycle life (i.e., from 2035 to 2055) for the preferred alternative are provided in **Table** 23**23**. The PDO crash reduction for Alternative 4 is negative due to the introduction of new traffic signals at Austin Run Blvd.

Table 23. Total Crash Reduction (20-year Cycle Life)

Location	PDO or O Crashes (Reduction)	B+C Crashes (Reduction)	K+A Crashes (Reduction)
ALTERNATIVE 1: Route 1 at I-95 On-Ramp	384.74	3.04	0.11
ALTERNATIVE 2: Route 1 at Garrisonville Road/Washington Drive & Route 1 at Town Center Drive/I-95 Off-Ramp	88.22	-8.58	6.69
ALTERNATIVE 3: Route 1 at Foreston Woods Drive/Austin Park Drive & Aquia Park Shopping Center	58.38	25.21	0.00
ALTERNATIVE 4: Route 1 at Coal Landing Road/Bells Hill Road & Austin Run Boulevard	-29.69	1.04	0.54
ALTTERNATIVE 5: Route 1 Corridor-Wide Improvements	3.48	1.14	0.21

Note: Crash Rate reduction percentages are assumed to remain the same over the 17-year and 20-year projections due to the assumed constant growth rate over the corridor.

9 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.

9.1 Planning Level Cost Estimates

Planning level cost estimates were developed for all the preferred improvement alternatives following the guidance from VDOT Fredericksburg District Location and Design (L&D) on developing planning level cost estimates for SMART SCALE. The development of the methodology occurred during a coordination meeting with VDOT on January 7, 2020 at the VDOT Fredericksburg Residency, and was further reviewed and finalized in coordination with VDOT L&D. Using this methodology, cost estimates were developed to the Year 2020 for SMART SCALE, and are included in the **Appendix**. The cost estimates included Construction (CN), Right-of-Way and Utilities Relocation (ROW) and Preliminary Engineering (PE) costs. The 2020 cost estimates were inflated to year 2035 dollars by an inflation rate of 2.5% and are shown in **Table 24**. The planning level cost estimates were developed to get a preliminary idea of the funding requirements for the proposed improvements along the corridor.

Table 24. Planning Level Cost Estimates (Year 2035 US Dollars)

Alternative/Location	Cost Estimate			
	Preliminary Engineering (PE)	Right-of-Way/Utilities (ROW)	Construction (CN)	Total
ALTERNATIVE 1: Route 1 and I-95 NB On-Ramp	$793,729	$2,649,104	$5,669,489	$9,112,322
ALTERNATIVE 2: Route 1 and Garrisonville Road / Washington Drive	$2,878,615	$16,687,531	$20,561,533	$40,127,679
ALTERNATIVE 3: Route 1 and Foreston Woods Drive / Austin Park Drive	$426,645	$1,334,317	$3,047,458	$4,808,420
ALTERNATIVE 4: Route 1 and Coal Landing Rd / Bells Hill Road	$777,248	$0	$5,551,770	$6,329,018
ALTERNATIVE 5: Corridor-Wide Shared-Use Path	$1,988,586	$5,763,292	$7,648,404	$15,400,282
			Total	**$75,777,721**

9.2 Planning Level Schedule Estimates

Planning level schedules were developed for all improvement alternatives. Schedule estimates were based on familiarity with complex projects within the Fredericksburg District as well as discussions with the SWG. **Table 25** provides a summary of schedules by phases of the project: Preliminary Engineering (PE), ROW and Utility Relocation (ROW) and Construction (CN). If several alternatives/locations are combined as one project, the overall combined schedule will likely be less than the sum of the individual schedule estimates.

Table 25. Planning Level Schedules (months)

Alternative/Location	Schedule Estimate			
	Preliminary Engineering (PE)[1]	Right-of-Way / Utilities (ROW)[3]	Construction (CN)[2]	Total[4]
ALTERNATIVE 1: Route 1 and I-95 NB On-Ramp	15	15	18	48
ALTERNATIVE 2: Route 1 and Garrisonville Road / Washington Drive	15	15	18	48
ALTERNATIVE 3: Route 1 and Foreston Woods Drive / Austin Park Drive	12	12	12	36
ALTERNATIVE 4: Route 1 and Coal Landing Rd / Bells Hill Road	9	12	9	30
ALTERNATIVE 5: Corridor-Wide Shared-Use Path	9	12	9	30

Notes:

1. PE durations assume 3 design submittals with 3-week review period
2. Construction duration includes pre-submittals (1.5 month) and close out/punch list items (1 month)
3. ROW for access management includes permit modifications
4. Total duration does not include time for procurement and award

9.3 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. 20-year period is typically used for small to medium size transportation projects. The B/C analysis provides a value comparing estimated monetary time delay savings and monetary crash savings that can be calculated as compared to the estimated engineering and construction capital cost of improvements. While it does give an indication of the value of improvements, it is not the sole factor that may be used in determining the value of improvements.

9.3.1 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 *2017 National Household Travel Survey (NHTS)*[5], average vehicle occupancies of 1.18 and 1.82 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"*[6], *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 by comparing the Preferred Build Alternative delay results to the No-Build delay results. 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

9.3.2 Safety Benefit

As part of the crash analysis, the differences in crashes between the 2055 *No-Build* and *Build* conditions were calculated for PDO, (B+C), and (K+A) 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)[7]. Cost savings per crash type are provided below:

- K+A = $923,829
- B+C = $82,160
- PDO = $10,549

The Present Value of Benefits (PVB_S) of the annual safety reduction benefits over a 20-year life-cycle was calculated using **Equation 6**:

Equation 6. Present Value of Benefits - Safety (PVB_S)

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

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

The total cost savings per alternative are provided in **Table 26** Additionally, the breakdown of the crash reduction and cost savings over the 20-year life cycle are provided in the **Appendix**.

