



# I-95 Northbound Rappahannock River Crossing

INTERCHANGE MODIFICATION REPORT  
SEPTEMBER 2019

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# Interchange Modification Report

## I-95 RAPPAHANNOCK RIVER CROSSING NORTHBOUND

### Commonwealth of Virginia

State Project Number: 0095-111-270, P101, R201, C501

Federal Project Number: NHPP-095-2(531)

UPC: 105510

This document has been prepared and submitted pursuant to 23 U.S.C. 111 to obtain FHWA approval to modify existing interchange ramps on a fully-controlled interstate highway.

Submitted September 2019 to:



Submitted by:



The request for reconfiguration of the interstate access points is approved for a Finding of Engineering and Operational Acceptability. This approval is conditional upon compliance with applicable federal requirements, specifically with the National Environmental Policy Act (NEPA). Completion of the NEPA process is considered acceptance of the general project location and concepts denoted in the environmental documentation.

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Federal Highway Administration, Virginia Division

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Virginia Department of Transportation

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Date of Approval

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Date of Approval

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# Interchange Modification Report

## I-95 RAPPAHANNOCK RIVER CROSSING NORTHBOUND

### Commonwealth of Virginia

This document has been prepared to satisfy the requirements set forth by Federal and State Policy for changes in interstate access. It is consistent with the Virginia Department of Transportation's Location and Design Division Instructional and Informational Memorandum LD-200.9, and in accordance with the FHWA's policy on *Access to the Interstate System* dated August 27, 2009.

Submitted September 2019 to:



Submitted by:



Prepared under the direction and review of:

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Fredericksburg District  
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# Interchange Modification Report

## I-95 RAPPAHANNOCK RIVER CROSSING NORTHBOUND

September 2019

Prepared for:



Prepared by:

Whitman, Requardt & Associates, LLP



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- Appendix B - Traffic Data
- Appendix C - VISSIM Model Calibration Documentation
- Appendix D - Conceptual Signing Plan
- Appendix E - Traffic Operations Analysis Results
- Appendix F - VISSIM Files (electronic files provided on CD)

## EXECUTIVE SUMMARY

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), has initiated an Interchange Modification Report (IMR) for the I-95 Rappahannock River Crossing Northbound project in Stafford and Spotsylvania Counties and the City of Fredericksburg. I-95 is the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C. and serves local, commuter, and regional traffic. Within the study area, I-95 suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. The peak period congestion is caused by a combination of through traffic along I-95 and traffic utilizing the Route 17 and Route 3 interchanges including a large portion of the traffic traveling along I-95 between Route 17 and Route 3. Since 1980, the George Washington Region has been the fastest growing planning district commission in Virginia with a growth of 545 percent over the past 60 years with the largest portion of recent growth occurring in Stafford and Spotsylvania Counties. The population in the region is forecasted to double by 2045 from the 350,516 in 2015. This continued growth in population and resulting traffic volume growth will result in a further degradation of traffic operating conditions and increase both the severity and duration of daily congestion.

### ES.1. PROJECT BACKGROUND

On July 6, 2016, FHWA approved the Interchange Modification Report (IMR) for Improvements to I-95 from Exit 133 to Exit 130 (herein referred to as April 2016 IMR). The proposed access modifications to I-95 from Exit 133 to Exit 130 included in the April 2016 IMR were the result of many years of planning by Fredericksburg Area Metropolitan Planning Organization (FAMPO) and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along I-95 between the Route 17 and Route 3 interchanges. The preferred alternative approved in the IMR included the following major components:

- Two-lane collector-distributor (C-D) roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes
- A flyover connection from the northbound I-95 C-D road to northbound Route 17
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

As documented in the April 2016 IMR, the proposed project would be implemented in different phases due to funding constraints.

- **I-95 Safety Improvements at Route 3 (Exit 130):** The first phase of work was the I-95 Safety Improvements at Route 3 (Exit 130) project which was completed in January 2019.
- **I-95 Rappahannock River Crossing Southbound Project:** Funding for improvements along southbound I-95 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River was secured through the Smart Scale program and was included in

the fiscal year (FY) 2017-2022 Six-Year Improvement Program (SYIP). During the Design-Build procurement process for this phase of the project, VDOT decided to reevaluate the configuration of the southbound C-D lanes contained in the April 2016 IMR to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along the southbound I-95 mainline lanes. As a result, the project design was modified and documented in the Interchange Modification Report Supplement to support the Rappahannock River Crossing Southbound Project (dated September 2017). This project is currently under construction.

- **I-95 Rappahannock River Crossing Northbound Project:** Improvements along northbound I-95 including the construction of the northbound C-D lanes and associated improvements at the Route 17 interchange will be the last phase of improvements and are the subject of this IMR. Similar to the I-95 Rappahannock River Crossing Southbound project, VDOT has decided to reevaluate the configuration of the northbound C-D lanes project.

In accordance with the FHWA approval letter for the April 2016 IMR which states that the “IMR will have to be reevaluated if modifications are made to the “accepted” concept detailed on page ES-3 of the document,” this IMR has been prepared to document modifications to the proposed northbound C-D lanes and Route 17 interchange referred to as the I-95 Rappahannock River Crossing Northbound project.

## ES.2. PURPOSE AND NEED

The purpose of the project is to:

- advance the recommendations, objectives, and policy identified in the Fredericksburg Area Master Planning Organization (FAMPO) Long Range Transportation Plan;
- address recurring congestion and safety deficiencies associated with peak period travel along the northbound I-95 mainline travel lanes;
- provide additional traffic capacity for travel between Route 3 and Route 17 along northbound I-95; and
- provide additional northbound I-95 traffic capacity over the Rappahannock River to allow for needed redundancy and flexibility during incidents, required maintenance, and bridge rehabilitation activities.

## ES.3. SCREENING OF ALTERNATIVES

As part of the previously approved Interchange Modification Report for Improvements to I-95 from Exit 133 to Exit 130 (April 2016 IMR), twelve alternatives in addition to the No Build alternative were developed and screened to evaluate each alternative and then select a preferred alternative. Following the approval of the April 2016 IMR, VDOT decided to reevaluate the configuration of both the northbound and southbound I-95 C-D lanes to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points.

The alternatives development process for the I-95 Rappahannock River Crossing Northbound project included the identification of “alternatives” for the northbound I-95 mainline lanes and C-D lanes and “options” for the Route 17 interchange to address the identified purpose and need. Separate options were considered for Route 17 both east and west of I-95. The identification of the alternatives and options was

considered independently while recognizing that the selected alternative for the northbound I-95 mainline lanes and C-D lanes would need to be compatible with the selected option at the Route 17 interchange.

A working group comprised of VDOT Fredericksburg and Northern Virginia District staff as well as technical support staff was formed to guide the development of a Build Alternative for the northbound I-95 mainline and C-D lanes. The group convened for a workshop and discussed design issues and constraints in order to reach a consensus on a preferred alternative. All alternatives discussed focused on improving operations and minimizing access points along the northbound I-95 mainline lanes.

The Build Alternative, which begins the northbound I-95 C-D lanes north of Route 3 in addition to the Route 17 interchange improvements was selected because it provides additional traffic capacity for travel between Route 3 and Route 17 and over the Rappahannock River bridge providing redundancy and flexibility during incidents and required maintenance and addresses recurring congestion and safety deficiencies identified within the project study area while having a construction cost that is within the available project budget. **Chapter 4** includes a detailed summary of the alternative evaluation and screen process.

#### **ES.4. SUMMARY OF PROPOSED ACTION**

The Build Alternative including typical sections for the I-95 Rappahannock River Crossing Northbound project is depicted in **Figure 4-13**. The proposed project consists of the following improvements along northbound I-95 and Route 17.

**Northbound I-95:** The Build Alternative along northbound I-95 has the following major components:

- Three-lane C-D road beginning at the entrance ramp from Route 3 and continuing parallel to the mainline lanes between Route 3 and Route 17.
- A two-lane slip ramp north of Route 3 from the northbound I-95 mainline lanes to the C-D road to provide access to the downstream Route 17 interchange from the northbound I-95 mainline lanes.
- New three-lane northbound I-95 mainline lanes transitioning to the median north of Fall Hill Avenue with a new parallel structure over the Rappahannock River.

**Route 17 – West of I-95:** The Build Alternative along Route 17 west of I-95 has the following major components:

- Signalize the southbound I-95 to westbound Route 17 right-turn movement and provide a triple right turn.
- Widen westbound Route 17 on the approach to the signalized intersection to provide four through lanes.
- Install a second westbound Route 17 left-turn lane to southbound Sanford Drive.

**Route 17 – East of I-95:** The Build Alternative along Route 17 east of I-95 has the following major components:

- Install a 3-phase signalized intersection at the northbound I-95 C-D lanes off-ramp to Route 17 with a signalized triple left-turn to westbound Route 17 and a right-turn lane to eastbound Route 17.

- Remove the northeast quadrant loop ramp from the northbound I-95 C-D lanes to westbound Route 17.
- Widen Route 17 in the vicinity of the new signal to provide three westbound Route 17 travel lanes to increase the efficiency of the traffic signal.

There is uncertainty in the ultimate project cost since the project has not yet been advertised or awarded to a contractor; therefore, two bid options are under consideration:

**Bid Option A – Auxiliary Lane between Route 17 and Centreport Parkway:** This option includes construction of an auxiliary lane that would extend along northbound I-95 from the C-D lane entrance north of Route 17 to the northbound I-95 off-ramp to Centreport Parkway to provide additional capacity at the merge between the northbound I-95 mainline lanes and C-D lanes.

**Bid Option B - Replacement of the C-D Road Bridge Over Route 17:** This option includes full replacement of the existing bridge carrying the C-D lanes over Route 17 and approximately 1,000 feet of approach and departure C-D roadway on either side of the bridge. The existing bridge has less than desirable vertical clearance above Route 17 and insufficient horizontal width between piers for any future widening of Route 17.

## ES.5. SUMMARY OF FINDINGS

### ES.5.1 TRAFFIC OPERATIONAL ANALYSIS FINDINGS

VISSIM Version 8, Build 15 microsimulation software was used for the evaluation of traffic operations for the I-95 Rappahannock River Crossing Northbound project. The traffic analysis demonstrates that the Build Alternative will improve operations along the I-95 corridor within the project area compared to No Build conditions under both 2022 and 2042 Build conditions based on a review of corridor travel times, speeds, densities, vehicle throughputs, and arterial intersection operation results of the microsimulation analysis. The results of the analysis described below do not include Bid Option A which is the construction of an auxiliary lane between Route 17 and Centreport Parkway. An analysis of Bid Option A is included in **Section 7.3.5**.

#### *2022 Conditions*

Under 2022 Build conditions, AM peak hour travel times are 1.6 minutes less (18% reduction) in the northbound I-95 mainline and 1.8 minutes less (61% reduction) in the northbound I-95 C-D lanes between the start of existing C-D lanes and the end of the C-D lanes corridor compared to No Build conditions. During the PM peak hour, travel times under Build conditions are similar to No Build conditions (differences are less than one minute).

Under 2022 No Build conditions, AM peak hour severe congestion is projected in the existing northbound I-95 C-D lanes at the Route 17 interchange which extends upstream into the northbound I-95 mainline lanes to the merge with the on-ramp from Route 3. Under 2022 Build conditions during the AM and PM peak hours, the northbound I-95 mainline lanes, C-D lanes and Express Lanes are projected to operate with light traffic conditions including all merge and diverge junctions serving the C-D lanes and Express Lanes. Under 2022 Build conditions, travel speeds along the northbound I-95 mainline lanes, C-D lanes, and Express Lanes segments range from 56 MPH to 72 MPH within the study limits during the AM and PM peak hours.

Along northbound I-95 during the AM peak hour, volume throughput increases compared to No Build conditions by as much as 290 vehicles (6 percent) over the Rappahannock River. Along northbound I-95 during the PM peak hour, there is a negligible change in volume throughput because all traffic demand is served under No Build and Build conditions.

The 2022 Build improvements along the corridor will reduce congestion and delays at the northbound I-95 C-D lanes weave at Route 17, eliminating the severe queues that extend along both the northbound I-95 mainline and C-D lanes. Improvements at the Route 17 interchange and the signalized intersection of Route 17 at Sanford Drive/Gateway Drive will reduce congestion and delays along westbound Route 17. During the AM and PM peak hours, all signalized and unsignalized intersections operate with light or moderate traffic conditions under Build conditions.

### ***2042 Conditions***

Under 2042 Build conditions, AM peak hour travel times are 11.1 minutes less in the northbound I-95 mainline between Route 620/Harrison Road and Truslow Road and approximately 1.7 minutes less in the northbound I-95 C-D lanes between the start of existing C-D lanes and the end of the C-D lanes compared to No Build conditions. During the PM peak hour, 2042 Build conditions travel times are 40.1 minutes less in the northbound I-95 mainline lanes between Route 620/Harrison Road and Truslow Road and 11.3 minutes less in the northbound I-95 C-D lanes between the start of existing C-D lanes and end of the C-D lane corridor compared to No Build conditions.

Under 2042 No Build conditions, severe congestion is projected in the northbound I-95 C-D lanes at the Route 17 interchange which extends upstream onto the northbound I-95 mainline lanes beyond Route 3 and onto eastbound and westbound Route 3. Severe congestion within the northbound C-D lanes and along westbound Route 17 is caused by the signalized intersection at Sanford Drive/Gateway Drive as well as the multiple weaves along westbound Route 17 in the vicinity of the I-95 interchange.

The Build Alternative improves the northbound I-95 mainline lanes, C-D lanes, and Express Lanes to operate with light or moderate traffic conditions during the AM peak hour with the exception of the northbound I-95 mainline and C-D lanes at the north end of the study area. The northbound I-95 mainline between the C-D lanes merge and the diverge to Centreport Parkway operates under severe congestion due to congestion north of the study area that extends upstream beyond Centreport Parkway. Severe congestion in the mainline lanes extend upstream into the C-D lanes and result in severe and heavy congestion between the diverge to the Express Lanes and the merge into the northbound I-95 mainline lanes. During the PM peak hour under Build conditions, all northbound I-95 mainline and C-D lanes operate with light traffic conditions. While additional capacity improvements along I-95 north of the project area are needed to accommodate the 2042 design year traffic volumes, improvements to this area are outside the scope of the I-95 Rappahannock River Crossing Northbound project. However, the I-95 Corridor Improvement Plan which is currently underway by the Commonwealth Transportation Board (CTB), supported by the Office of Intermodal Planning and Investment (OIPI), the Virginia Department of Transportation (VDOT), and the Department of Rail and Public Transportation (DRPT), will identify key problem areas along the I-95 corridor and identify potential solutions and areas for additional review and study including improvements to address weekday and weekend congestion along I-95.

Along northbound I-95, volume throughput increases compared to No Build conditions by as much as 1,970 vehicles (38 percent) during the AM peak hour and 2,200 vehicles (94 percent) during the PM peak hour over the Rappahannock River.

The 2042 Build improvements along the corridor will reduce congestion and delays along the northbound I-95 C-D lanes weave at Route 17, eliminating the severe queues that extend along both the northbound I-95 mainline lanes and C-D lanes and cause severe delays on eastbound and westbound Route 3. Improvements at the Route 17 interchange and the signalized intersection of Route 17 at Sanford Drive/Gateway Drive will reduce congestion and delays along westbound Route 17. During the AM and PM peak hours, all signalized and unsignalized intersections operate with light or moderate traffic conditions under Build conditions.

### **ES.5.2 CRASH ANALYSIS FINDINGS**

I-95, Route 3, and Route 17 within the study area are characterized by recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. This congestion creates the potential for crashes, especially rear end and sideswipe crashes. A total of 2,511 crashes were reported along I-95, Route 3, Route 17, and the associated interchange ramps and minor street approaches within the study area between January 2013 and December 2017. 550 crashes (22 percent) resulted in an injury and eight (0.3%) crashes resulted in a fatality. 1,431 (57 percent) of the crashes were rear end collisions which frequently can be contributed to congested and stop-and-go conditions, 252 (10 percent) were angle crashes, 359 (14 percent) were sideswipe crashes, and 333 (13 percent) were fixed-object crashes. Calculated crash rates per 100 million vehicle miles traveled (VMT) along I-95 were compared to VDOT's annually-published 2017 average crash rates for Statewide Urban Interstates. The northbound crash rate of 115.9 is 66 percent higher than the than the average crash rate for Statewide Urban Interstates. Of the 152 total 0.10-mile segments analyzed, 99 segments (65 percent) have a total crash rate greater than the Statewide Urban Interstates average crash rate (69.9 crashes per 100 million VMT). Twelve segments (8 percent) have a total crash rate more than three times the Statewide Urban Interstates crash rate.

Overall it can be concluded that the Build Alternative should have a positive safety benefit along the northbound I-95 mainline lanes compared to existing conditions. Recurring daily congestion due to heavy commuter traffic especially during the morning peak period creates the potential for crashes along northbound I-95. The predominant crash type is rear end crashes, which account for 57 percent of all crashes and are frequently attributed to congestion. The proposed Build Alternative will increase capacity along northbound I-95 and reduce conflict points along the mainline lanes thereby reducing the potential for congestion-related crashes and improving safety along the corridor compared to No Build conditions.

A primary safety benefit of the Build Alternative compared to No Build conditions is the reduction in the number of conflict points and weaving movements along the I-95 northbound mainline lanes. With the Build Alternative, the number of conflict points along the mainline lanes is reduced from six to five conflict points compared to No Build conditions. The Build Alternative has the potential to improve safety by reducing conflicts points along the higher speed I-95 northbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions.

A quantitative crash analysis using HSM methodologies was performed to document the safety impacts associated with the proposed Build Alternative. Based on a review of available Crash Modification Factors (CMF), a reduction of 4.1 crashes per year (10 percent reduction) is predicted within the limits of the proposed northbound C-D lanes. A reduction of 1.4 crashes per year (30 percent reduction) is predicted at the Route 17 interchange. A reduction of 9.0 crashes per year (21 percent) is predicted along northbound I-95 between the northbound C-D lanes entrance along northbound I-95 and Centreport Parkway due to the addition of an auxiliary lane with the potential Bid Option A.

## **ES.6. RESPONSE TO FHWA INTERSTATE ACCESS POLICY REQUIREMENTS**

FHWA has established Eight Policy Points as defined in FHWA's *Interstate System Access Informational Guide*. On May 22, 2017 following the approval of the IJR Framework Document, FHWA published a change to their *Policy on Access to the Interstate System*. The revised policy reduces the policy points to be considered for access approvals from eight to two. Because the policy became effective immediately, this IJR addresses the two considerations and requirements defined in the May 22, 2017 memorandum.

### **ES.6.1 CONSIDERATION AND REQUIREMENT 1: OPERATIONAL AND SAFETY ANALYSIS**

*An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).*

Traffic operational analyses were performed and are documented in **Chapter 7**. The operational and safety analyses extend along I-95 from south of the Route 3 interchange to the south-facing ramps at the Centreport Parkway interchange and along Route 3 and Route 17 in the vicinity of I-95 consistent with the IMR Framework Document. The analysis includes at least one major signalized intersection along Route 17 and Route 3 on both the east and west sides of I-95.

Existing crash data was summarized and both a qualitative and quantitative safety analysis was performed to document the anticipated safety benefits of the proposed Build Alternative in **Chapter 8**.

A conceptual signing plan depicting all major guide signs was also prepared and is discussed in **Section 5.5** and is included in **Appendix D**.

## ES.6.2 CONSIDERATION AND REQUIREMENT 2: CONNECTS TO PUBLIC ROAD AND PROVIDES FOR ALL MOVEMENTS

*The proposed access connects to a public road only and will provide for all traffic movements. Less than “full interchanges” may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.*

Full interchanges accommodating all traffic movements are currently provided at both the I-95 at Route 3 and I-95 at Route 17 interchanges. The proposed improvements associated with the I-95 Rappahannock River Crossing Northbound project would not remove any movements and would provide for all traffic movements.

All elements of the project will be designed in accordance with AASHTO and VDOT standards to the extent practical. Design criteria are identified in **Section 5.1**. Two design waivers are required and are summarized in **Table ES-1**.

**Table ES-1: Summary of Design Waivers**

Design Waiver	Location	Required Value	Value Provided
Design Waiver: Reduced left and right shoulder widths <i>Required only for Base project; not required for Bid Option B</i>	Existing C-D lanes bridge over Route 17	Left: 4 ft Paved 6 ft Total  Right: 10 ft Paved 12 ft Total	Left: 4 ft Paved 4 ft Total  Right: 10 ft Paved 10 ft Total
Design Waiver: Reduced left and right shoulder width	Ramp connection from C-D lanes to Fred Ex under Truslow Road bridge	Left: 4 ft Paved 6 ft Total  Right: 8 ft Paved 10 ft Total	Left: 4 ft Paved 4 ft Total  Right: 8 ft Paved 8 ft Total

If Bid Option B – Replacement of the C-D Road Bridge Over Route 17 is incorporated into the project, the design waiver for reduced left and right shoulder widths will not be required. Safety and mitigation strategies pertaining to the usage of the design waivers are discussed in their respective reports.

## 1. INTRODUCTION

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), has initiated an Interchange Modification Report (IMR) for the I-95 Rappahannock River Crossing Northbound project in Stafford and Spotsylvania Counties and the City of Fredericksburg. The project proposes to relocate the three existing northbound mainline lanes into the median and repurpose the three existing mainline lanes as collector-distributor (C-D) lanes along northbound I-95 from north of the Route 3 (Exit 130) interchange to north of the Route 17 (Exit 133) interchange. The proposed project also includes the construction of a new parallel bridge across the Rappahannock River and improvements to the Route 17 interchange. Construction of a northbound I-95 auxiliary lane between the Route 17 and Centreport Parkway (Exit 136) interchanges will potentially be included in the project depending on funding availability.