Table 26. Crash Cost Savings Analysis (PVB_s over 20-Year Cycle Life)

Alternative	PDO (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Alternative 1	$3,088,923	$190,028	$78,773	$3,357,724
Alternative 2	$708,266	$(536,277)	$4,701,804	$4,873,844
Alternative 3	$468,728	$1,276,242	$0	$2,044,971
Alternative 4	-$238,398	$64,802	$380,950	$207,354
Alternative 5	$27,971	$71,543	$144,947	$244,462

[5] FHWA Report No. FHWA-PL-11-022, Summary of Travel Trends: 2009 National Household Travel Survey
[6] USDOT Guidance: "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations, Revision 2 (2016 Update)"
[7] Virginia Department of Transportation (VDOT) Highway Safety Improvement Program (HSIP) VA Specific Crash Cost Table

9.3.3 Benefit-Cost Ratio (BCR)

The 2035 cost estimate for each alternative, shown previously in **Table 24,** was used in the calculation of B/C ratios. **Equation 7** was used to develop the B/C ratios:

Equation 7. Benefit/Cost Ratio (BCR)

$$BCR = PVB/PVC$$

Where,

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

PVC = Present Value of Costs = 2035 Cost Estimate

Table 27 summarizes the calculated BCR for each of the improvement alternatives. The delay reduction benefit of Alternative 1 is negative due to the increase in delay at the intersection for the Build condition.

Table 27. Benefit-Cost Analysis Summary per Improvement Alternative

Alternative	Delay Reduction Benefit (PVB_D)	Safety Benefit (PVB_S)	Present Value of Costs (PVC)	Benefit-Cost Ratio (BCR)
Alternative 1	-$9,940,043	$3,357,725	$9,112,322	-0.72
Alternative 2	$120,057,577	$4,873,844	$40,127,679	3.11
Alternative 3	$14,466,113	$2,044,971	$4,808,419	3.43
Alternative 4	$66,114,903	$207,354	$6,329,017	10.48
Alternative 5	$0	$244,462	$15,400,281	0.02

* Alternative 5 primarily address pedestrian improvements and traffic control elements deficiencies along the corridor. These measures do not have direct benefit with delay reduction, hence, delay reduction values were not identified.

9.4 Project Prioritization

Improvement projects should be prioritized at a regional level. **Table 28** summarizes these factors for each improvement alternative proposed by this study. 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 agencies;
- Safety Improvements and their benefits;
- Geometric Improvements;
- No anticipated ROW Impacts: Projects that require additional right-of-way are typically more costly and impactful, and are not preferred.

Table 28. Project Prioritization Criteria

Alternative	B/C Ratio	Safety Improvements	Operation Improvements	No Anticipated ROW Impacts
Alternative 1	-0.73	✓		
Alternative 2	3.11	✓	✓	
Alternative 3	3.42	✓	✓	
Alternative 4	10.28		✓	✓
Alternative 5	0.02	✓		

✓ Indicates the criteria for the corresponding improvement alternative is fulfilled

Based on the review of the criteria and the calculated BCR, the following alternatives are identified which can potentially be submitted for SMART SCALE or seek other funding sources:

- Alternative 2 (Route 1 / Garrisonville Rd Quadrant Roadway Intersection)
- Alternative 3, (Route 1 /Foreston Woods Rd Intersection)
- Alternative 4, (Route 1 /Coal Landing Rd Intersection)
- Alternative 5 (Route 1 corridor-wide improvements)

This list is based on the selection criteria as summarized in **Table 28**. The District, in coordination with the localities, may choose to advance some or all of these projects at their discretion.

10 Conclusions And Recommendations

The STARS Route 1 (Jefferson Davis Highway) 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:

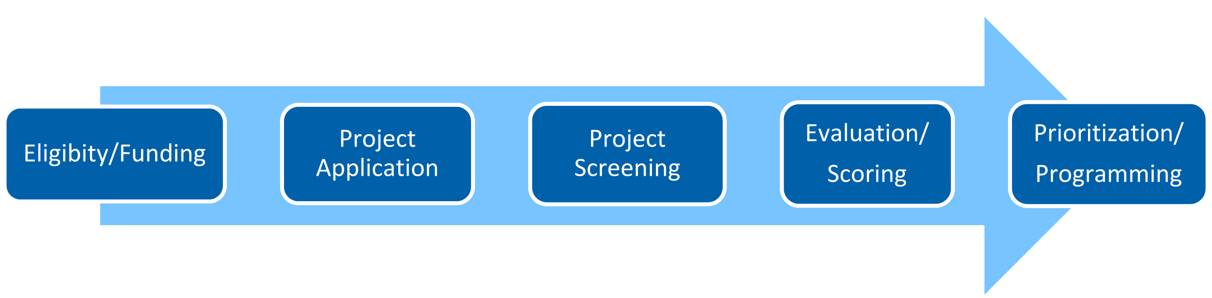
- Constrained Long Range Transportation Plan (CLRP)
- Transportation Improvement Plan (TIP)
- Statewide Transportation Improvement Plan (STIP)
- VDOT Six-Year Improvement Program (SYIP)

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 Fredericksburg District, the scoring factors with the highest weight are:

- Accessibility (15%)
- Economic Development (5%)
- Safety (5%)
- Environmental Quality (10%)
- Congestion Mitigation (45%)
- Efficient Land Use (20%)

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.