I-95 is the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C. and serves local, commuter, and regional traffic. Within the study area, I-95 suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. The peak period congestion is caused by a combination of through traffic along I-95 and traffic utilizing the Route 17 and Route 3 interchanges including a large portion of the traffic traveling along I-95 between Route 17 and Route 3. The existing I-95 facility within the study limits includes three northbound and three southbound travel lanes with an existing C-D road at the Route 17 interchange.

The George Washington Region includes the four counties of Stafford, Spotsylvania, King George, and Caroline and the City of Fredericksburg. Since 1980, the George Washington Region has been the fastest growing planning district commission in Virginia with a growth of 545 percent over the past 60 years with the largest portion of recent growth occurring in Stafford and Spotsylvania Counties. The population in the region is forecasted to double by 2045 from the 350,516 in 2015. This continued growth in population and resulting traffic volume growth will result in a further degradation of traffic operating conditions and increase both the severity and duration of daily congestion.

### 1.1 BACKGROUND

On July 6, 2016, FHWA approved the Interchange Modification Report (IMR) for Improvements to I-95 from Exit 133 to Exit 130 (herein referred to as April 2016 IMR). The proposed access modifications to I-95 from Exit 133 to Exit 130 included in the April 2016 IMR were the result of many years of planning by Fredericksburg Area Metropolitan Planning Organization (FAMPO) and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along I-95 between the Route 17 and Route 3 interchanges. The preferred alternative approved in the IMR included the following major components:

- Two-lane collector-distributor (C-D) roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes

- A flyover connection from the northbound I-95 C-D road to northbound Route 17
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

As documented in the April 2016 IMR, the proposed project would be implemented in different phases due to funding constraints.

- **I-95 Safety Improvements at Route 3 (Exit 130):** The first phase of work was the I-95 Safety Improvements at Route 3 (Exit 130) project which was completed in January 2019. Details of this project are discussed in more detail in **Section 4.2.2**.
- **I-95 Rappahannock River Crossing Southbound Project:** Funding for improvements along southbound I-95 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River was secured through the Smart Scale program and was included in the fiscal year (FY) 2017-2022 Six-Year Improvement Program (SYIP). During the Design-Build procurement process for this phase of the project, VDOT decided to reevaluate the configuration of the southbound C-D lanes contained in the April 2016 IMR to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along the southbound I-95 mainline lanes. As a result, the project design was modified and documented in the Interchange Modification Report Supplement to support the Rappahannock River Crossing Southbound Project (dated September 2017). This project is currently under construction and is discussed in more detail in **Section 4.2.3**.
- **I-95 Rappahannock River Crossing Northbound Project:** Improvements along northbound I-95 including the construction of the northbound C-D lanes and associated improvements at the Route 17 interchange will be the last phase of improvements and are the subject of this IMR. Similar to the I-95 Rappahannock River Crossing Southbound project, VDOT has decided to reevaluate the configuration of the northbound C-D lanes project as discussed in **Section 4.4**.

In accordance with the FHWA approval letter for the April 2016 IMR which states that the “IMR will have to be reevaluated if modifications are made to the “accepted” concept detailed on page ES-3 of the document,” this IMR has been prepared to document modifications to the proposed northbound C-D lanes and Route 17 interchange referred to as the I-95 Rappahannock River Crossing Northbound project.

## 1.2 RELATIONSHIP TO OTHER HIGHWAY IMPROVEMENT PLANS/PROGRAMS

The proposed improvements along I-95 overlap with or are located adjacent to several recently completed improvements and planned improvements.

### 1.2.1 Fall Hill Avenue

The Fall Hill Avenue project was completed in April 2017 and included the widening of Fall Hill Avenue from two to four lanes and an extension of Mary Washington Boulevard. As part of the project, the Fall Hill Avenue bridge over I-95 was widened to four lanes to provide room for the future northbound and southbound I-95 C-D lanes.

### 1.2.2 I-95 Safety Improvements at Route 3 (Exit 130)

This project was the first phase of improvements to I-95 between Exit 133 and 130. Construction was completed in January 2019. The I-95 Safety Improvements at Route 3 enhanced safety by reducing conflict points and weaving at the I-95 and Route 3 interchange and is discussed in more detail in **Section 4.2.2**.

### 1.2.3 I-95 Rappahannock River Crossing Southbound

This project is the second phase of the improvements to I-95 between Exit 133 and 130 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River. Construction of the project began in August 2018 and is scheduled to be completed in 2022. Details of this project are discussed in more detail in **Section 4.2.3**.

### 1.2.4 I-95 Express Lanes Extension to Fredericksburg (Fred Ex)

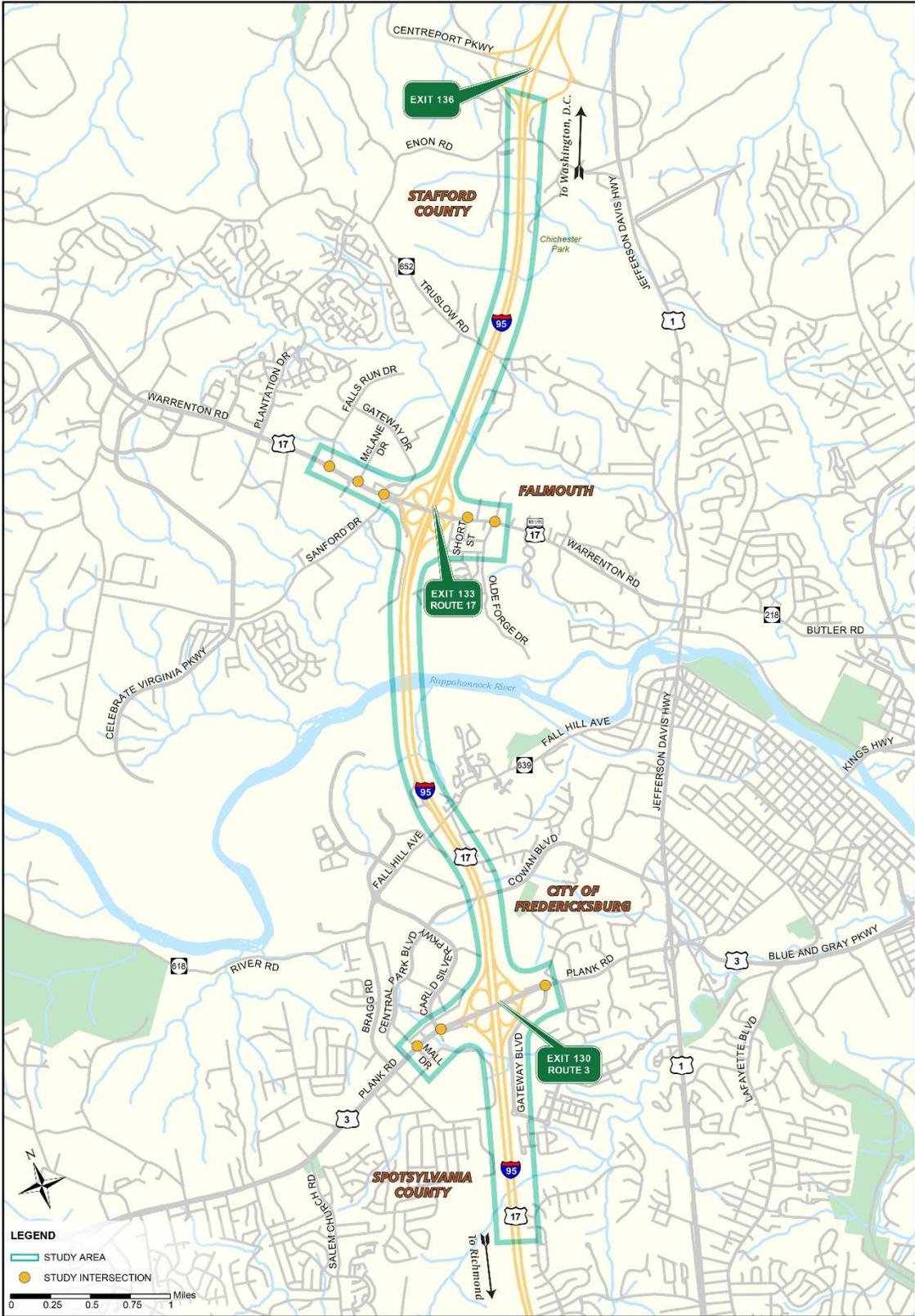
The I-95 Express Lanes Extension to Fredericksburg (Fred Ex) contract was awarded for construction in spring 2019 and includes the construction of two new reversible HOV/HOT lanes (Express Lanes) along a 10-mile segment within the median of I-95 between the Route 610/Garrisonville Road interchange (Exit 143) and the Route 17 interchange. The Express Lanes conceptual design was developed to include connections to both the northbound and southbound I-95 C-D lanes between Exit 130 and Exit 133. An Interchange Justification Report was approved for the Fred Ex project in March 2018. The current project schedule shows construction beginning in 2019 and completion in 2022. It is expected that the Fred Ex lanes will open to traffic prior to the completion of the I-95 Rappahannock River Crossing Northbound project.

## 1.3 STUDY AREA / PROJECT LOCATION

The project area is located within Stafford and Spotsylvania Counties and the City of Fredericksburg. **Figure 1-1** depicts the IMR study area which was established to include the influence area of the proposed improvements along I-95 and the proposed interchange improvements at Route 17 and Route 3. The southern limit of the study area extends along I-95 approximately 3.6 miles south of Route 3. The northern limit of the study area along I-95 extends north of the Route 17 interchange to the south-facing ramps at the Centreport Parkway interchange. Along Route 3, the study limits extend from west of the Central Park Boulevard/Mall Drive intersection to east of the Gateway Boulevard/Ramseur Street intersection. Along Route 17/ Route 17 Business, the study limits extend from west of Falls Run Drive to east of Olde Forge Drive. The following summarizes the study intersections as depicted in **Figure 1-1**:

- Route 3 and Central Park Boulevard/Mall Drive
- Route 3 and Carl D. Silver Parkway
- Route 3 at SB I-95 Off-Ramp (implemented as part of the I-95 Safety Improvements at Route 3)
- Route 3 at NB I-95 On-Ramp (implemented as part of the I-95 Safety Improvements at Route 3)
- Route 3 and Gateway Boulevard/Ramseur Street
- Route 17 and Falls Run Drive
- Route 17 and McLane Drive
- Route 17 and Sanford Drive/ Gateway Drive
- Route 17 Business and Short Street (signal to be removed)
- Route 17 Business at Olde Forge Drive (future signal)

Figure 1-1: Study Area



## 1.4 PURPOSE AND NEED

The purpose of the project is to:

- advance the recommendations, objectives, and policy identified in the Fredericksburg Area Master Planning Organization (FAMPO) Long Range Transportation Plan;
- address recurring congestion and safety deficiencies associated with peak period travel along the northbound I-95 mainline travel lanes;
- provide additional traffic capacity for travel between Route 3 and Route 17 along northbound I-95; and
- provide additional northbound I-95 traffic capacity over the Rappahannock River to allow for needed redundancy and flexibility during incidents, required maintenance, and bridge rehabilitation activities.

## 1.5 CONSISTENCY WITH REGIONAL PLANS AND COORDINATION WITH LOCALITIES

The I-95 Northbound Rappahannock River Crossing project is included in the Fredericksburg Area Metropolitan Planning Organization (FAMPO) 2045 Long Range Transportation Plan (LRTP), adopted April 16, 2018. The Rappahannock River Crossing Project is included in the FY 2018 – FY 2021 Statewide Transportation Improvement Program (STIP) and FAMPO’s FY 2015 – FY 2018 Transportation Improvement Program (TIP). VDOT has been coordinating with FAMPO, the City of Fredericksburg, and Stafford and Spotsylvania Counties throughout the project development process for improvements to the I-95 corridor including changes to the northbound phase of the project. A Citizen Information Meeting was held on January 30, 2019 to present the proposed improvements along northbound I-95 to the public. A Public Hearing was held on August 22, 2019.

**Table 1-1: Summary of Public Engagement**

Meeting	Location	Date
Citizen Information Meeting	James Monroe High School Fredericksburg, VA	January 30, 2019
Public Hearing	James Monroe High School Fredericksburg, VA	August 22, 2019

## 2. METHODOLOGY

The IMR was developed following both federal and VDOT guidance contained in the documents listed below:

- Interstate, NHS Non-Interstate and Non-NHS (IJR / IMR Guidance) - VDOT Instructional and Informational Memorandum - IIM-LD-200.9 (January 2017)
- VDOT Traffic Operations and Safety Analysis Manual (TOSAM) - Version 1.0 (November 2015)
- FHWA Interstate System Access Informational Guide (August 2010)
- FHWA (Virginia Division) Standard Operating Procedure for New or Revised Interstate Access Points (September 2010)
- FHWA Interstate Access Policy (August 2009) and FHWA Interstate Access Policy Update (May 22, 2017)

The IMR Framework Document (see **Appendix A**) outlines the scope of work of the IMR including the study area, the traffic forecasting and analysis methodology, and study assumptions. The Framework Document also outlines the FHWA policy points to be utilized and level of detail for each point.

On May 22, 2017, FHWA published a change to their Policy on Access to the Interstate System. The revised policy reduces the policy points to be considered for access approvals from eight to two. These changes were made to streamline the approval process and eliminate duplication of efforts with other project reviews including the NEPA review process. Because the policy became effective on its publication date of May 22, 2017, this IJR addresses the two considerations and requirements defined in the memorandum as follows:

- Consideration and Requirement 1: Operational and safety analysis
- Consideration and Requirement 2: Connects to a public road and provides for all movements

The following summarizes the traffic forecasting methodology, the traffic operations methodology, and the safety analysis methodology as outlined in the IMR Framework Document.

### 2.1 TRAFFIC DATA COLLECTION

Traffic volume data collected for the Fred Ex IJR was used to establish baseline traffic conditions. An extensive data collection effort was undertaken in September, November, and December 2016 including automatic ramp counts, intersection turning movement counts, and VDOT's permanent count stations. Ramp counts were conducted for a minimum of 48 consecutive hours on non-holiday Tuesdays, Wednesdays, and Thursdays during typical school and non-holiday periods. Turning movement counts were also conducted on a typical, non-holiday Tuesday, Wednesday, or Thursday when schools were in session for a twelve-hour period. In addition to the data collected as part of the Fred Ex IJR, VDOT provided turning movement counts at the intersections of Route 17 at Falls Run Drive, Route 17 at McLane Drive, and Route 3 at Central Park Boulevard, which were not previously included in the Fred Ex IJR. Traffic data at Route 17 Business and Olde Forge Drive was obtained from the Route 3 and Route 17 Business Corridor STARS Study. Existing traffic data is included in **Appendix B. Table 2-1** includes location descriptions and sources of counts on the I-95 mainline and ramps and **Table 2-2** includes

intersection turning movement count locations and sources. For the purposes of this study, Route 17 is referred to in east-west directions although it is signed as a north-south route.

**Table 2-1: Mainline and Ramp Count Locations**

Exit	From	To	Source
NB I-95 Mainline	Route 17	Centreport Parkway	Fred Ex IJR
SB I-95 Mainline	Centreport Parkway	Route 17	Fred Ex IJR
130	SB I-95	WB Route 3	Fred Ex IJR
130	SB I-95	EB Route 3	Fred Ex IJR
130	WB Route 3	SB I-95	Fred Ex IJR
130	EB Route 3	SB I-95	Fred Ex IJR
130	NB I-95	WB Route 3	Fred Ex IJR
130	NB I-95	EB Route 3	Fred Ex IJR
130	WB Route 3	NB I-95	Fred Ex IJR
130	EB Route 3	NB I-95	Fred Ex IJR
133	SB I-95	NB Route 17	Fred Ex IJR
133	SB I-95	SB Bus Route 17	Fred Ex IJR
133	SB Route 17	SB I-95	Fred Ex IJR
133	NB Bus Route 17	SB I-95	Fred Ex IJR
133	NB I-95	SB Bus Route 17	Fred Ex IJR
133	NB I-95	NB Route 17	Fred Ex IJR
133	SB Route 17	NB I-95	Fred Ex IJR
133	NB Bus Route 17	NB I-95	Fred Ex IJR
136	NB I-95	Centreport Pkwy	Fred Ex IJR
136	Centreport Pkwy	SB I-95	Fred Ex IJR

**Table 2-2: Intersection Turning Movement Count Locations**

Mainline Roadway	Intersecting Roadway	Source
Route 3	Central Park Boulevard/Mall Drive	VDOT
Route 3	Carl D Silver Parkway	Fred Ex IJR
Route 3	Gateway Boulevard/Ramseur Street	Fred Ex IJR
Route 17	Falls Run Drive	VDOT
Route 17	McLane Drive	VDOT
Route 17	Sanford Drive/Gateway Drive	Fred Ex IJR
Route 17 Business	Short Street	Fred Ex IJR
Route 17 Business	Route 17 at Olde Forge Drive	VDOT STARS Study

## 2.2 DEVELOPMENT OF BALANCED EXISTING TRAFFIC VOLUMES

The balanced existing traffic volumes developed for the Fred Ex IJR were used as the basis for the existing traffic volumes. Given the existing duration of at-capacity conditions along I-95, multiple hours during the AM and PM peak periods were evaluated. Consistent with the Fred Ex IJR, the AM peak period was determined to be a three-hour period from 6:00 AM to 9:00 AM and the PM peak period was determined to be a four-hour period from 3:00 PM to 7:00 PM with the peak hours as 7:00 AM to 8:00 AM and 5:00 PM to 6:00 PM. Existing (2016) peak hour and daily traffic volumes are included in **Chapter 6**.

Heavy vehicle percentages were reviewed along the corridor and minimal variation was found within each hour within the peak periods. Therefore, a peak period heavy vehicle percentage was selected for each direction of northbound and southbound I-95 for both the AM and PM peak periods and applied to each hour of the analysis period.

## 2.3 TRAFFIC FORECASTS AND ANALYSIS YEARS

### 2.3.1 Forecast Years

Forecasts were developed for the following scenarios:

- Existing conditions (2016)
- Opening year (2022)
  - No Build Conditions (see **Section 4.2** for included projects)
  - Build Alternative (including the No Build projects plus the proposed improvements associated with the I-95 Rappahannock River Crossing Northbound project)
- Design year (2042)
  - No Build Conditions (see **Section 4.2** for included projects)
  - Build Alternative (including the No Build projects plus the proposed improvements associated with the I-95 Rappahannock River Crossing Northbound project)

### 2.3.2 Traffic Forecasting Methodology

The travel demand forecasts were based on the approved forecasts prepared for the Fred Ex IJR and reassigned to the roadway network to establish future year No Build and Build conditions. Travel demand forecasts for the opening year and design year and for both No Build and Build conditions were based on the latest adopted regional Travel Demand Forecast Model maintained by the Metropolitan Washington Council of Governments [Version 2.3.57a Travel Demand Model (MWCOG Model) with Round 8.4 Cooperative Land Use Forecasts] that was approved by MWCOG on October 11, 2016. A detailed summary of the forecasting methodology is summarized in Chapter 2 of the Fred Ex IJR and can be accessed here: [http://www.virginiadot.org/projects/resources/Fredericksburg/Fred\\_Ex\\_Final\\_IJR\\_Report.pdf](http://www.virginiadot.org/projects/resources/Fredericksburg/Fred_Ex_Final_IJR_Report.pdf) (accessed 5/20/2019).

Traffic forecasts for the intersections of Route 17 at McLane Drive, Route 17 at Falls Run Drive, and Route 3 at Central Park Boulevard, which were not included in the Fred Ex study area, were prepared based on model growth rates provided by the Fred Ex Study Team from the approved travel demand model. Forecasts for the Route 17 Business at Olde Forge Drive intersection were based on forecasts contained in the Route 3 and Route 17 Business Corridor STARS Study.

Opening year (2022) and design year (2042) No Build and Build peak hour and daily traffic volumes are included in **Chapter 6**.

## **2.4 TRAFFIC OPERATIONS ANALYSIS METHODOLOGY**

### **2.4.1 Analysis Tools**

VDOT's TOSAM includes a *Software Selection Tool (SST)* used to select the most appropriate traffic analysis tool for any given analytical scenario. The Software Selection Tool was used to select the most appropriate tool for this study. VISSIM was determined to be the preferred tool to analyze the oversaturated I-95 transportation network which is also consistent with the analysis performed for the Fred Ex IJR. VISSIM Version 8, Build 15 was used for the evaluation of traffic operations.

Synchro Version 8 was used as the basis for signal timing inputs into the VISSIM models, but was not used to report measures of effectiveness for intersections. Existing signal timing data and existing Synchro networks for the study area were provided by VDOT and the City of Fredericksburg.

### **2.4.2 VISSIM Model Extents**

The calibrated base year VISSIM model prepared for the Fred Ex IJR was used for the I-95 Rappahannock River Crossing Northbound project due to the overlapping study limits. The Fred Ex model was expanded to include the intersections of Route 3 at Central Park Boulevard, Route 17 at Falls Run Drive, Route 17 at McLane Drive, and Route 17 Business at Olde Forge Drive. The VISSIM model prepared for the Fred Ex IJR extends to milepoint 162 (approximately 36 miles north of the study area). As such, the VISSIM model for the I-95 Rappahannock River Crossing Northbound project was established to extend north of the Centreport Parkway interchange (Exit 136) to assist with replicating northbound I-95 congestion downstream of the study area during the AM peak period.

### **2.4.3 Analysis Periods**

The AM and PM peak periods were evaluated consistent with the Fred Ex IJR. Microsimulation analysis was conducted for multiple hours during each of these peak periods (6:00 AM – 9:00 AM and 3:00 PM – 7:00 PM) as these periods represent the periods of peak congestion along the corridor. For the AM peak period, a two-hour seeding period from 4:00 AM – 6:00 AM was utilized; this was followed by the three-hour analysis period from 6:00 AM – 9:00 AM. For the PM peak period, a one-hour seeding period from 2:00 PM – 3:00 PM was utilized and this was followed by a four-hour analysis period from 3:00 PM – 7:00 PM. Consistent with the Fred Ex IJR, the summer weekend peak period was not analyzed; however, this period will be analyzed as part of the I-95 Corridor Improvement Plan to address weekend congestion along I-95 through Fredericksburg.

### **2.4.4 VISSIM Model Number of Runs**

Consistent with the Fred Ex IJR, which documented the appropriate number of simulation runs at a 95<sup>th</sup> confidence level with a 10% tolerance, 10 model runs were performed for both the AM and PM peak periods. This was based on a review of corridor travel times, corridor average speeds, and throughput along northbound I-95 south of Centreport Parkway during the AM peak hour and along southbound I-95 north of Route 17 during the PM peak hour.

## 2.4.5 VISSIM Model Calibration and Validation

Default parameters remained consistent with the Fred Ex VISSIM models. The Wiedemann 99 car following model was used for the I-95 mainline and ramps while the Wiedemann 74 car following model was used along arterials. Driver behavior parameters modified as part of the Fred Ex calibration were not removed due to the need for more aggressive or passive behaviors throughout the corridor. Desired speed distributions also remained consistent with the Fred Ex VISSIM models. The Fred Ex IJR Existing Conditions VISSIM Model Calibration memo is included in **Appendix C**.

At the expanded study intersections along Route 3, Route 17 and Route 17 Business, the VISSIM model was calibrated consistent with the approved Fred Ex IJR calibration thresholds to ensure the simulated traffic volumes are within allowable tolerances. Model calibration thresholds used to calibrate the expanded study intersections are shown in **Table 2-3**.

**Table 2-3: VISSIM Model Calibration Criteria for Intersections<sup>1</sup>**

Simulated Measure	Calibration Thresholds
Simulated Traffic Volume (vph) for the top 85% of the network intersection movements	Overall Simulation Period (by movement): Within $\pm 20\%$ for $<1,000$ vph Within $\pm 10\%$ for $\geq 1,000$ vph  Peak Hour (by movement) Within $\pm 20\%$ for $<1,000$ vph Within $\pm 10\%$ for $\geq 1,000$ vph

<sup>1</sup> Calibration thresholds are consistent with those approved for the Fred Ex IJR

The traffic calibration results of the top 85 percent of turning movements throughout the entire study area for both the AM and PM peak hours are shown in **Table 2-4** for each of the simulated traffic volume calibration thresholds. During the AM and PM peak hours as well as overall peak periods, 100 percent of the corridor intersection turning movements with volumes greater than 1,000 vehicles are within the calibration thresholds. Of the turning movements with volumes less than 1,000 vehicles, 98 percent of the movements meet calibration thresholds during the AM overall peak period, 95 percent of the movements meet calibration thresholds during the AM peak hour, 100 percent of the movements meet calibration thresholds during the PM overall peak period, and 98 percent of the movements meet calibration thresholds during the PM peak hour. Overall, calibration thresholds are met for 99 percent and 100 percent of the movements during the AM and PM peak periods, respectively, while 96 percent and 99 percent of the movements meet calibration thresholds during the AM and PM peak hours, respectively. A detailed summary of the calibration results for all intersection turning movements within the study area is contained in **Appendix C**.

**Table 2-4: Intersection Movement Volume Calibration Summary**

	AM		PM	
	Overall	Peak Hour	Overall	Peak Hour
Within 10% Volume >1,000	100% (17 Movements)	100% (16 Movements)	100% (28 Movements)	100% (16 Movements)
Within 20% Volume <1,000	98% (59 Movements)	95% (60 Movements)	100% (48 Movements)	98% (60 Movements)
Overall Summary	99% (76 Movements)	96% (76 Movements)	100% (76 Movements)	99% (76 Movements)

In addition to the expansion of the model to include the additional study intersections along Route 3, Route 17, and Route 17 Business, a reduced speed area was coded in the microsimulation model along northbound I-95 approximately 3.8 miles north of Centreport Parkway. The reduced speed area was consistent with travel speed outputs from the Fred Ex IJR microsimulation model in order to replicate the future congestion which occurs north of the study area and extends upstream of the Centreport Parkway interchange and into the Route 17 interchange area. Based on a review of the Fred Ex IJR model results, the reduced speed areas were only required in the 2042 design year models during the AM peak period. **Appendix C** contains documentation and a comparison of the travel speeds and volume throughput results from the Fred Ex IJR and the I-95 Rappahannock River Crossing Northbound VISSIM model.

#### 2.4.6 Development of Future Year Models

The base year calibrated VISSIM models were modified to reflect the committed No Build project (see **Section 4.2**) and future year forecasts to generate the 2022 and 2042 No Build VISSIM models. The future No Build VISSIM models were then modified to incorporate the Build Alternative and generate the future 2022 and 2042 Build models.

In order to effectively test and compare alternatives for the I-95 Rappahannock River Crossing Northbound project including interchange improvement options at Route 17, uncongested conditions along northbound I-95 north of the study area are required in order to provide a meaningful comparison of traffic operations. However, even with improvements to the north of the study area associated with Fred Ex and other No Build projects, northbound congestion to the north of the study area in the 2042 design year AM peak hour is anticipated to spill back into the I-95 Rappahannock River Crossing Northbound project limits. To address this constraint, the demand for northbound I-95 Express Lanes was increased in the 2042 design year during the AM peak period by shifting traffic from the mainline lanes into the Express Lanes. The shift of vehicles from the northbound I-95 mainline lanes to Express Lanes maintains the calibration parameters of approved Fred Ex IJR model and anticipated capacity constraints along northbound I-95 mainline lanes while relieving congestion just north of Route 17 and balances traffic volumes between the mainline and Express Lanes. It is anticipated that the shifting of vehicles between the mainline lanes and Express Lanes will occur as a result of congestion pricing in response to traffic volumes fluctuations and congestion during peak periods. A summary of the traffic volume reassignments and a discussion of the methodology and approach to maintaining uncongested conditions along northbound I-95 in the vicinity of the Route 17 interchange is presented in **Appendix C**.

### 2.4.7 Measures of Effectiveness

Measures of effectiveness (MOEs) from the VISSIM outputs were used to document operations for existing conditions, no build conditions (2022 and 2042), and build conditions (2022 and 2042). The following is a summary of the MOEs documented for each scenario.

- All movements
  - Volume input versus volume throughput to establish unmet demand (vehicles)
- I-95 Freeway Mainline Segments
  - Corridor and segment travel time (min)
  - Average travel speed (mph) by segment and overall corridor
  - Average density (veh/lane/mile)
- I-95 Freeway Ramp Merge, Diverge, and Weave Segments
  - Average travel speed (mph)
  - Average density (veh/lane/mile)
- Ramp Terminals/Arterial Intersections
  - Average Delay (sec/veh) for overall intersection, approach, and movement
  - Maximum queue length (feet) by lane group
  - Average queue length (feet) by lane group

Operational conditions for the I-95 freeway facility and arterial intersections were color-coded to reflect various congestion levels based on density and delay thresholds established in the Highway Capacity Manual. **Tables 2-5 and 2-6** summarize the thresholds for freeway segments, signalized intersections, and unsignalized intersections. In accordance with the TOSAM, level of service (LOS) was not used as a measure of effectiveness.

**Table 2-5: Freeway Measures of Effectiveness**

Congestion Level	Freeways	Weaves / Ramps
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28
Moderate Traffic	>26 - 35	>28 - 35
Heavy Congestion	>35 - 45	>35 - 45
Severe Congestion	>45	>45

Source: VDOT TOSAM – Version 1.0 (page F-31)

**Table 2-6: Intersection Measures of Effectiveness**

Congestion Level	Intersections	
	Signalized	Unsignalized
	Average Delay (sec/veh)	Average Delay (sec/veh)
Light Traffic	≤ 35	≤ 25
Moderate Traffic	>35 - 55	>25 - 35
Heavy Congestion	>55 - 80	>35 - 50
Severe Congestion	>80	>50

## 2.5 SAFETY ANALYSIS METHODOLOGY

Crash data within the study area was reviewed for a five-year period from January 1, 2013 through December 31, 2017. Crash data was obtained from the VDOT Tableau-Crash Analysis Tool (T-CAT). Using the latitude and longitude information from each crash, the crash data was converted to a shapefile to geospatially depict the location of each crash.

Crash data was summarized in both tabular format and on maps depicting crash characteristics including crash type and crash severity. High crash locations were identified based on both crash frequency and crash rate. The crash rates along northbound and southbound I-95 were compared to statewide and regional crash rates. Based on a review of the crash data frequency and rates, a qualitative assessment was performed to document the safety impacts of the Build Alternative. The quantitative safety analysis focused on the review of available crash modification factors (CMFs) and their application to the proposed Build Alternative. In addition to a review of CMFs, a comparison of conflict points along the northbound I-95 mainline and C-D lanes was also performed to compare No Build conditions to the Build Alternative.

## 3. EXISTING CONDITIONS

### 3.1 EXISTING ROADWAY NETWORK

#### 3.1.1 I-95 Corridor

I-95 within the study limits includes three northbound and three southbound travel lanes and serves as a critical highway for commuters, interstate and intrastate freight movements, national defense, and commercial activities. I-95 is collocated with Route 17 from south of the study area at the Exit 126 (Route 17/Route 1) interchange to the Exit 133 (Route 17/Route 17 Business) interchange. Along northbound I-95, a collector-distributor (C-D) roadway is provided for movements to and from the Route 17 interchange extending from approximately 0.5 miles south of Route 17 to 0.7 miles north of Route 17. The posted speed limit along northbound and southbound I-95 is 65 MPH.

#### 3.1.2 Arterial Roadways

**Route 3/Plank Road:** Route 3 is functionally classified as a Principal Arterial. Within the limits of the study area, Route 3 generally has three eastbound and westbound travel lanes with auxiliary lanes at signalized intersections. West of I-95, Route 3 has four westbound travel lanes between Carl D. Silver Parkway and Central Park Boulevard/Mall Drive. The posted speed limit along Route 3 is 45 MPH for both the eastbound and westbound directions. East of Gateway Boulevard, the posted speed limit is 35 MPH for both eastbound and westbound directions.

**US Route 17/US Route 17 Business/Warrenton Road:** Route 17/Route 17 Business is functionally classified as an Other Principal Arterial. Within the limits of the study area, eastbound Route 17 has three travel lanes with the rightmost lane dropping onto the ramp to southbound I-95 and two eastbound lanes plus auxiliary lanes continuing through the I-95 interchange and through the Short Street signalized intersection. Along westbound Route 17, there are two travel lanes at the Short Street intersection transitioning to three lanes plus auxiliary lanes through the I-95 interchange and to the western study limits. The posted speed limit along Route 17/Route 17 Business is 45 MPH for both the eastbound and westbound directions.

#### 3.1.3 I-95 Interchanges

Within the study area, there are three grade-separated interchanges that provide direct access to I-95:

**I-95 at Route 3/Plank Road (Exit 130):** The Route 3 interchange was previously a cloverleaf interchange and for the purposes of the existing conditions traffic analysis, the interchange is assumed to operate with a cloverleaf configuration consistent with the time period when traffic data was collected. However, recent improvements were implemented at the interchange as part of the I-95 Safety Improvements at Route 3 project as discussed in **Section 4.2.2**.

**I-95 at Route 17/Warrenton Road (Exit 133):** The Route 17 interchange is a cloverleaf interchange with a collector-distributor roadway along northbound I-95 serving the Route 17 interchange ramps.

**I-95 at Route 8900/Centreport Parkway (Exit 136):** The Centreport Parkway interchange is a diamond interchange with signalized intersections serving the ramp junctions along Centreport Parkway.

### 3.1.4 Signalized Intersections

The following is a description of the intersections located within the study area:

**Route 3 at Central Park Boulevard/Mall Drive:** This signalized intersection is located 0.5 miles west of I-95. Eastbound Route 3 has two left-turn lanes, three through lanes, and a channelized right-turn lane. Westbound Route 3 has two left-turn lanes, three through lanes and a shared through/right-turn lane. Northbound Mall Drive and southbound Central Park Boulevard have a left-turn lane, a shared left-turn lane/through lane, a through lane, and a right-turn lane (the northbound right-turn lane is channelized). Eastbound and westbound Route 3 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with split phasing. The southbound right-turn lane also operates with a right-turn overlap.

**Route 3 at Carl D. Silver Parkway:** This signalized intersection is located 0.4 miles west of I-95. Eastbound Route 3 has two left-turn lanes, four through lanes, and a channelized free right-turn lane. Westbound Route 3 has one left-turn lane, four through lanes and two channelized right-turn lanes under signalization. Northbound Carl D. Silver Parkway has a shared left-turn lane/through lane and a right-turn lane. Southbound Carl D. Silver Parkway has two left-turn lanes, a shared left-turn lane/through lane, and a channelized right-turn lane under stop control. Eastbound and westbound Route 3 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with split phasing.

**Route 3 at Gateway Boulevard/ Ramseur Street:** This signalized intersection is located 0.3 miles east of I-95. Eastbound Route 3 has a left-turn lane, three through lanes, and a right-turn lane that is an auxiliary lane from the ramp from northbound I-95. Westbound Route 3 has two left-turn lanes, three through lanes and a right-turn lane. Northbound Gateway Boulevard has a left-turn lane, a shared left-turn/through lane, and a right-turn lane. Southbound Ramseur Street has a single shared lane. Eastbound and westbound Route 3 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with split phasing.

**Route 17 at Falls Run Drive:** This signalized intersection is located 0.7 miles west of I-95. Eastbound Route 17 has a left-turn lane, three through lanes, and a right-turn lane. Westbound Route 17 has two left-turn lanes, three through lanes and a right-turn lane. The northbound approach that serves the Park and Ride lot has a shared left-turn/through lane and two right-turn lanes. The southbound approach includes a left-turn lane, a shared left-turn /through lane, and a right-turn lane. Eastbound and westbound Route 17 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with split phasing. Right turns on red are permitted from the rightmost northbound right-turn lane from the Park and Ride lot.

**Route 17 at McLane Drive:** This signalized intersection is located 0.5 miles west of I-95. Eastbound and westbound Route 17 both have a left-turn lane, three through lanes, and a right-turn lane. The northbound and southbound approaches both have a single shared lane. Eastbound and westbound Route 17 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with concurrent phasing.

**Route 17 at Sanford Drive/Gateway Drive:** This signalized intersection is located 0.3 miles west of I-95. Eastbound Route 17 has a left-turn lane, three through lanes, and a right-turn lane. Westbound Route 17 has a left-turn lane, four through lanes and a right-turn lane. Northbound Sanford Drive has a shared left-

turn/through lane and two right-turn lanes. Southbound Gateway Drive has two left-turn lanes, a shared left-turn/through lane, and a right-turn lane. Eastbound and westbound Route 17 operate with protected-only left-turn phasing and the northbound and southbound approaches operate with split phasing. The northbound Sanford Drive right-turn lane operates with a right-turn overlap.

**Route 17 Business at Short Street:** This signalized intersection is located 0.25 miles east of I-95. Eastbound Route 17 Business has a shared left-turn/through lane, a through lane, and a right-turn lane that is an auxiliary lane from the ramp from northbound I-95. Westbound Route 17 Business has a left-turn lane, a through lane and a shared through/right-turn lane. The northbound approach has a shared left-turn/through lane and a right-turn lane. The southbound approach has a single shared lane. Westbound Route 17 Business operates with protected-permissive left-turn phasing and the northbound and southbound approaches operate with split phasing.

**Route 17 Business at Olde Forge Drive:** This intersection is located 0.4 miles east of I-95 and is currently unsignalized, but is planned to be signalized when the traffic signal at Route 17 at Short Street is removed. The intersection is currently a three-legged unsignalized intersection with the northbound approach operating under stop control. The eastbound Route 17 Business approach includes a two-way left-turn lane, a through lane, and a shared through/right-turn lane. The westbound Route 17 Business approach includes a two-way left-turn lane and two through lanes. The northbound Olde Forge Drive approach includes a single shared lane.

## 3.2 ALTERNATIVE TRAVEL MODES

The I-95 corridor is a heavily traveled commuter route with a high percentage of passenger car usage; however, the study area also includes other travel modes as discussed below.:

### 3.2.1 Transit Service

Public transportation in the region is provided by Fredericksburg Regional Transit (FRED). FRED serves Spotsylvania, and Stafford Counties, as well as the City of Fredericksburg and Mary Washington University. FRED operates a total of 21 local fixed bus routes, including shuttle service to the Fredericksburg and Spotsylvania County VRE stations. Service is provided from 4:30 AM to 8:30 PM, Monday through Friday.

Commuter rail service within the Fredericksburg Region is provided by VRE. The Fredericksburg Line includes two stations in close proximity to the study area including the Spotsylvania Station and the Fredericksburg Station. During the morning, only northbound service is provided, with a total of eight trains departing. During the afternoon and evening, only southbound service is provided, with eight trains arriving in the region.

Commuter bus service is provided within the Study Area by MARTZ Group, a private transit provider. Commuter bus service is provided from Fredericksburg and Stafford to Crystal City, the Pentagon, and Washington, D.C. Service is provided from the park and ride located at Route 17 and Falls Run Drive within the study area and at Route 3 and Salem Church Road located just west of the study area.

### 3.2.2 Passenger Rail Service

Intercity passenger rail service in the Fredericksburg region is provided by the National Railroad Passenger Corporation (Amtrak). Amtrak operates three routes with service to the Fredericksburg station (FBG): Northeast Regional, Carolinian/Piedmont, and Silver Service / Palmetto. The Northeast Regional route provides service north to Washington, D.C., New York City, and Boston, Massachusetts, and south to Richmond, Newport News, and Norfolk, Virginia. Weekday service on the Northeast Regional route includes seven southbound trains and five northbound trains.

### 3.2.3 Park and Ride Services and Ridesharing

Carpooling and ridesharing is an important component of the transportation system in Fredericksburg. There are publicly owned and maintained park-and-ride facilities throughout the Fredericksburg Region including several that provide access to roadways within the study area. **Table 3-1** summarizes the four park-and-ride facilities located in close proximity to the Route 3 and Route 17 corridors. GWRideConnect provides free ridesharing services for commuters within the Fredericksburg region and between the Fredericksburg region and major employment centers in Washington, D.C., Northern Virginia, Richmond, and Dahlgren. With the future extension of the Express Lanes to Route 17 (Fred Ex), demand for additional park and ride facilities will increase.

**Table 3-1: Park and Ride Facilities**

Name	Location	Jurisdiction	Capacity	Transit Service
Old Salem Church	Route 3 at Salem Church Road	Spotsylvania County	672	FRED/MARTZ
Route 3 West/Gordon Road	Route 3 at Gordon Road	Spotsylvania County	1,044	FRED
Fredericksburg VRE Commuter Lot	Fredericksburg VRE Station	City of Fredericksburg	631	FRED/VRE/Amtrak
Falls Run Drive	Route 17 at Falls Run Drive	Stafford County	1,024	FRED/MARTZ

### 3.2.4 Pedestrian and Bicycle Accommodations

There are no bicycle or pedestrian facilities along the I-95 corridor or along the Route 3 and Route 17 corridors with the exception of sections of sidewalk along the north and south sides of Route 17 west of Sanford Drive/Gateway Drive and along the south side of Route 17 between Short Street and Olde Forge Drive. No bicycle or pedestrian facilities are provided in the immediate vicinity of the interchanges serving I-95.

## 3.3 EXISTING TRAFFIC VOLUMES

Detailed information on existing traffic volumes is included in **Chapter 6**.

## 3.4 OPERATIONAL PERFORMANCE

### 3.4.1 Speeds

INRIX® speed data was obtained from the Regional Integrated Transportation Information System (RITIS) database for the I-95 corridor. RITIS provides mean speed data for individual roadway segments established by INRIX® (generally between ramp terminals). Speed data was obtained in 15-minute intervals for weekdays (Tuesdays, Wednesdays and Thursdays) during September and October 2016 (excluding holidays) and averaged. Mean speeds for each segment were tabulated based upon location and time of day to generate speed contour plots. Speed contour plots for the northbound and southbound I-95 mainline lanes are shown in **Figures 3-1 and 3-2**. It should be noted that the RITIS data does not have a separate roadway segment that begins/ends at the Centreport Parkway interchange and therefore speed data is depicted to the Route 630/Courthouse Road interchange, the next interchange to the north of the study area.

**Northbound I-95 Mainline Lanes (see Figure 3-1):** During the morning peak period, heavy congestion and low travel speeds occur between 7:45 AM and 8:15 AM along northbound I-95 approaching the diverge to the C-D lanes serving the Route 17 interchange. This can be attributed to the poor operations of the weave conditions along the northbound C-D lanes and the operation of the loop ramp in the northeast quadrant of the Route 17 interchange. Congestion is most severe and speeds are lowest for the longest duration in the northern portion of the study area north of Route 17 to the Courthouse Road interchange where average travel speeds are less than 55 mph from 6:15 AM to 8:45 AM with the lowest average travel speeds of approximately 35 mph from 6:45 AM to 7:45 AM.

During the evening peak period, travel speeds along northbound I-95 within the study area are free flow.

**Southbound I-95 Mainline Lanes (see Figure 3-2):** During the evening peak period, heavy congestion and low travel speeds (less than 55 mph) occur between 3:30 PM and 6:45 PM along southbound I-95 approaching Route 17. Within the Route 17 interchange, low speeds occur between 3:45 PM and 6:45 PM with the lowest average speed of approximately 30 mph from 5:15 PM to 6:15 PM. Congestion continues downstream approaching the Rappahannock River and the Route 3 interchange.

During the morning peak period, travel speeds along southbound I-95 within the study area are free flow.

Detailed information on operational performance for existing conditions is included in **Chapter 7**.

Figure 3-1: 2016 Northbound I-95 Mainline Lane Speeds

	Route 1 On-Ramp		Route 3		Rappahannock River		Route 17		Courthouse Rd Off-Ramp
5:00	69		69		69		68		69
5:15	68		67		68		67		68
5:30	69		68		69		68		69
5:45	69		67		68		67		69
6:00	68		64		66		65		68
6:15	68		64		66		65		67
6:30	69		65		65		65		65
6:45	69		65		66		64		63
7:00	67		63		63		63		63
7:15	67		62		62		62		64
7:30	67		62		61		59		61
7:45	66		57		49		51		59
8:00	65		56		51		52		58
8:15	66		61		58		58		59
8:30	67		62		60		59		60
8:45	67		62		60		60		61
9:00	67		65		62		61		60

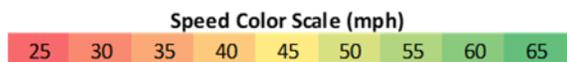
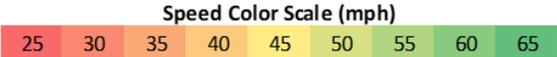


Figure 3-2: 2016 Southbound I-95 Mainline Lane Speeds

	Route 1 On-Ramp		Route 3		Rappahannock River		Route 17		Courthouse Rd Off-Ramp
14:00	69	68	64	61	60	62			
14:15	69	68	63	60	60	62			
14:30	68	67	63	62	61	60			
14:45	67	68	63	62	61	60			
15:00	66	67	63	63	62	58			
15:15	67	67	62	62	61	56			
15:30	68	67	60	58	57	54			
15:45	68	68	58	53	52	52			
16:00	68	68	56	50	49	52			
16:15	67	67	55	44	42	50			
16:30	67	66	54	41	36	47			
16:45	67	66	54	41	34	42			
17:00	67	66	52	39	32	40			
17:15	68	66	50	37	31	40			
17:30	68	65	44	34	29	38			
17:45	68	65	44	33	28	37			
18:00	69	65	45	35	30	41			
18:15	69	66	51	40	38	46			
18:30	69	66	53	46	46	54			
18:45	68	66	55	53	54	60			
19:00	68	66	59	58	59	64			



### **3.5 EXISTING SAFETY CONDITIONS**

Detailed information on existing safety conditions is included in **Chapter 8**.

### **3.6 EXISTING ENVIRONMENTAL CONSTRAINTS**

Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA), and in accordance with Federal Highway Administration (FHWA) regulations, an Environmental Assessment (EA) has been prepared and a Finding of No Significant Impact (FONSI) was issued by the FHWA on November 17, 2015. The EA analyzed and documented the potential social, economic, and environmental effects associated with the proposed transportation improvements and the FONSI concluded that the project would not have significant impacts on the environment. Since approval of the EA and issuance of the FONSI, VDOT has proposed design modifications (analyzed in this IMR). Based on these design modifications, VDOT conducted a Re-evaluation of the EA. The Re-evaluation of the EA was approved by FHWA on December 04, 2018. The EA and Re-evaluation include information from various technical reviews and identified environmental constraints related to historic properties, natural resources, water quality, threatened and endangered species, air quality, noise, etc. The EA and Re-evaluation, identify and further explain the environmental resources that are within the study area and discuss the potential impact that the project would have on those resources.

## 4. ALTERNATIVES CONSIDERED

### 4.1 PREVIOUS STUDIES AND PROJECT HISTORY

The process of developing alternatives to address the documented safety and operational deficiencies along I-95 between Route 3 (Exit 130) and Route 17 (Exit 133) has been ongoing for several years. The I-95 Access Study, which resulted in an approved Interchange Justification Report (IJR) in April 2011, included a new interchange along I-95 between Exit 133 and Exit 130, a four-mile toll road that provided an alternate access to Route 3, and northbound and southbound Collector-Distributor (C-D) roads. The toll road project and new interchange project were not pursued; however, VDOT decided to pursue the implementation of portions of the I-95 Access Study. The I-95 Interchange Modification Report - Improvements to I-95 between Exit 133 and 130 was approved in April 2016, considered and screened twelve alternatives in addition to the No Build alternative, and then selected a preferred alternative. The screening and evaluation of the alternatives considered daily traffic volumes, densities, and level of service for the AM and PM peak hours along the I-95 mainline lanes and the proposed C-D roads, operations at the Route 17 and Route 3 interchanges including the elimination of weaving, and other relevant factors. As a result of the screening process, Alternative 3A was selected as the preferred alternative in the April 2016 IMR and consisted of the following major components:

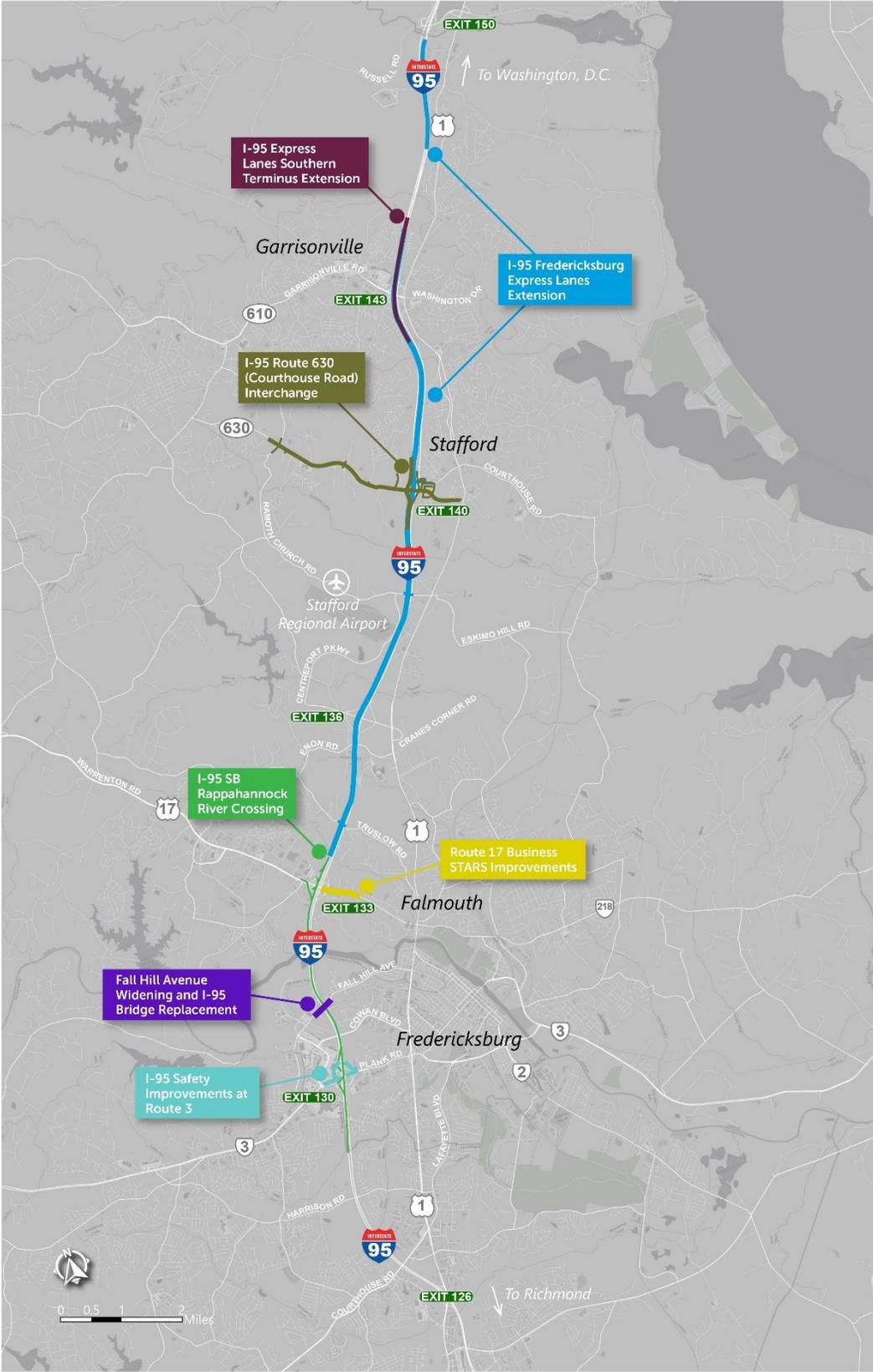
- Two-lane C-D roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes and a flyover connection from the northbound I-95 C-D road to westbound Route 17
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

As discussed in **Section 1.1**, the improvements to I-95 and the Route 3 and Route 17 interchanges have been implemented in different phases due to funding constraints. Improvements to the Route 3 interchange were implemented as part of the I-95 Safety Improvements at Route 3 (Exit 130) (see **Section 4.2.2**) and improvements along southbound I-95 are under construction as part of the I-95 Rappahannock River Crossing Southbound project (See **Section 4.2.3**).

### 4.2 NO BUILD ALTERNATIVE

The No Build Alternative has been included for evaluation as a benchmark for the comparison of future conditions and impacts. The No Build Alternative would retain the existing configuration along northbound I-95 and allow for routine maintenance and safety upgrades. This alternative also assumes that the projects currently programmed and funded in FY 2018 – FY 2021 Statewide Transportation Improvement Program (STIP) and FAMPO's FY 2015 – FY 2018 Transportation Improvement Program (TIP) will be implemented. These No Build projects are discussed in more detail below and are depicted in **Figure 4-1**.

Figure 4-1: Previously Completed and No Build Projects



I-95 Rappahannock River Crossing Northbound

### 4.2.1 Fall Hill Avenue

The Fall Hill Avenue project was completed in April 2017 and included the widening of Fall Hill Avenue from two to four lanes and an extension of Mary Washington Boulevard. As part of the project, the Fall Hill Avenue bridge over I-95 was widened to four lanes to provide room for the future northbound and southbound I-95 C-D lanes.

### 4.2.2 I-95 Safety Improvements at Route 3 (Exit 130)

This project was the first phase of the improvements to I-95 between Exit 133 and 130. Construction was completed in January 2019. The I-95 Safety Improvements at Route 3 enhanced safety by reducing conflict points and weaving at the I-95 and Route 3 interchange. The project was funded with federal Highway Safety Improvement Program (HSIP) funds. Additional project information is located at: [http://www.virginiadot.org/projects/fredericksburg/interstate\\_95\\_safety\\_improvements\\_at\\_route\\_3\\_exit\\_130.asp](http://www.virginiadot.org/projects/fredericksburg/interstate_95_safety_improvements_at_route_3_exit_130.asp) (accessed 3/28/19).

The following is a summary of the improvements:

#### Southbound I-95 Exit Ramp Improvements

- The off-ramp from southbound I-95 to Route 3 westbound was extended and widened.
- A physically-separated lane was constructed for southbound I-95 traffic destined for Carl D Silver Parkway at Central Park eliminating any weaving along westbound Route 3 by these vehicles.
- Three right turn lanes were built for traffic exiting I-95 to Route 3 westbound. These lanes are signal-controlled at a new signal along westbound Route 3 eliminating merging and weaving along westbound Route 3. Eastbound Route 3 traffic does not stop at this new traffic signal.

#### Route 3 Eastbound On-Ramp Improvements

- The cloverleaf ramp from eastbound Route 3 to northbound I-95 was removed thereby eliminating the weaves along eastbound Route 3 and northbound I-95.
- Eastbound Route 3 traffic now accesses I-95 northbound using three left-turn lanes that were constructed along Route 3, just east of the I-95 overpass. Traffic now turns left onto the northbound on-ramp at a new intersection controlled by a traffic signal. Eastbound Route 3 traffic does not stop at this new traffic signal.

The following is a summary of the configuration of the two new signalized intersections implemented as part of the project:

- **Route 3 at Southbound I-95 Off-Ramp:** This two-phase signalized intersection serves the ramp from southbound I-95 to westbound Route 3. Westbound Route 3 has five through lanes and eastbound Route 3 is not signal controlled. The southbound off-ramp approach has three signalized right-turn lanes and a physically separated right-turn lane that provides direct access to Carl D Silver Parkway.
- **Route 3 at Northbound I-95 On-Ramp:** This two-phase signalized intersection serves the ramp from eastbound Route 3 to northbound I-95. Westbound Route 3 has two through lanes,

a shared through/right-turn lane, and a right-turn lane. Eastbound Route 3 has three left-turn lanes and three through lanes. The eastbound Route 3 through lanes are not signal controlled.

### 4.2.3 I-95 Rappahannock River Crossing Southbound

This project is the second phase of the improvements to I-95 between Exit 133 and 130. Funding for improvements along southbound I-95 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River was secured through the Smart Scale program and was included in the fiscal year (FY) 2017-2022 Six-Year Improvement Program (SYIP). Construction of the project began in August 2018 and is scheduled to be completed in 2022. Additional project information is located at:

[http://www.virginiadot.org/projects/fredericksburg/i-95\\_southbound\\_rappahannock\\_river\\_crossing.asp](http://www.virginiadot.org/projects/fredericksburg/i-95_southbound_rappahannock_river_crossing.asp)  
(accessed 5/20/19).

The following is a summary of the improvements:

#### Collector-Distributor (C-D) Roads and new I-95 Southbound Mainline Lanes

- Relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes. The diverge from the existing I-95 southbound mainline lanes to the C-D lanes will be located north of the Route 17 interchange and the merge with the C-D lanes will be located south of the Route 3 interchange. There will be three new southbound I-95 mainline lanes between Route 17 and Route 3 for the entire limits of the C-D road. A new three-lane bridge along the I-95 southbound mainline lanes will be constructed over the Rappahannock River within the median.
- The repurposed C-D lanes will diverge from the new I-95 mainline lanes as a two-lane exit ramp. The two lanes will be maintained along the southbound I-95 C-D road through the Route 17 interchange. South of the Route 17 interchange, a third lane will be added along the C-D road from the two-lane entrance from eastbound Route 17. At the Route 3 interchange, one of the three C-D lanes will be dropped onto the ramp to westbound Route 3. South of the off-ramp to westbound Route 3, the C-D road will include two lanes through the weave with the Route 3 loop ramps and the merge with the ramp from eastbound Route 3 to southbound I-95. The two C-D lanes will then merge with the new I-95 mainline lanes as a two-lane entrance ramp.

#### Improvements to Southbound I-95 at Route 17 Interchange

- The southbound I-95 diverge to Route 17 will be relocated to just south of Truslow Road and will merge with the ramp from the future Express Lanes and form a second C-D lane facility parallel to the C-D lanes serving the Route 17 interchange ramps. The general locations and alignment of the Route 17 ramps will remain essentially the same as existing conditions. The second C-D lane facility will merge with the primary C-D lane facility just south of the loop ramp to eastbound Route 17 Business.
- The eastbound Route 17 to I-95 southbound on-ramp will be widened to two lanes; however, the lane configuration on the eastbound Route 17 approach to Sanford Drive will be revised to convert the right-turn lane to a shared through/right-turn lane that drops at the ramp to southbound I-95.

This will provide two continuous eastbound lanes beginning west of Sanford Drive that serve the on-ramp to southbound I-95.

### **Improvements to Southbound I-95 at Route 3 Interchange**

- The Route 3 interchange merge and diverge points along the southbound I-95 mainline lanes will be located along the repurposed southbound C-D lanes and the locations and alignment of the ramps will remain essentially the same as existing conditions.
- Along the southbound I-95 C-D road, one of the three C-D lanes will be dropped onto the ramp to westbound Route 3 providing a two-lane exit. South of the diverge to Route 3, a two-lane C-D road will continue through the two Route 3 loop ramps and the merge with the ramp from Route 3 before merging with the I-95 southbound mainline lanes.

#### **4.2.4 I-95 Express Lanes Extension to Fredericksburg (Fred Ex)**

The I-95 Express Lanes Extension to Fredericksburg (Fred Ex) contract was awarded for construction in spring 2019 and includes the construction of two new reversible HOV/HOT lanes (Express Lanes) along a 10-mile segment within the median of I-95 between the Route 610/Garrisonville Road interchange (Exit 143) and the Route 17 interchange (Exit 133). The Express Lanes conceptual design was developed to include connections to both the northbound and southbound I-95 C-D lanes between Exit 130 and Exit 133. An Interchange Justification Report was approved for the Fred Ex project in March 2018. The current project schedule shows construction beginning in 2019 and completion in 2022. It is expected that the Fred Ex lanes will open to traffic prior to the completion of the I-95 Rappahannock River Crossing Northbound project. Additional project information is located at: [http://www.virginia-dot.org/projects/fredericksburg/i-95\\_express\\_lanes\\_fredericksburg\\_extension.asp](http://www.virginia-dot.org/projects/fredericksburg/i-95_express_lanes_fredericksburg_extension.asp) (accessed 4/5/19).

#### **4.2.5 Route 17 Business STARS Improvements**

As part of the Route 3 and Route 17 Business Corridor Studies conducted under the Strategically Targeted Affordable Roadway Solutions (STARS) program, improvements were identified along Business Route 17 including the extension of the existing raised median that terminates approximately 200 feet west of the Short Street intersection. The raised median would be extended through the existing signalized intersection at Short Street and to the Olde Forge Drive intersection. The traffic signal at Short Street would be removed and a new signal would be installed at the Olde Forge Drive intersection. The existing Route 698 (RV Parkway) would be realigned north of Route 17 Business to intersect Business Route 17 opposite Olde Forge Drive. Additionally, the auxiliary lane from the ramp from northbound I-95 to southbound Business Route 17 would continue as a shared through/right-turn lane at Short Street and become a right-turn lane drop lane onto Olde Forge Drive. Additional project information is located at: [https://www.virginia-dot.org/projects/fredericksburg/route\\_3\\_and\\_route\\_17\\_business\\_corridor\\_studies.asp](https://www.virginia-dot.org/projects/fredericksburg/route_3_and_route_17_business_corridor_studies.asp) (accessed 5/20/19).

In the interim, as part of a planned development along Route 17 Business, the traffic signal at Olde Forge Drive and RV Parkway is planned to be installed in late 2019 in conjunction with the removal of the existing traffic signal at Route 17 Business at Short Street and the installation of a raised median to limit all access along Route 17 Business between Short Street and Old Forge Drive to right-in/right out only.

### 4.3 TRANSPORTATION SYSTEM MANAGEMENT OPTION

A Transportation System Management (TSM) alternative was considered to address the needs of the corridor. TSM strategies focus on improving the operational efficiency of the roadway transportation system without adding major system improvements, such as adding lanes or new ramps. While many TSM strategies currently exist or are planned along the I-95 corridor including the proposed Express Lanes to the north (Fred Ex), travel time information on dynamic message signs (DMS), traffic detection and corridor monitoring, and park and ride facilities at various locations with transit service alternatives, the needs of the corridor cannot be adequately satisfied solely by a TSM alternative. Therefore, the TSM alternative was eliminated from detailed study.

### 4.4 BUILD ALTERNATIVES

#### 4.4.1 Build Alternatives Development

The alternatives development process included the identification of “alternatives” for the northbound I-95 mainline lanes and C-D lanes and “options” for the Route 17 interchange to address the identified purpose and need. Separate options were considered for Route 17 both east and west of I-95. The identification of the alternatives and options was considered independently while recognizing that the selected alternative for the northbound I-95 mainline lanes and C-D lanes would need to be compatible with the selected option at the Route 17 interchange. Reasonable design alternatives were considered with a goal of satisfying the purpose and need for the project.

#### 4.4.2 Northbound I-95 Mainline Lanes and C-D Lanes

Three alternatives were considered for the northbound I-95 lanes. With all alternatives, it was assumed that the mainline lanes would be relocated into the median north of Fall Hill Avenue to minimize property impacts and consistent with the I-95 Rappahannock River Crossing Southbound project which is currently under construction. All options would also include a direct connection from the C-D road north of Route 17 to the future Express Lanes (Fred Ex).

There is uncertainty in the ultimate project cost since the project has not yet been advertised or awarded to a contractor. Therefore, an auxiliary lane that would extend from the C-D lane entrance north of Route 17 to the northbound I-95 off-ramp to Centreport Parkway to provide additional capacity at the merge between the northbound I-95 mainline lanes and C-D lanes will be considered as a bid option. This option would be constructed if it can be implemented within the project budget.

**Alternative 1 - Braided Ramps:** This alternative would have similar features to the preferred alternative presented in the April 2016 IMR and includes the following major components (see **Figure 4-2**):

- Two-lane northbound I-95 C-D road beginning at the entrance ramp from Route 3 and continuing parallel to the mainline lanes between Route 3 and Route 17.
- New three-lane northbound I-95 mainline lanes transitioning to the median north of Fall Hill Avenue with a new parallel structure over the Rappahannock River.
- Braided ramps along northbound I-95 between the C-D road and the mainlines lanes approaching the Route 17 interchange to accommodate movements from the northbound I-95 mainline lanes to Route 17 and from Route 3 to the northbound I-95 mainline lanes.

**Alternative 2 - Begin C-D Lanes North of Route 3:** This alternative would have the following major components (see **Figure 4-3**):

- Three-lane C-D road beginning at the entrance ramp from Route 3 and continuing parallel to the mainline lanes between Route 3 and Route 17.
- A two-lane slip ramp north of Route 3 from the northbound I-95 mainline lanes to the C-D road to provide access to the downstream Route 17 interchange from the northbound I-95 mainline lanes.
- New three-lane northbound I-95 mainline lanes transitioning to the median north of Fall Hill Avenue with a new parallel structure over the Rappahannock River.

**Alternative 3 - Begin C-D Lanes South of Route 3:** This alternative would have the following major components (see **Figure 4-4**):

- Two-lane C-D road beginning south of Route 3 and continuing parallel to the three northbound I-95 mainline lanes through the Route 3 interchange and merging with the ramp from Route 3.
- Three-lane C-D road between Route 3 and Route 17 with one of the lanes from the Route 3 entrance ramp creating the third C-D lane.
- New three-lane northbound I-95 mainline lanes transitioning to the median north of Fall Hill Avenue with a new parallel structure over the Rappahannock River.

A working group comprised of VDOT Fredericksburg and Northern Virginia District staff as well as technical support staff was formed to guide the development of a Build Alternative for the northbound I-95 mainline and C-D lanes. The group convened for a workshop and discussed design issues and constraints in order to reach a consensus on a preferred alternative. All alternatives discussed focused on improving operations and minimizing access points along the northbound I-95 mainline lanes. **Table 4-1** provides a comparison of alternatives under consideration including a rating of the options from good to poor based on the evaluation criteria.

**Table 4-1: Comparison of Northbound I-95 Mainline Lanes and C-D Lanes Alternatives**

Criteria	No Build	Alternative 1: Braided Ramps	Alternative 2: Begin C-D Lanes North of Route 3	Alternative 3: Begin C-D Lanes South of Route 3
Address recurring congestion and safety deficiencies	●	●	●	●
Reduction of conflict points along the mainline lanes	●	●	●	●
Flexibility and redundancy during maintenance activities and incidents along the northbound I-95 mainline lanes including the Rappahannock River bridge	●	●	●	●
Additional capacity along northbound I-95 for travel between Route 3 and Route 17	●	●	●	●
Construction cost	N/A	●	● \$89.5 million	● \$112.6 million

Good	Fair	Poor
●	●	●

**Alternative 1: Braided Ramps** would not provide redundancy and flexibility during incidents since access to the northbound I-95 C-D lanes would only be provided from the Route 3 interchange. Additionally, this alternative would not be compatible with the Fred Ex project due to the location of the braided ramps along northbound I-95 approaching the Route 17 interchange in relation to the left-hand entrance ramp to the Express Lanes. Therefore, this alternative was eliminated from further consideration.

The working group's initially preferred alternative was **Alternative 3: Begin C-D Lanes South of Route 3** which would provide a C-D road beginning south of the Route 3 interchange and tie into the existing northbound C-D lanes at the Route 17 interchange in addition to three northbound I-95 mainline lanes. This alternative was preferred by the working group because it would remove all conflict points along the northbound I-95 mainline lanes at both the Route 3 and Route 17 interchanges while providing additional traffic capacity for travel between Route 3 and Route 17 and additional traffic capacity over the Rappahannock River bridge including redundancy and flexibility during incidents and required maintenance. However, Alternative 3 has a higher cost (approximately \$23 million more) compared to Alternative 2: Begin C-D Lanes North of Route 3 due to the additional improvements required south of Fall Hill Avenue to provide a C-D lane beginning south of the Route 3 interchange. Additionally, Alternative 3 cannot be funded within the project budget.

Both Alternatives 2 and 3 would both provide additional traffic capacity for travel between Route 3 and Route 17 and additional traffic capacity over the Rappahannock River bridge including redundancy and flexibility during incidents and required maintenance and address recurring congestion and safety deficiencies identified within the project study area. Although Alternative 2 would only remove one of the conflict points along the northbound I-95 mainline lanes at the Route 3 interchange, based on the operational analysis documented in Chapter 7, the merge and diverge points along northbound I-95 would operate acceptably in the 2042 design year without the construction of a C-D lane through the Route 3 interchange. Therefore, **Alternative 2: Begin C-D Lanes North of Route 3 was selected as the preferred Build Alternative** because it best meets the purpose and need for the project while having a construction cost that is within the available project budget.

Following the selection of Alternative 2 as the preferred Build Alternative for the I-95 northbound mainline lanes and C-D lanes, the study team further refined the concept as presented in **Section 4.4**.

Figure 4-2: Alternative 1 - Braided Ramps (Sheet 1 of 2)

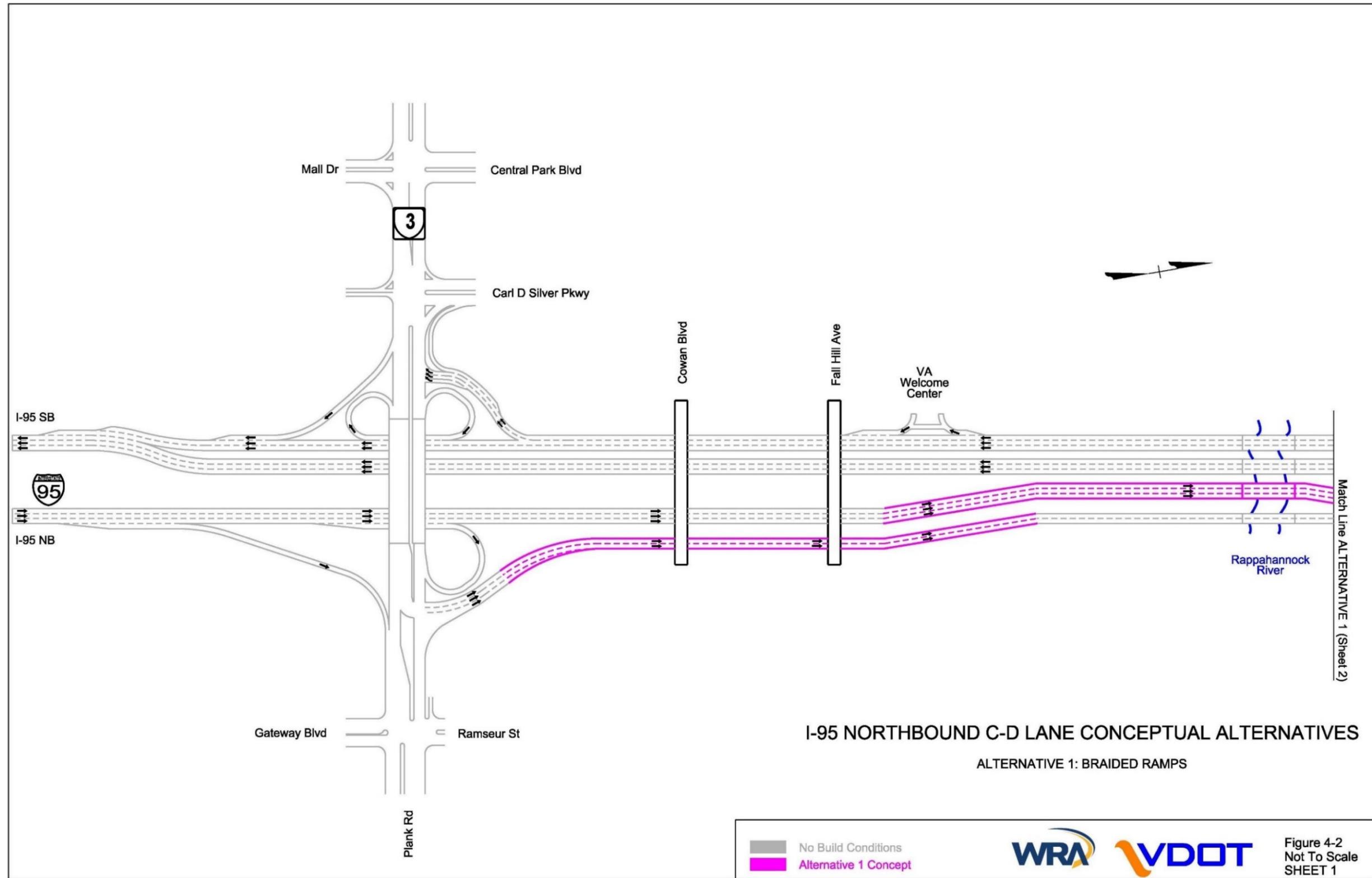


Figure 4-2: Alternative 1 - Braided Ramps (Sheet 2 of 2)

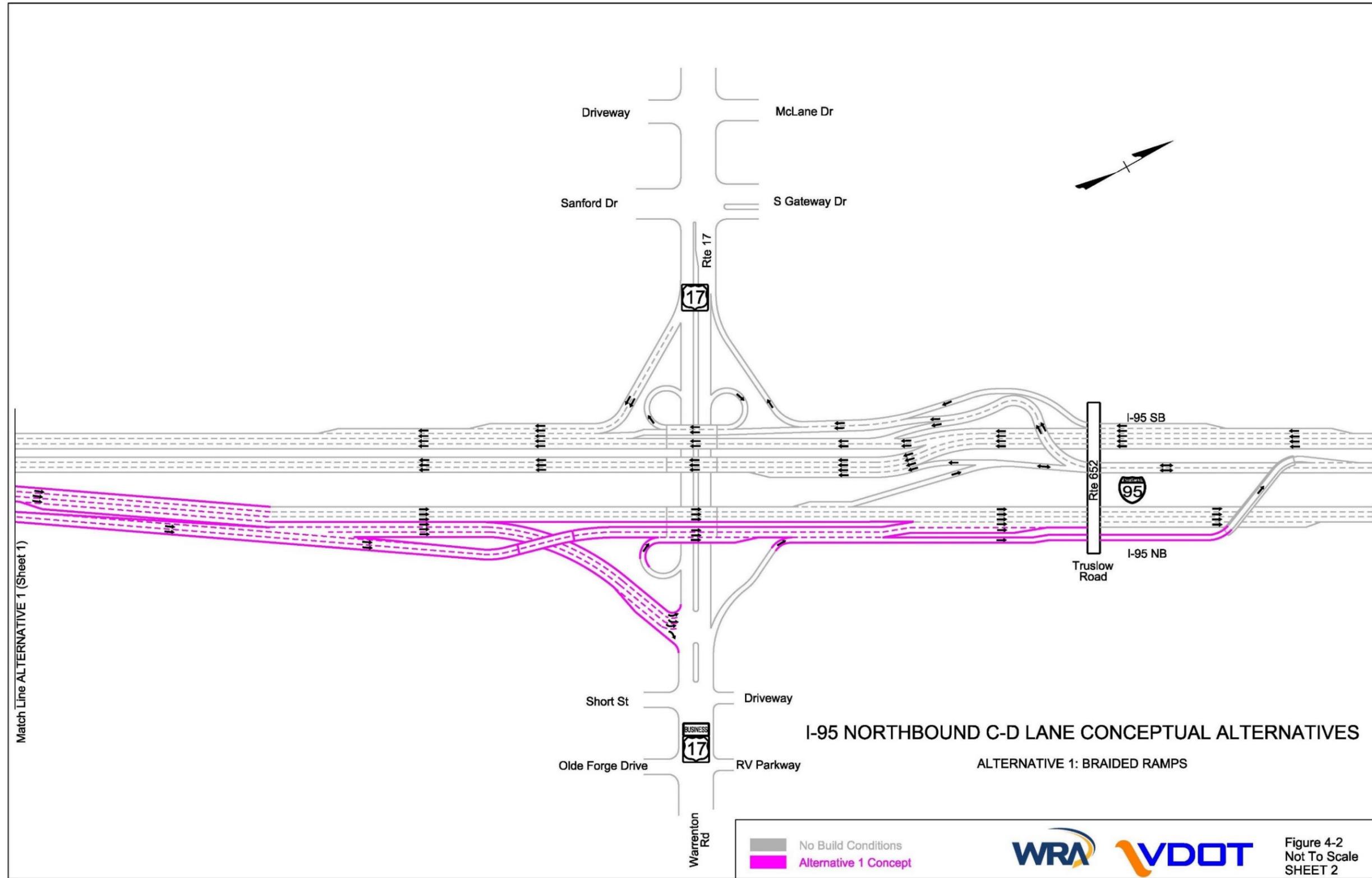


Figure 4-3: Alternative 2 - Begin C-D Lanes North of Route 3 (Sheet 1 of 2)

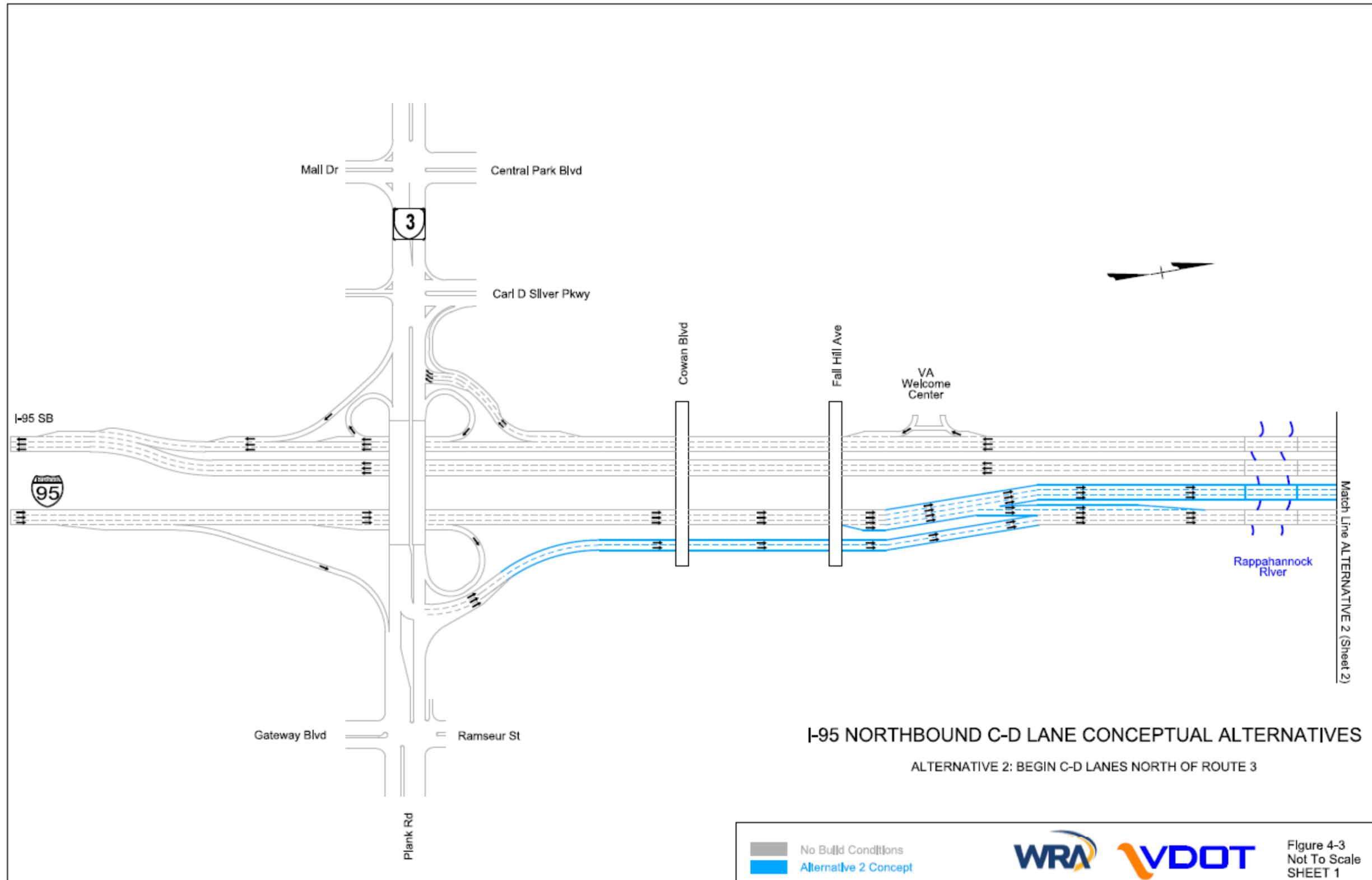


Figure 4-3: Alternative 2 - Begin C-D Lanes North of Route 3 (Sheet 2 of 2)

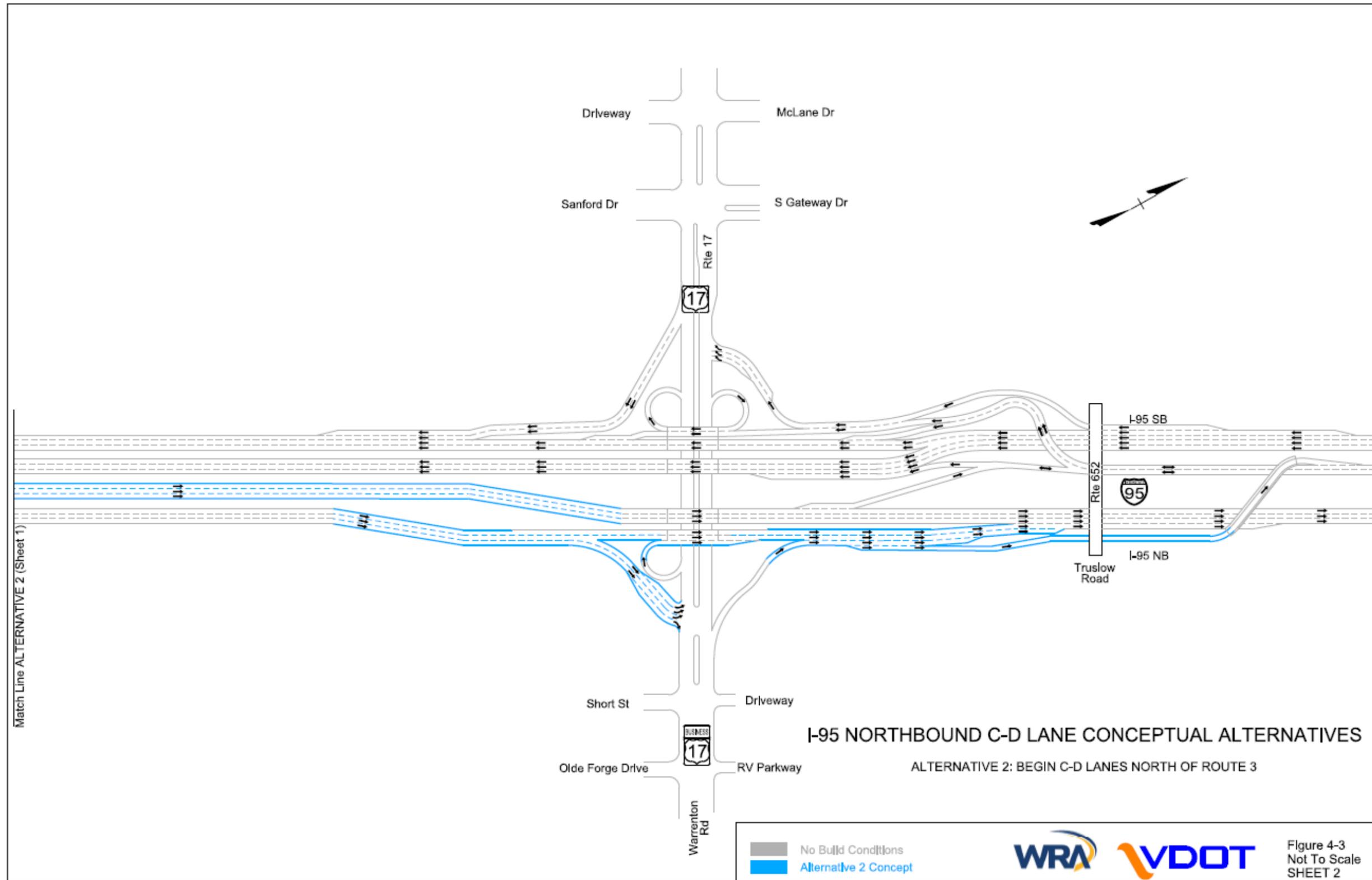


Figure 4-4: Alternative 3 - Begin C-D Lanes South of Route 3 (Sheet 1 of 2)

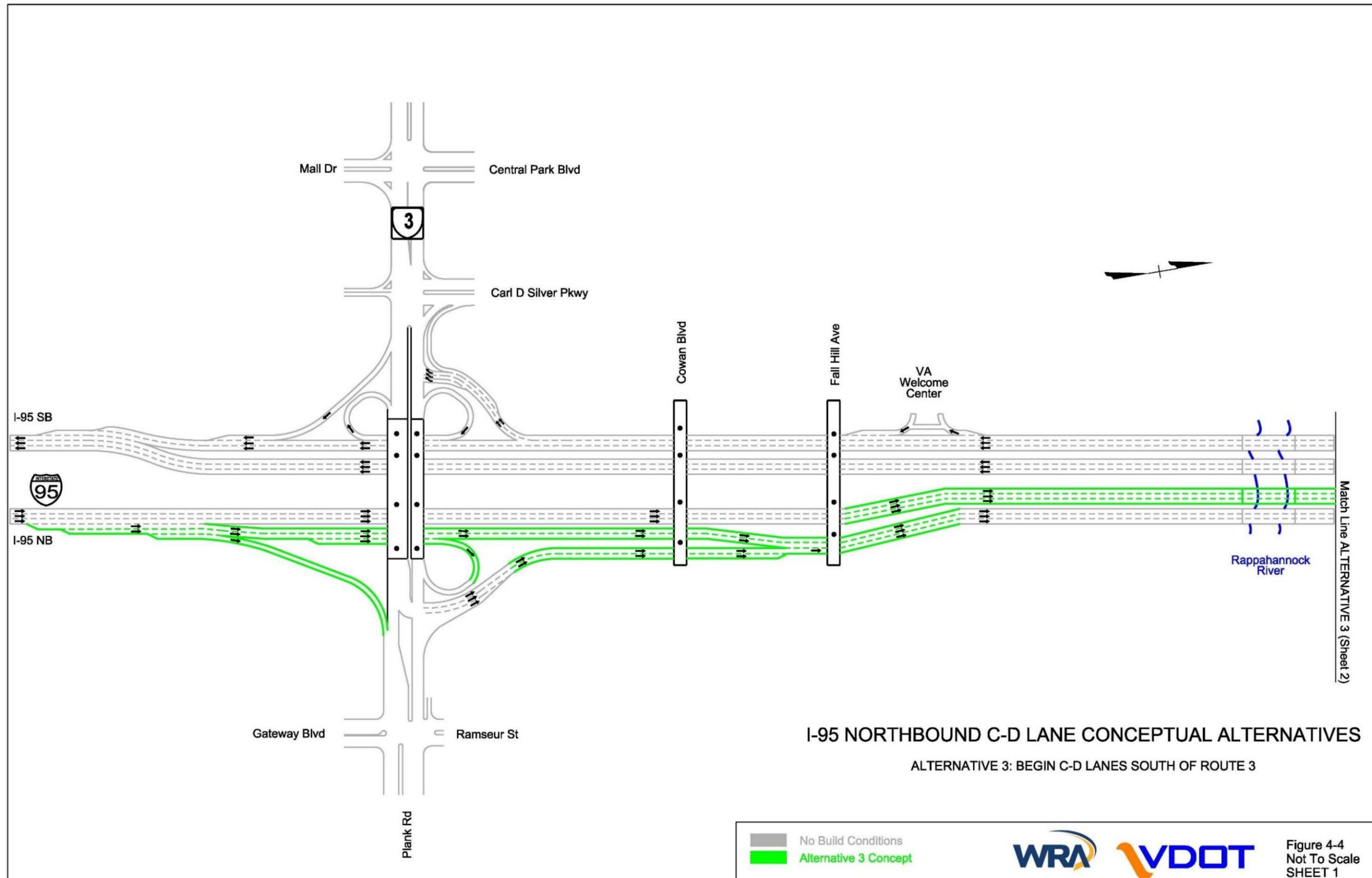
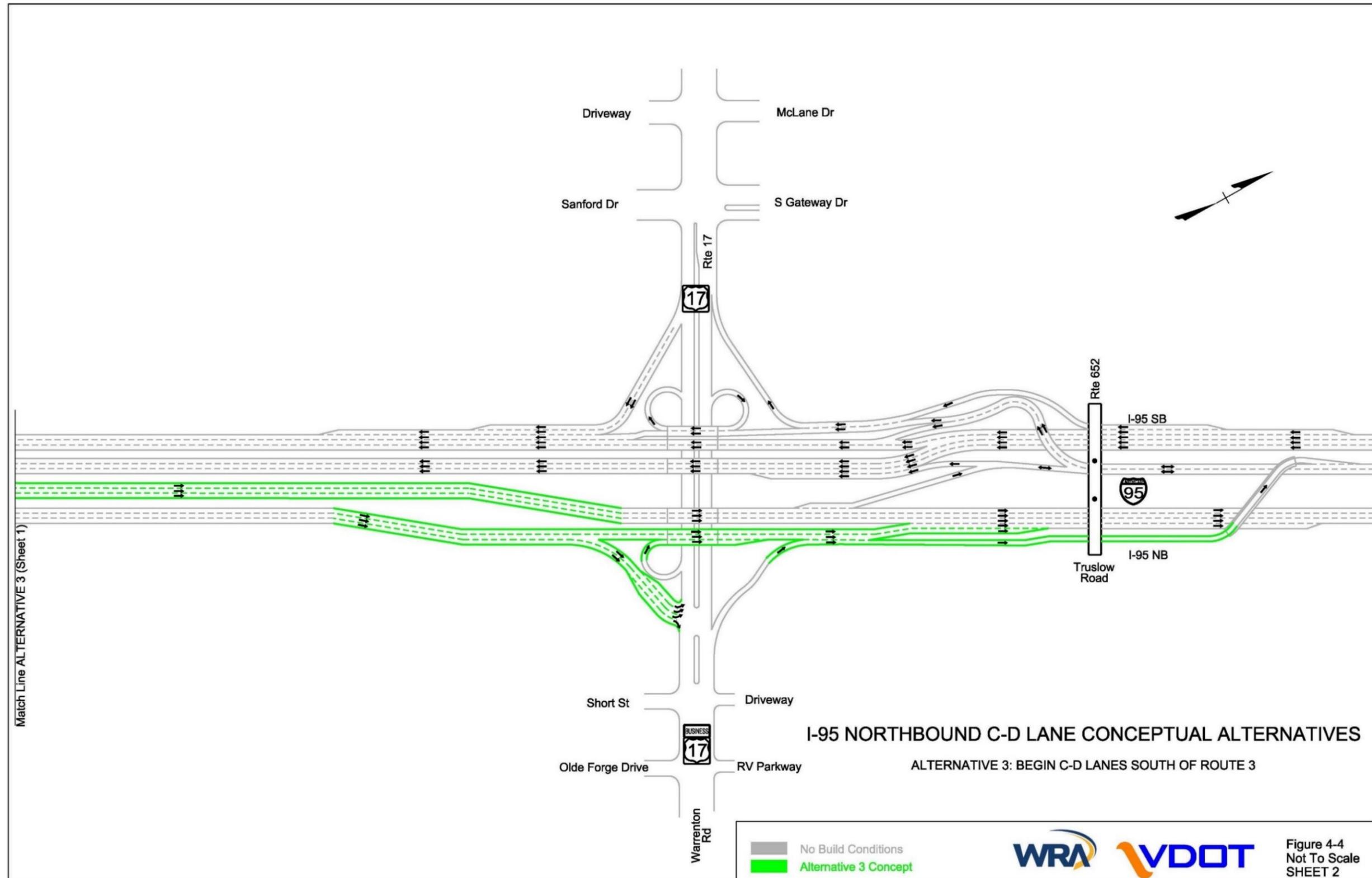


Figure 4-4: Alternative 3 - Begin C-D Lanes South of Route 3 (Sheet 2 of 2)



### 4.4.3 Route 17 Interchange

Several options were considered for the Route 17 interchange including options to the west of I-95 and to the east of I-95 as depicted in **Figure 4-5** below. Options east and west of I-95 were considered independently while recognizing that the selected option for Route 17 west of I-95 would need to be compatible with the selected option east of I-95 as well as with the selected alternative for the I-95 mainline lanes and C-D lanes.

**Figure 4-5: Route 17 Interchange Study Areas**



#### 4.4.3.1. Route 17 Interchange – West of I-95

Two options were considered for Route 17 west of I-95 including making no improvements to this area. The range of options considered focused on removing the weaves along westbound Route 17 between the ramp from southbound I-95 and the Sanford Drive/Gateway Drive intersection. Without any improvements in this area, westbound Route 17 queues approaching the Sanford Drive/Gateway Drive intersection will extend upstream through the I-95 interchange and impact the overall operation of the interchange. This can be attributed to traffic weaving from the ramp from southbound I-95 to the westbound Route 17 left turn to southbound Sanford Drive in addition to traffic along westbound Route 17 weaving across traffic entering from the ramp from southbound I-95 to make a right turn onto northbound Gateway Drive. Both of these weaving movements occur in a distance of approximately 450 feet between the I-95 southbound on-ramp and the Sanford Drive/Gateway Drive intersection. The following is a summary of the major components of the two options considered:

**Option A: Free Flow Right Turn from Southbound I-95 with No Westbound Left to Sanford Drive (see Figure 4-6)**

- Maintain the free-flow ramp from southbound I-95 to westbound Route 17
- Prohibit westbound Route 17 left turns to Sanford Drive; westbound Route 17 traffic destined for southbound Sanford Drive would be diverted to make a right turn onto Gateway Drive, a right

turn onto Stanstead Drive and then a left-turn onto Gateway Drive to travel across Route 17 to access Sanford Drive

**Option B: Signalized Triple Right Turn (see Figure 4-7)**

- Signalize the southbound I-95 to westbound Route 17 right-turn movement and provide a triple right turn
- Widen westbound Route 17 on the approach to the signalized intersection to provide four through lanes
- Install a second westbound Route 17 left-turn lane to southbound Sanford Drive

**Table 4-2** summarizes the advantages and disadvantages of the two options under consideration for the Route 17 interchange west of I-95 in addition to making no improvements to Route 17 west of I-95. The following criteria were used to evaluate the seven options:

- Traffic operations
- Removal of the weave along westbound Route 17 to the left turn to southbound Sanford Drive
- Removal of the weave along westbound Route 17 to the right turn to northbound Gateway Drive
- Number of new traffic signals along Route 17
- Right of way and property impacts
- Signing

**Figure 4-6: Option A - Free Flow Right Turn from Southbound I-95 with No Westbound Left to Sanford Drive (2042 Design Year PM Peak Hour)**



Figure 4-7: Option B - Signalized Triple Right Turn (2042 Design Year AM Peak Hour)



**Option A: Free Flow Right Turn from Southbound I-95 with No Westbound Left to Sanford Drive** was eliminated because it does not remove the weave along westbound Route 17 between the ramp from southbound I-95 and Gateway Drive which results in queue that extend upstream from the intersection and through the I-95 interchange (see **Figure 4-6**). Additionally, it would divert traffic to the southbound Gateway Drive approach increasing delays on that approach to the intersection. This option would also be difficult to sign for the prohibited westbound Route 17 left turn to Sanford Drive and would likely result in illegal left turns. Therefore, **Option B: Signalized Triple Right Turn** was selected as the preferred option based on the removal of the weaves along westbound Route 17 which is critical to reducing queues along westbound Route 17 downstream of the I-95 interchange ramps. Although an additional traffic signal would be located along westbound Route 17 with this option, the queues would not extend into upstream intersections or onto the southbound I-95 C-D lanes (see **Figure 4-7**) and it would not be a critical traffic signal along the corridor due to the efficient two-phase operation of the signal. **Section 7** further documents the traffic operations of Option B: Signalized Triple Right Turn.

Table 4-2: Comparison of Route 17 – West of I-95 Options

Measure of Effectiveness	No Route 17 Improvements	Option A – Free Flow Right Turn from SB I-95 with No WB Left to Sanford Dr	Option B – Signalized Triple Right Turn
<b>Description</b>	<ul style="list-style-type: none"> <li>No improvements along Route 17</li> </ul>	<ul style="list-style-type: none"> <li>Maintain free-flow ramp from SB I-95 to WB Route 17</li> <li>Prohibit WB Route 17 left turns to Sanford Drive</li> </ul>	<ul style="list-style-type: none"> <li>Signalize the SB I-95 to WB Route 17 right-turn movement (triple right turn)</li> <li>Install WB Route 17 double left turn to Sanford Drive</li> </ul>
<b>Traffic Operations <sup>1</sup></b>	<ul style="list-style-type: none"> <li>✗ Weave along WB Route 17 between SB I-95 ramp and Sanford Drive/Gateway Drive generates queues that extend upstream through I-95 interchange</li> <li>✗ WB Route 17 left turn to Sanford Drive queues extend out of the turn bay</li> </ul>	<ul style="list-style-type: none"> <li>✗ Weave along WB Route 17 between SB I-95 ramp and Sanford Drive/Gateway Drive generates queues that extend upstream through I-95 interchange</li> <li>✗ Diverts traffic to SB Gateway Drive shared through/left-turn lane increasing queues and delays</li> <li>✗ Increases queues/delays on northbound Sanford Drive due to removal of overlap signal phase with WB Route 17 left turn</li> </ul>	<ul style="list-style-type: none"> <li>✓ Eliminates weave along WB Route 17 between SB I-95 ramp and Sanford Drive/Gateway Drive</li> <li>✓ SB I-95 off-ramp queues from signal do not extend to C-D road</li> </ul>
<b>Removes Weave along WB Route 17 to the Left Turn to SB Sanford Drive</b>	✗ Does not remove weave	✓ Removes the weave by eliminating the left-turn to SB Sanford Drive	✓ Removes the weave by signalizing the right turn from the ramp from SB I-95
<b>Removes Weave along WB Route 17 to the Right Turn to NB Gateway Drive</b>	✗ Does not remove weave	✗ Does not remove weave	✓ Removes the weave by signalizing the right turn from the ramp from SB I-95
<b>Number of New Traffic Signals along Route 17</b>	✓ No additional signals	✓ No additional signals west of I-95	✗ One additional half signal west of I-95 (does not stop EB Route 17)
<b>Right of Way / Property Impacts</b>	✓ No right of way impacts	✗ Requires widening of Route 17 downstream of Gateway Drive intersection when combined with Option 2, 3, or 5 (East of I-95)	✓ Requires minor widening of Route 17 downstream of Gateway Dr
<b>Signing</b>	✓ No existing signing challenges	✗ Difficult to sign for prohibited left turn to Sanford Drive; may result in illegal left turns	✓ No signing challenges

<sup>1</sup> Assumes unconstrained operations along northbound I-95 north of the Route 17 interchange to provide a meaningful comparison of interchange options

#### 4.4.3.2. Route 17 Interchange – East of I-95

Eight options were considered for Route 17 east of I-95 including making no improvements to this area. The range of options developed focused on removing the weaves along both the northbound I-95 C-D lane serving Route 17, minimizing the number of new signals along Route 17, and the ability to improve traffic operations along both northbound I-95 and Route 17. The following is a summary of the major components of each of the options:

##### **Option 1 – Triple Left Turn (see Figure 4-8)**

- Install 3-phase signalized intersection at the northbound I-95 C-D lanes off-ramp to Route 17 with a signalized triple left-turn to westbound Route 17 and a right-turn lane to eastbound Route 17
- Remove the northeast quadrant loop ramp from the northbound I-95 C-D lanes to westbound Route 17
- Widen Route 17 in the vicinity of the new signal to provide three westbound Route 17 travel lanes to increase the efficiency of the traffic signal

**Option 2 - Grade Separate Northbound I-95 Off Ramp:** Three options were considered to grade separate the off-ramp from the northbound I-95 C-D lanes to westbound Route 17 as follows:

##### **Option 2A – Route 17 Over (see Figure 4-9)**

- Grade separate eastbound Route 17 over a new off-ramp from the northbound I-95 C-D lanes to westbound Route 17 and provide a two-lane left-hand entrance along westbound Route 17
- Provide five lanes on westbound Route 17 under the I-95 bridges to accommodate two lanes from northbound I-95, two lanes from westbound Route 17 Business, and one lane to the loop ramp to southbound I-95
- Remove the northeast quadrant loop ramp from the northbound I-95 C-D lanes to westbound Route 17

##### **Option 2B – Outside Flyover (see Figure 4-10)**

- Grade separate eastbound Route 17 under a new off-ramp from the northbound I-95 C-D lanes to westbound Route 17 and provide a two-lane left-hand entrance along westbound Route 17
- Provide five lanes on westbound Route 17 under the I-95 bridges to accommodate two lanes from northbound I-95, two lanes from westbound Route 17 Business, and one lane to the loop ramp to southbound I-95
- Remove the northeast quadrant loop ramp from the northbound I-95 C-D lanes to westbound Route 17

##### **Option 2C – Inside Flyover (see Figure 4-11)**

- Grade separate a new off-ramp from the northbound I-95 C-D lanes to westbound Route 17 and provide a new two-lane loop ramp in the northeast quadrant with a left-hand entrance along westbound Route 17

- Provide five lanes on westbound Route 17 under the I-95 bridges to accommodate two lanes from northbound I-95, two lanes from westbound Route 17 Business, and one lane to the loop ramp to southbound I-95
- Remove the existing northeast quadrant loop ramp from the northbound I-95 C-D lanes to westbound Route 17

### **Option 3 – Two-Lane Loop Ramp**

- Widen the existing northeast quadrant loop ramp to provide two lanes from the northbound I-95 C-D lanes to westbound Route 17
- Remove the northwest and southeast quadrant loop ramps to eliminate weaves approaching and downstream of the new the two-lane loop ramp
- Install traffic signals along Route 17 both east and west of I-95 to accommodate the westbound Route 17 left turn to southbound I-95 and the eastbound Route 17 left turn to northbound I-95.

### **Option 4 – Lengthened Westbound Route 17 Weave**

- Relocate the diverge location for the northwest quadrant loop ramp from westbound Route 17 to southbound I-95 and lengthen the westbound Route 17 weave between the loop ramps by 200 feet

### **Option 5 – I-95 Northbound Mainline Lanes Flyover (see Figure 4-12)**

- Install a grade-separated loop ramp from the northbound I-95 mainline lanes to westbound Route 17 adjacent to the existing northeast quadrant loop ramp
- Provide five lanes on westbound Route 17 under the I-95 bridges to accommodate two lanes from the two loop ramps, two lanes from westbound Route 17 Business, and one lane to the loop ramp to southbound I-95

**Table 4-3** summarizes the advantages and disadvantages of the seven options under consideration for the Route 17 interchange east of I-95 in addition to making no improvements to Route 17 east of I-95. The following criteria were used to evaluate the eight options:

- Traffic operations
- Removal of the weave along the northbound I-95 C-D lanes
- Removal of the weave along westbound Route 17
- Removal of the weave along eastbound Route 17
- Number of new traffic signals along Route 17
- Right of way and property impacts
- Construction cost

**Option 3 – Two-Lane Loop Ramp** was eliminated because it requires the installation of two additional traffic signals along Route 17 including a signal west of the I-95 interchange downstream from the Sanford Drive/Gateway Drive signalized intersection. Additionally, there would be a high percentage of trucks along the two-lane loop ramp from the northbound I-95 C-D lanes to westbound Route 17 which is not desirable for truck operations. The geometry for this option was not developed in full detail as it was eliminated based on a review of traffic operations. **Option 4 – Lengthened Westbound Route 17 Weave**

was eliminated because it does not address capacity deficiencies along the northbound I-95 C-D lanes within the weave between the loop ramps. The geometry for this option was not developed in full detail as it was eliminated based on a review of traffic operations. **Option 5 – I-95 Northbound Mainline Lanes Flyover** was eliminated because it does not fully address capacity issues within the weave along the northbound I-95 C-D lanes, requires relocation of the northbound I-95 C-D lanes, and has a high construction cost and right of way impacts compared to other options that provide greater benefits to traffic operations.

VDOT reached a consensus on the preferred option for the Route 17 interchange east of I-95. **Option 1 – Triple Left Turn** was selected based on a review of technical information and input from stakeholders because it best meets the project purpose and need while balancing impacts to adjacent properties and minimizing project costs. In terms of traffic operations, both Options 1 and 2 including Options 2A, 2B, and 2C would operate with acceptable traffic operations. Although Option 1 introduces a new traffic signal that stops both eastbound and westbound Route 17 and would result in greater travel times for the northbound I-95 to westbound Route 17 movement, Option 1 minimizes right of way impacts to adjacent properties and has the lowest project cost compared to other options under consideration that result in acceptable traffic operations. Additionally, Option 1 does not preclude a future grade separation of the movement from the northbound I-95 C-D lanes to westbound Route 17 (Option 2). **Section 7** further documents the traffic operations of Option 1 – Triple Left Turn.

#### 4.4.4 Summary of Preferred Build Alternative

**Figure 4-13** depicts the preferred Build Alternative for the I-95 Rappahannock River Crossing Northbound project including the selected Build Alternative for the northbound I-95 mainline lanes and C-D lanes (**Alternative 2 – Begin C-D Lanes North of Route 3**) and the selected options for the Route 17 interchange. West of I-95, **Option B - Signalized Triple Right Turn** was selected as the Build Alternative. East of I-95, **Option 1 - Triple Left Turn** was selected as the Build Alternative.

There is uncertainty in the ultimate project cost since the project has not yet been advertised or awarded to a contractor; therefore, two bid options are under consideration:

**Bid Option A – Auxiliary Lane between Route 17 and Centreport Parkway:** This option includes construction of an auxiliary lane that would extend along northbound I-95 from the C-D lane entrance north of Route 17 to the northbound I-95 off-ramp to Centreport Parkway to provide additional capacity at the merge between the northbound I-95 mainline lanes and C-D lanes.

**Bid Option B - Replacement of the C-D Road Bridge Over Route 17:** This option includes full replacement of the existing bridge carrying the C-D lanes over Route 17 and approximately 1,000 feet of approach and departure C-D roadway on either side of the bridge. The existing bridge has less than desirable vertical clearance above Route 17 and insufficient horizontal width between piers for any future widening of Route 17. Replacing the bridge during construction of the overall project will avoid future construction disruptions within the interchange, provide 16.5-foot vertical clearance, and provide horizontal clearance to match the other recently constructed bridges within the interchange to support future Route 17 widening.

VDOT reached a consensus on the preferred Build Alternative based on a review of the technical information, stakeholder input, and the ability of each option to meet the project purpose and need. The

preferred Build Alternative will be presented at an upcoming Public Hearing on August 22, 2019 and is discussed in more detail in **Chapter 5**.

Figure 4-8: Option 1 - Triple Left Turn

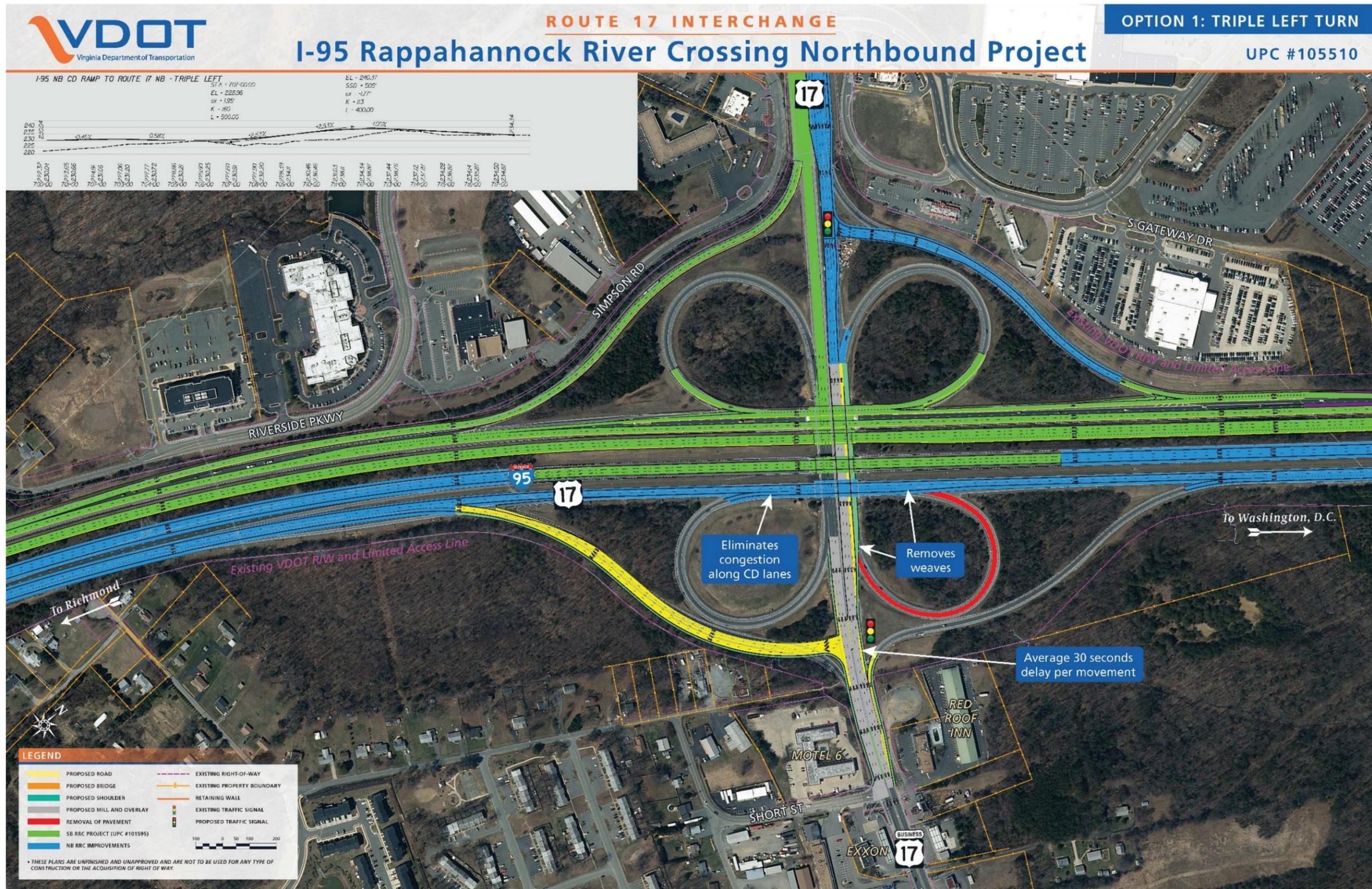


Figure 4-9: Option 2A – Grade Separate Northbound I-95 Off-Ramp – Route 17 Over

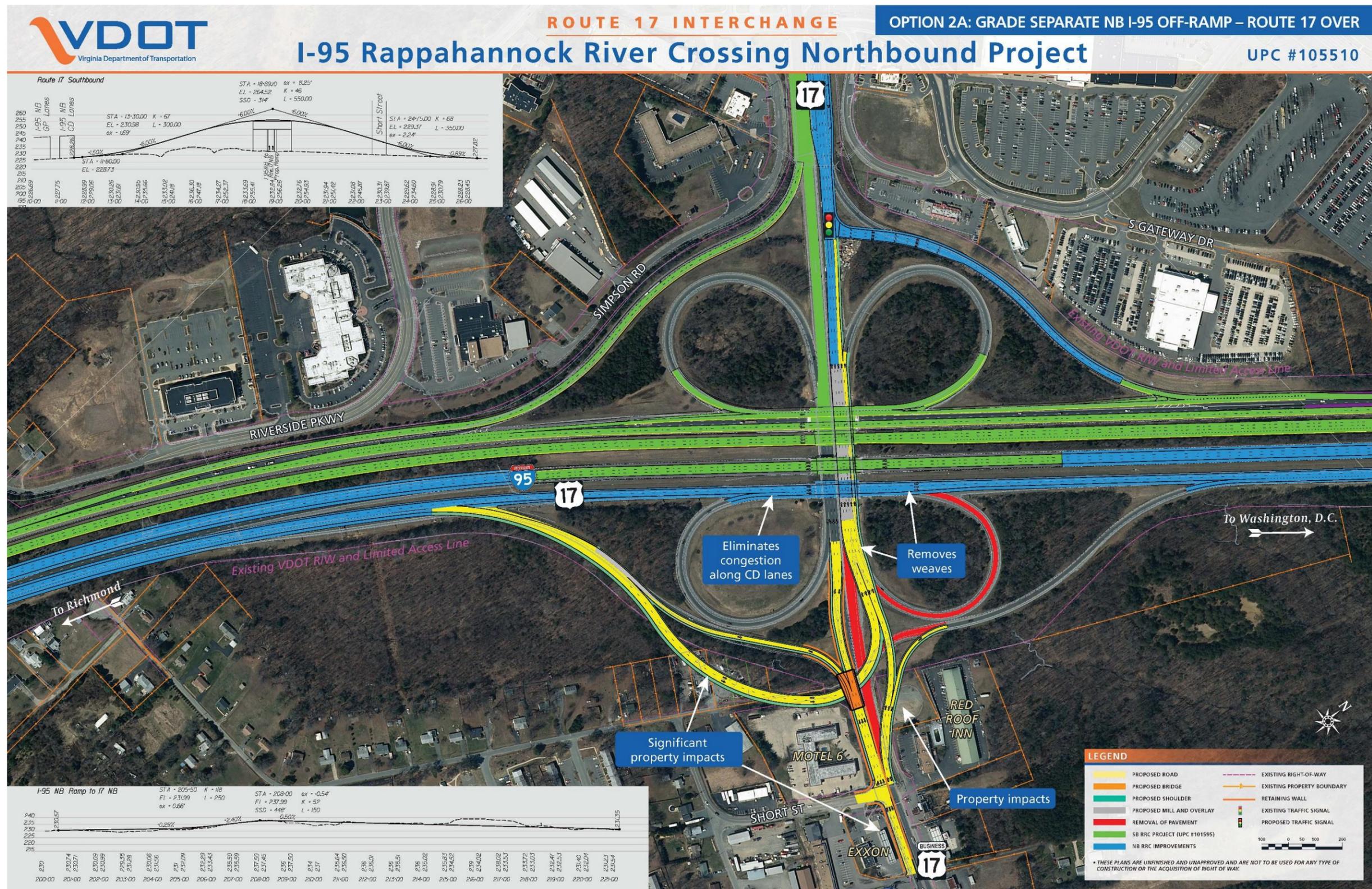




Figure 4-11: Option 2C – Grade Separate Northbound I-95 Off-Ramp – Inside Flyover

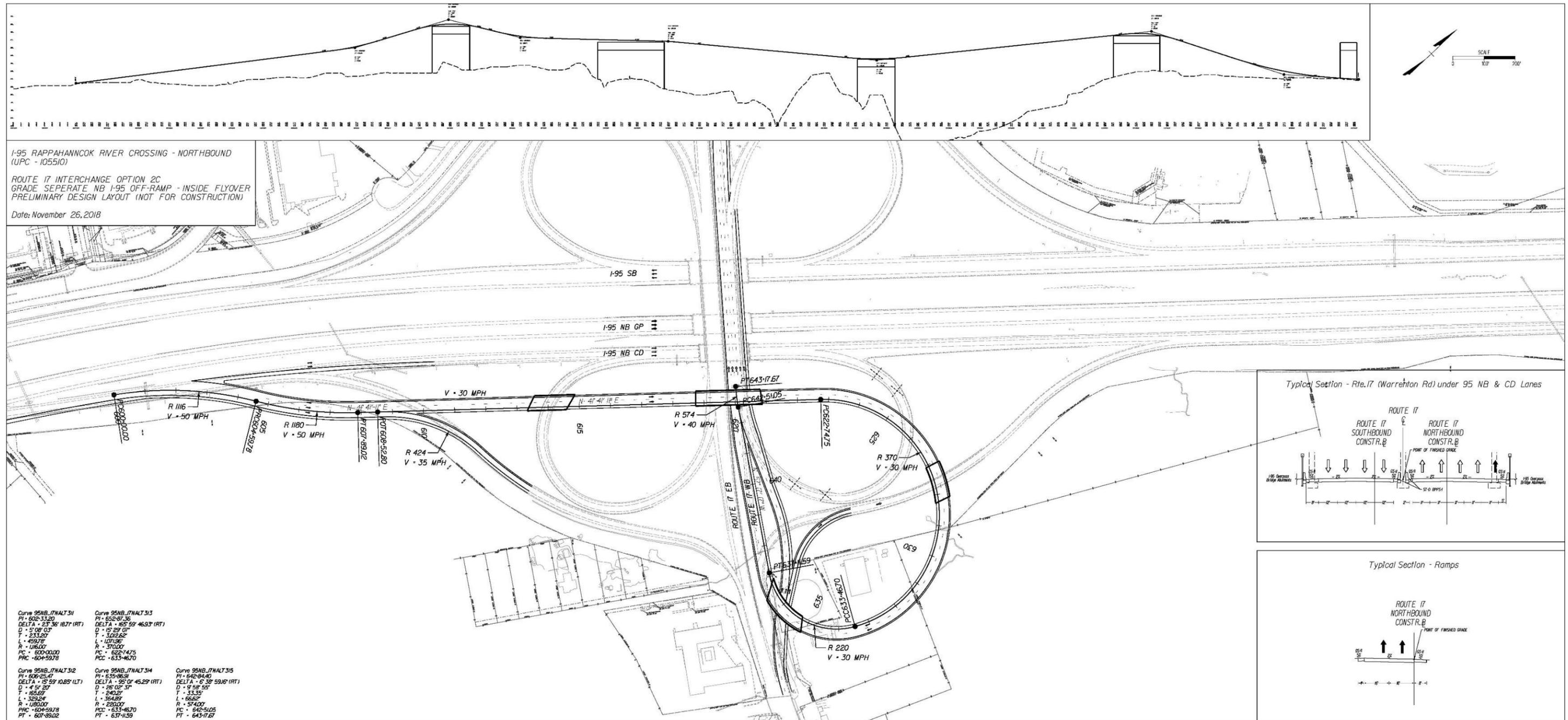


Figure 4-12: Option 5 – I-95 Northbound Mainline Lanes Flyover

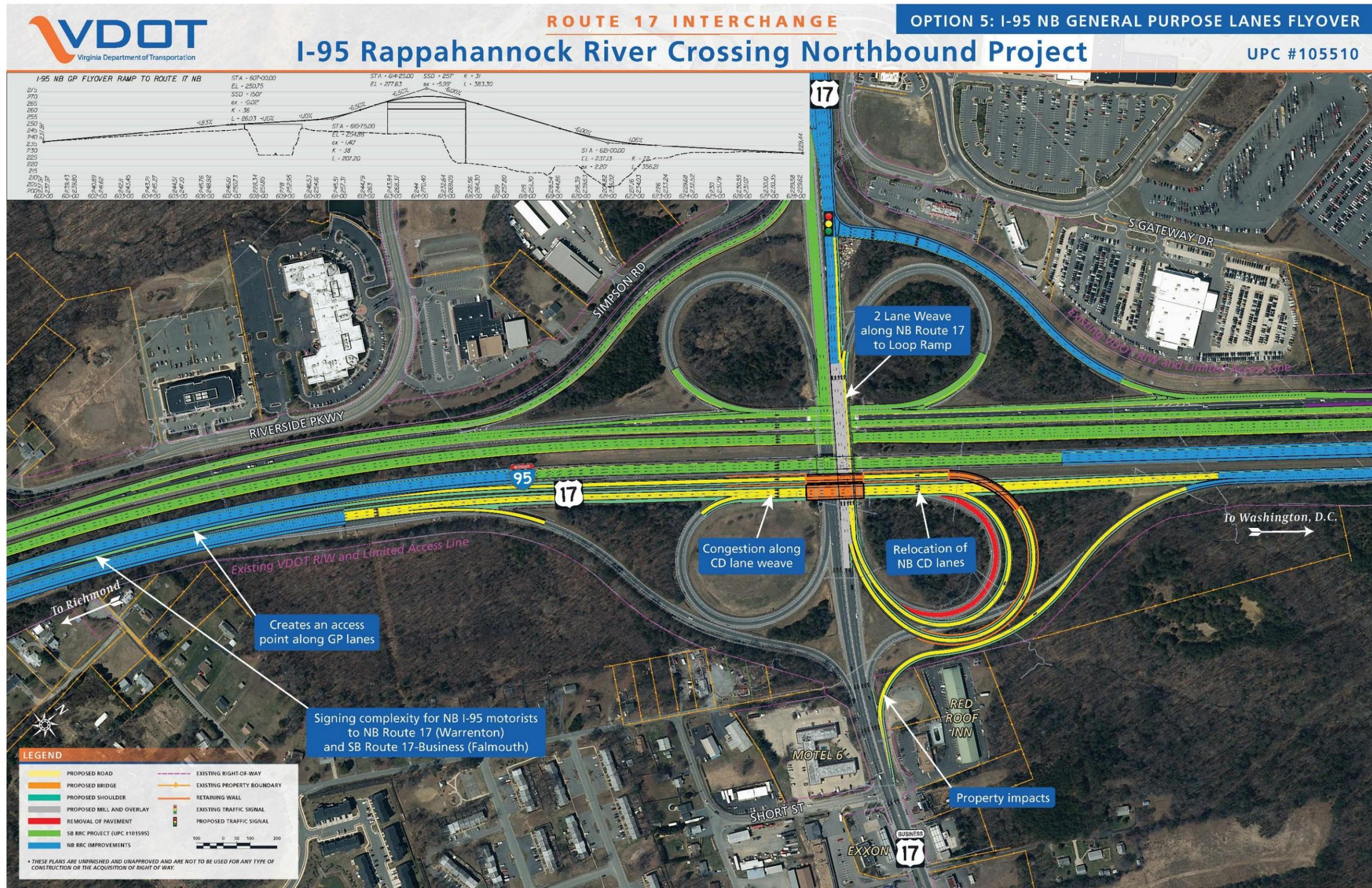
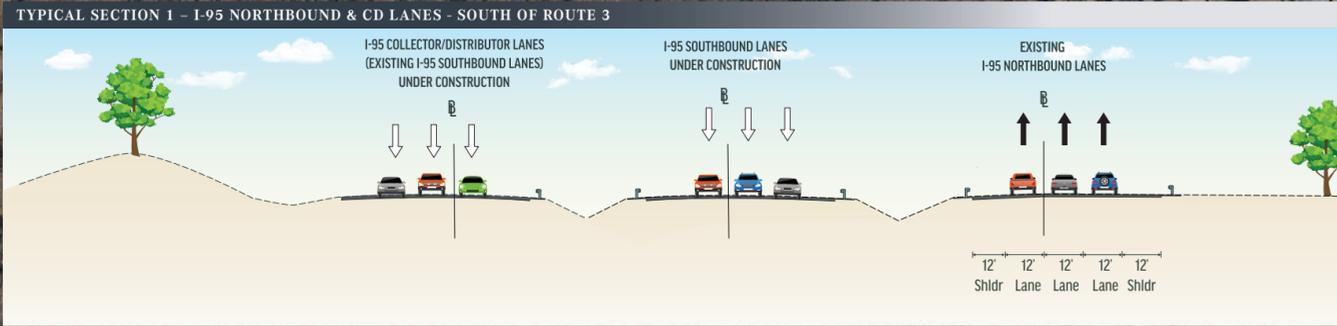


Table 4-3: Comparison of Route 17 – East of I-95 Options

Measure of Effectiveness	No Route 17 Improvements	Option 1 - Triple Left Turn	Option 2 – Grade Separate NB I-95 Off-Ramp			Option 3 – Two-Lane Loop Ramp	Option 4 – Lengthened WB Route 17 Weave	Option 5 – I-95 NB Mainline Lanes Flyover
			Option 2A - Route 17 Over	Option 2B – Outside Flyover	Option 2C – Inside Flyover			
<b>Description</b>	<ul style="list-style-type: none"> <li>No improvements along Route 17 east of I-95</li> </ul>	<ul style="list-style-type: none"> <li>Install 3-phase signalized intersection at the NB C-D lanes I-95 off-ramp to Route 17 (signalized triple left-turn and right-turn lane)</li> <li>Remove the NE loop ramp</li> <li>Widen Route 17 in the vicinity of the new signal</li> <li>Does not preclude a future grade separation (Option 2)</li> </ul>	<ul style="list-style-type: none"> <li>Grade separate EB Route 17 over the off-ramp from the NB I-95 C-D lanes to WB Route 17 (left entrance along WB Route 17)</li> <li>Remove the NE loop ramp</li> <li>Includes 5 lanes on WB Route 17 under I-95 bridges</li> </ul>	<ul style="list-style-type: none"> <li>Grade separate EB Route 17 under the off-ramp from the NB I-95 C-D lanes to WB Route 17 (left entrance along WB Route 17)</li> <li>Remove the NE loop ramp</li> <li>Includes 5 lanes on WB Route 17 under I-95 bridges</li> </ul>	<ul style="list-style-type: none"> <li>Grade separate the off-ramp from the NB I-95 C-D lanes to WB Route 17 (new NE quadrant loop ramp with a left entrance along WB Route 17)</li> <li>Remove the existing NE loop ramp</li> <li>Includes 5 lanes on WB Route 17 under I-95 bridges</li> </ul>	<ul style="list-style-type: none"> <li>Widen the existing NE quadrant loop ramp to provide two lanes</li> <li>Remove the NW and SE loop ramps to eliminate weaves with the two-lane loop ramp</li> </ul>	<ul style="list-style-type: none"> <li>Relocate the diverge location for the NW quadrant loop ramp and lengthen the WB Route 17 weave by 200 feet</li> </ul>	<ul style="list-style-type: none"> <li>Install a grade-separated loop ramp from NB I-95 mainline lanes to WB Route 17 adjacent to the existing NE quadrant loop ramp</li> <li>Includes 5 lanes on WB Route 17 under I-95 bridges</li> </ul>
<b>Traffic Operations <sup>1</sup></b>	<ul style="list-style-type: none"> <li>Severe congestion on NB and SB C-D Lanes, Route 17, and Route 3 caused by NB C-D Lanes weave between loop ramps</li> <li>NE loop ramp volume (2,100 veh/hr) exceeds capacity of a 25-mph loop ramp (1,900 pc/hr)</li> </ul>	<ul style="list-style-type: none"> <li>NB left-turn queues from signalized ramp do not extend to NB I-95 C-D Lanes</li> <li>NB I-95 vehicles traveling to Route 17 may choose the appropriate travel lane on the off-ramp based on their downstream destination on Route 17, reducing the amount of lane changing and weaving on WB Route 17</li> </ul>	<ul style="list-style-type: none"> <li>Free flow operation for NB I-95 to WB Route 17</li> <li>Queues from Route 17 ramps do not extend onto NB I-95 C-D Lanes</li> <li>No congestion along EB Route 17 between loop ramps</li> </ul>	<ul style="list-style-type: none"> <li>Free flow operation for NB I-95 to WB Route 17</li> <li>Queues from Route 17 ramps do not extend onto NB I-95 C-D Lanes</li> <li>No congestion along EB Route 17 between loop ramps</li> </ul>	<ul style="list-style-type: none"> <li>Free flow operation for NB I-95 to WB Route 17</li> <li>Queues from Route 17 ramps do not extend onto NB I-95 C-D Lanes</li> <li>No congestion along EB Route 17 between loop ramps</li> </ul>	<ul style="list-style-type: none"> <li>Installation of two-lane loop ramp requires removal of NW and SW loop ramps to provide free-flow entries and exits from the loop; this requires installation of two additional signals along Route 17 to accommodate the eliminated loop ramp movements</li> <li>Poor truck operations on two-lane loop ramp</li> <li>Eastbound Route 17 queues approaching ramp signal to SB I-95 extend through Sanford Drive intersection</li> </ul>	<ul style="list-style-type: none"> <li>Congestion along the NB I-95 C-D Lanes due to the weave between the loop ramps causes congestion extending along the C-D Lanes to Route 3 as well as congestion on Route 3 and Route 17</li> <li>Congestion on EB Route 17 weave extends into SB I-95 C-D Lanes</li> <li>Negligible improvements compared to the “No Route 17 Improvements” option</li> </ul>	<ul style="list-style-type: none"> <li>Congestion in weave along NB I-95 C-D lanes</li> <li>Creates an additional diverge along the NB I-95 mainline lanes</li> <li>Free flow operation for NB I-95 mainline lanes to WB Route 17</li> <li>Queues from Route 17 ramps do not extend onto NB I-95 C-D lanes</li> <li>No congestion along EB Route 17 between loop ramps</li> </ul>
<b>Removes Weave along NB I-95 C-D Lanes</b>	✗ No	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✗ No	✗ No
<b>Removes Weave along WB Route 17</b>	✗ No	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✗ No	✗ No
<b>Removes Weave along EB Route 17</b>	✗ No	✗ No	✗ No	✗ No	✗ No	✓ Yes	✗ No	✗ No
<b>Number of New Traffic Signals along Route 17</b>	✓ 0	✗ 1 full signal (3-phase) east of I-95 (stops EB and WB Route 17)	✓ 0	✓ 0	✓ 0	✗ 2 half signals to allow two-lane loop ramp to operate without a weave	✓ 0	✓ 0
<b>Right of Way / Property Impacts</b>	✓ None	✓ Minor property impact to parcels along the ramp from NB I-95 to Route 17 due to ramp widening	✗ Impacts to properties along Route 17 east of I-95 ramps and properties in the SE quadrant of the interchange	✗ High impacts to properties in the SE quadrant of the interchange	✗ High impacts to properties in the NE quadrant of the interchange	✗ Moderate right of way impacts to hotel property on the NE quadrant due to ramp widening	✓ No right of way impacts	✗ Impacts to properties in the NE quadrant of the interchange
<b>Construction Cost</b>	--	✓ \$5 million	✗ \$25 million ✗ High increase in right of way/utility and construction costs compared to Option 1	✗ \$19 million ✗ High increase in right of way/utility and construction costs compared to Option 1	✗ \$43 million ✗ High increase in right of way/utility and construction costs compared to Option 1	Not available (Construction cost estimate was not developed because option was eliminated based on a review of traffic operations)	✓ \$200,000	✗ \$29 million ✗ High increase in right of way/utility and construction costs compared to Option 1 ✗ Construction of elevated ramp requires relocation of NB I-95 C-D lanes

<sup>1</sup> Assumes unconstrained conditions along northbound I-95 north of the Route 17 interchange to provide a meaningful comparison of interchange option

# I-95 Rappahannock River Crossing Northbound Project

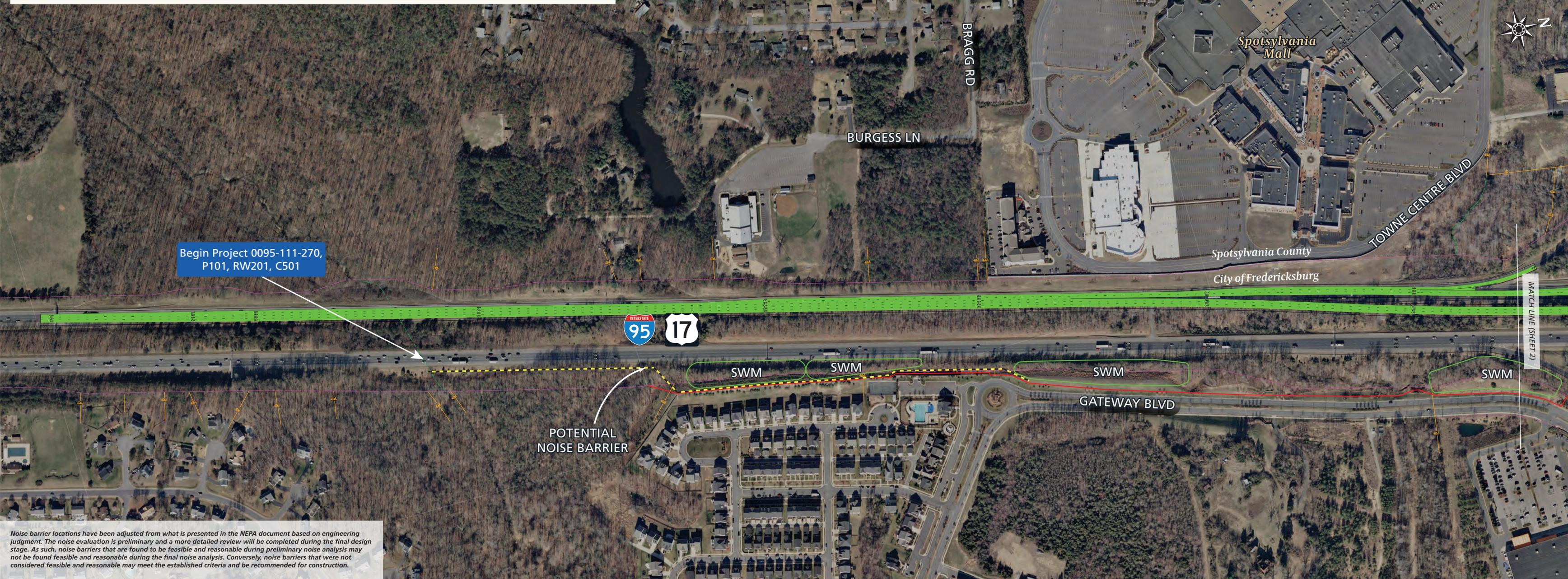


**LEGEND**

PROPOSED ROAD	RECENTLY CONSTRUCTED FALL HILL AVENUE PROJECT (UPC #88699)	EXISTING NOISE BARRIER
PROPOSED BRIDGE	I-95 RAPPAHANNOCK RIVER CROSSING SOUTHBOUND PROJECT (UPC #101595) UNDER CONSTRUCTION	PROPOSED NOISE BARRIER
PROPOSED SHOULDER	POTENTIAL RIGHT OF WAY	POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
PROPOSED MILL AND OVERLAY	POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY	COUNTY/CITY BOUNDARY
REMOVAL OF PAVEMENT	EXISTING RIGHT-OF-WAY	EXISTING TRAFFIC SIGNAL
RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)	LIMITS OF CONSTRUCTION	PROPOSED TRAFFIC SIGNAL
PROPOSED I-95 EXPRESS LANES FREDERICKSBURG EXTENSION (FRED EX) (UPC #110527)	EXISTING PROPERTY BOUNDARY	

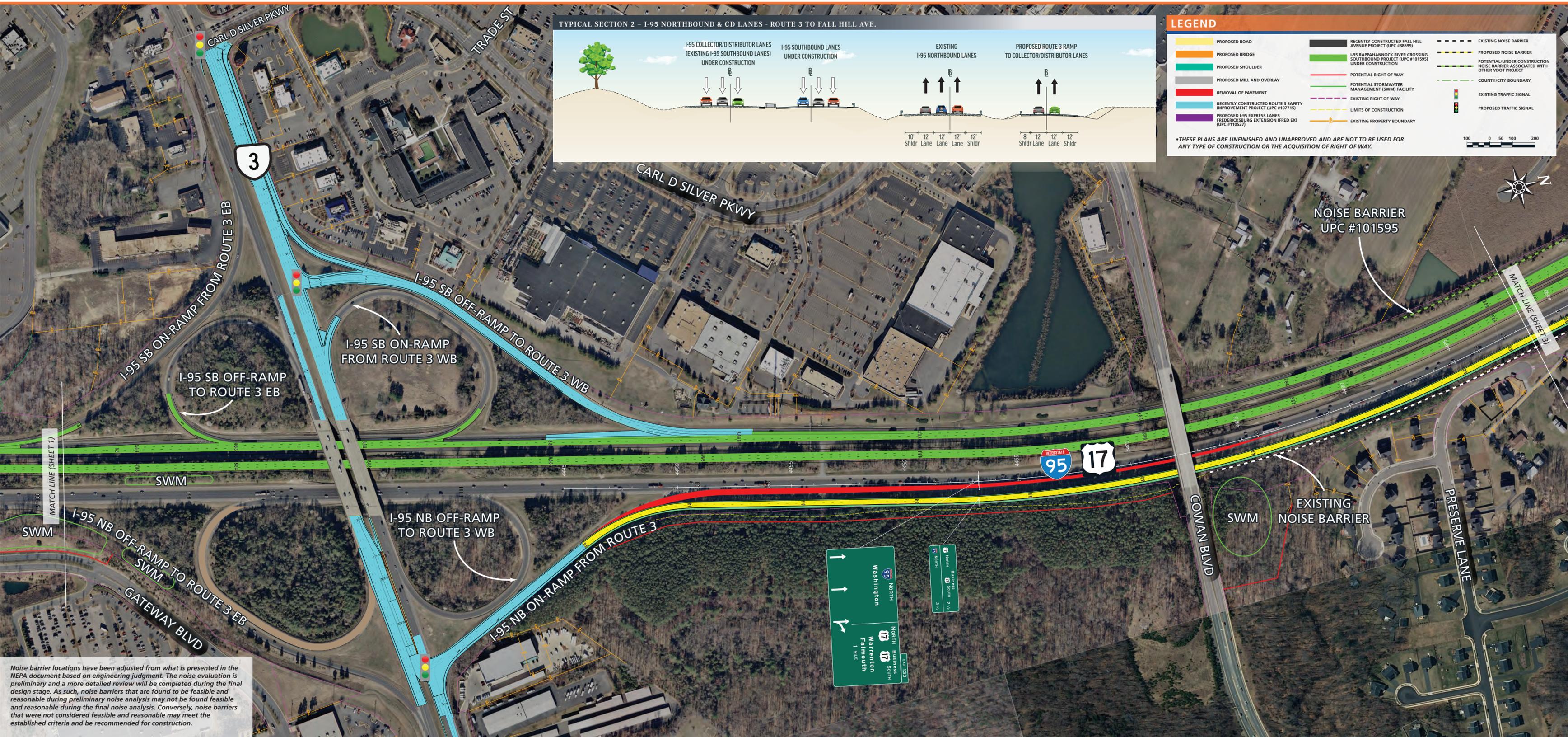
\*THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR THE ACQUISITION OF RIGHT OF WAY.

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Noise barrier locations have been adjusted from what is presented in the NEPA document based on engineering judgment. The noise evaluation is preliminary and a more detailed review will be completed during the final design stage. As such, noise barriers that are found to be feasible and reasonable during preliminary noise analysis may not be found feasible and reasonable during the final noise analysis. Conversely, noise barriers that were not considered feasible and reasonable may meet the established criteria and be recommended for construction.

# I-95 Rappahannock River Crossing Northbound Project



**LEGEND**

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PROPOSED SHOULDER	POTENTIAL RIGHT OF WAY	POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
PROPOSED MILL AND OVERLAY	POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY	COUNTY/CITY BOUNDARY
REMOVAL OF PAVEMENT	EXISTING RIGHT-OF-WAY	EXISTING TRAFFIC SIGNAL
RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)	LIMITS OF CONSTRUCTION	PROPOSED TRAFFIC SIGNAL
PROPOSED I-95 EXPRESS LANES (FRED EX) (UPC #110527)	EXISTING PROPERTY BOUNDARY	

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# I-95 Rappahannock River Crossing Northbound Project



**LEGEND**

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PROPOSED SHOULDER	POTENTIAL RIGHT OF WAY	POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
PROPOSED MILL AND OVERLAY	POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY	COUNTY/CITY BOUNDARY
REMOVAL OF PAVEMENT	EXISTING RIGHT-OF-WAY	EXISTING TRAFFIC SIGNAL
RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)	LIMITS OF CONSTRUCTION	PROPOSED TRAFFIC SIGNAL
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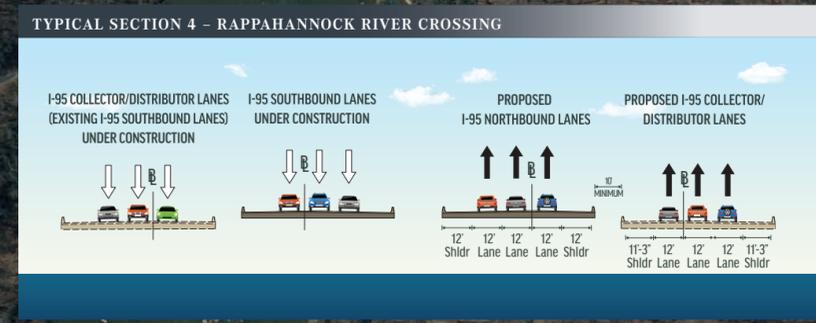
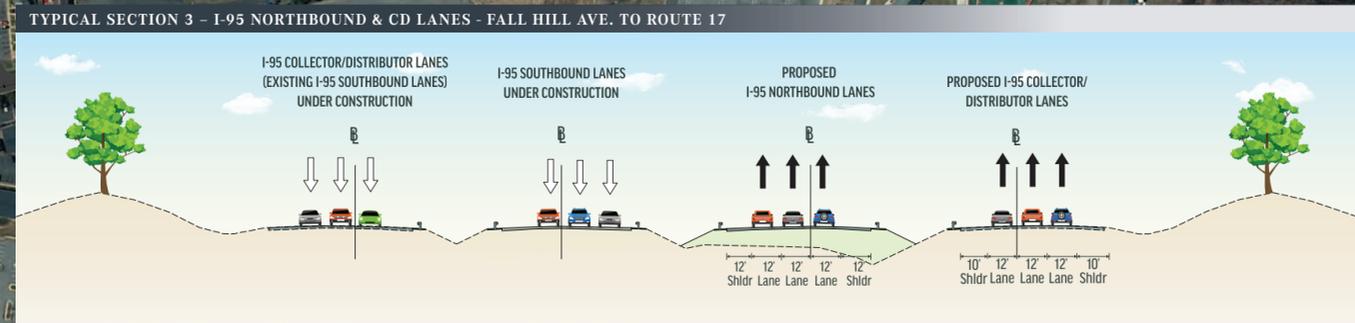
NOISE BARRIER  
UPC #101595

I-95 Southbound Lanes  
Rappahannock River  
Crossing:  
Project 0095-111-259, B604

MATCH LINE (SHEET 2)

MATCH LINE (SHEET 4)

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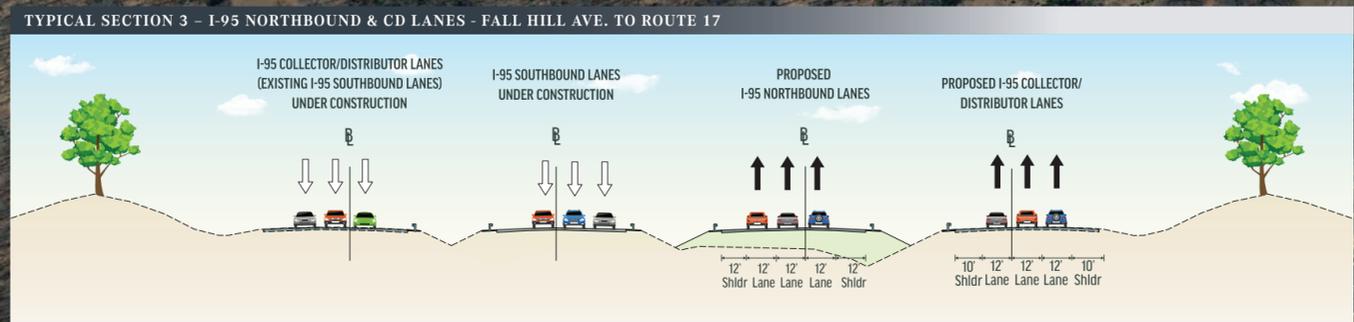
# I-95 Rappahannock River Crossing Northbound Project

**LEGEND**

PROPOSED ROAD	RECENTLY CONSTRUCTED FALL HILL AVENUE PROJECT (UPC #88699)	EXISTING NOISE BARRIER
PROPOSED BRIDGE	I-95 RAPPAHANNOCK RIVER CROSSING SOUTHBOUND PROJECT (UPC #101595) UNDER CONSTRUCTION	PROPOSED NOISE BARRIER
PROPOSED SHOULDER	POTENTIAL RIGHT OF WAY	POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
PROPOSED MILL AND OVERLAY	POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY	COUNTY/CITY BOUNDARY
REMOVAL OF PAVEMENT	EXISTING RIGHT-OF-WAY	EXISTING TRAFFIC SIGNAL
RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)	LIMITS OF CONSTRUCTION	PROPOSED TRAFFIC SIGNAL
PROPOSED I-95 EXPRESS LANES, FREDERICKSBURG EXTENSION (FRED EX) (UPC #110527)	EXISTING PROPERTY BOUNDARY	

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# I-95 Rappahannock River Crossing Northbound Project

## ROUTE 17 INTERCHANGE CONFIGURATION

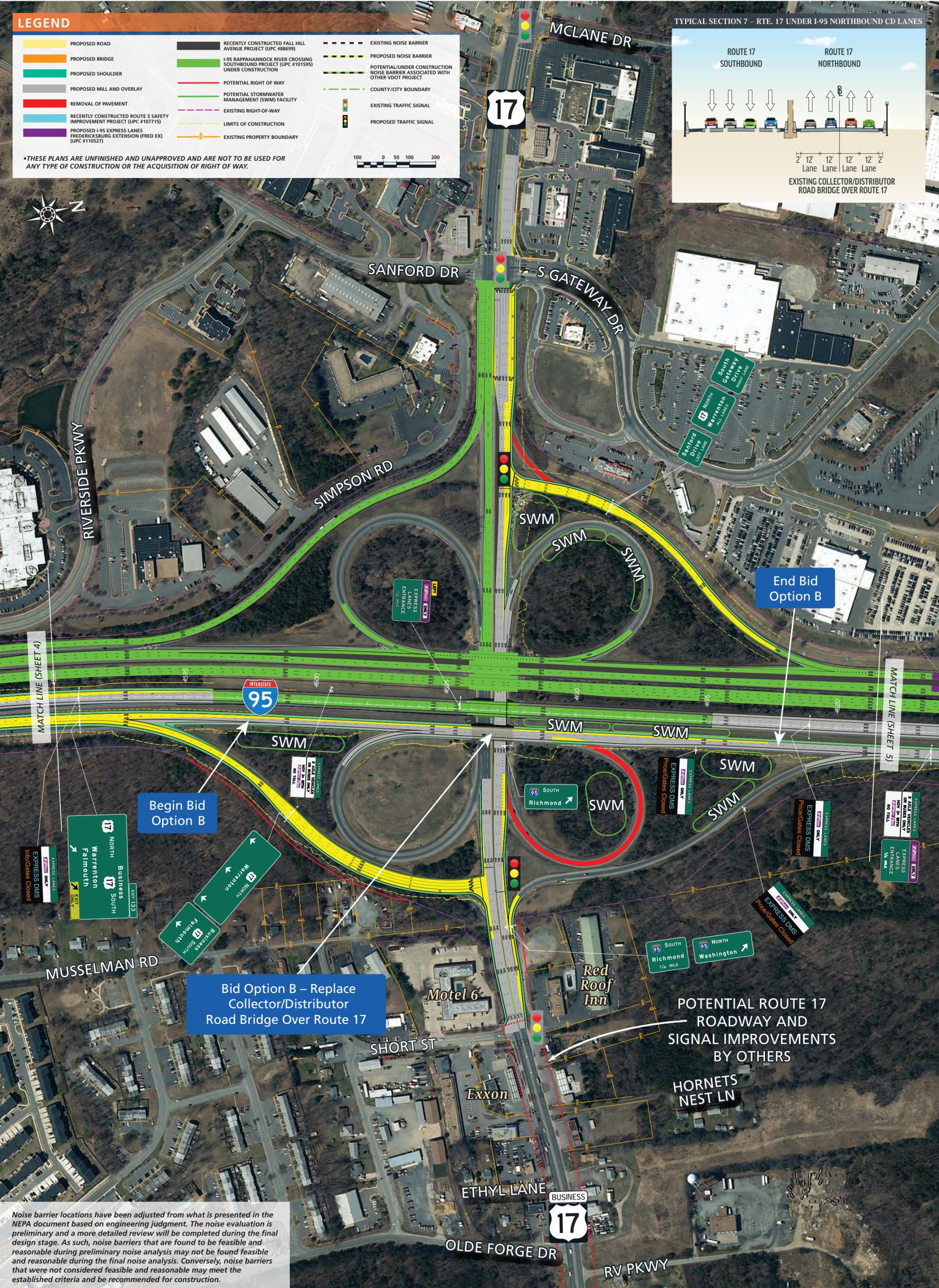
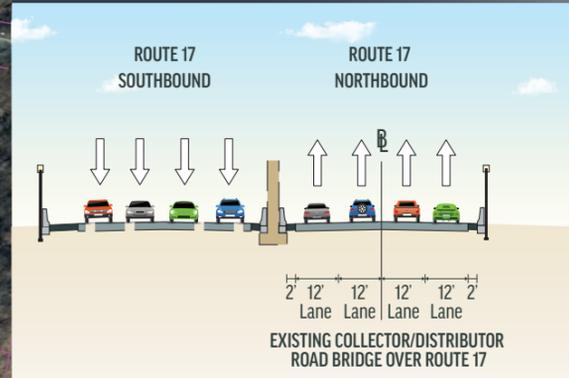
**LEGEND**

	PROPOSED ROAD		RECENTLY CONSTRUCTED FALL HILL AVENUE PROJECT (UPC #88699)		EXISTING NOISE BARRIER
	PROPOSED BRIDGE		I-95 RAPPAHANNOCK RIVER CROSSING SOUTHBOUND PROJECT (UPC #101595) UNDER CONSTRUCTION		PROPOSED NOISE BARRIER
	PROPOSED SHOULDER		POTENTIAL RIGHT OF WAY		POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
	PROPOSED MILL AND OVERLAY		POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY		COUNTY/CITY BOUNDARY
	REMOVAL OF PAVEMENT		EXISTING RIGHT-OF-WAY		EXISTING TRAFFIC SIGNAL
	RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)		LIMITS OF CONSTRUCTION		PROPOSED TRAFFIC SIGNAL
	PROPOSED I-95 EXPRESS LANES FREDERICKSBURG EXTENSION (FRED EX) (UPC #110527)		EXISTING PROPERTY BOUNDARY		

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TYPICAL SECTION 7 - RTE. 17 UNDER I-95 NORTHBOUND CD LANES



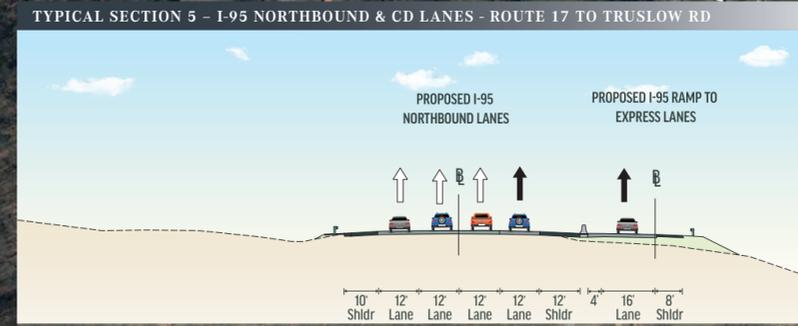
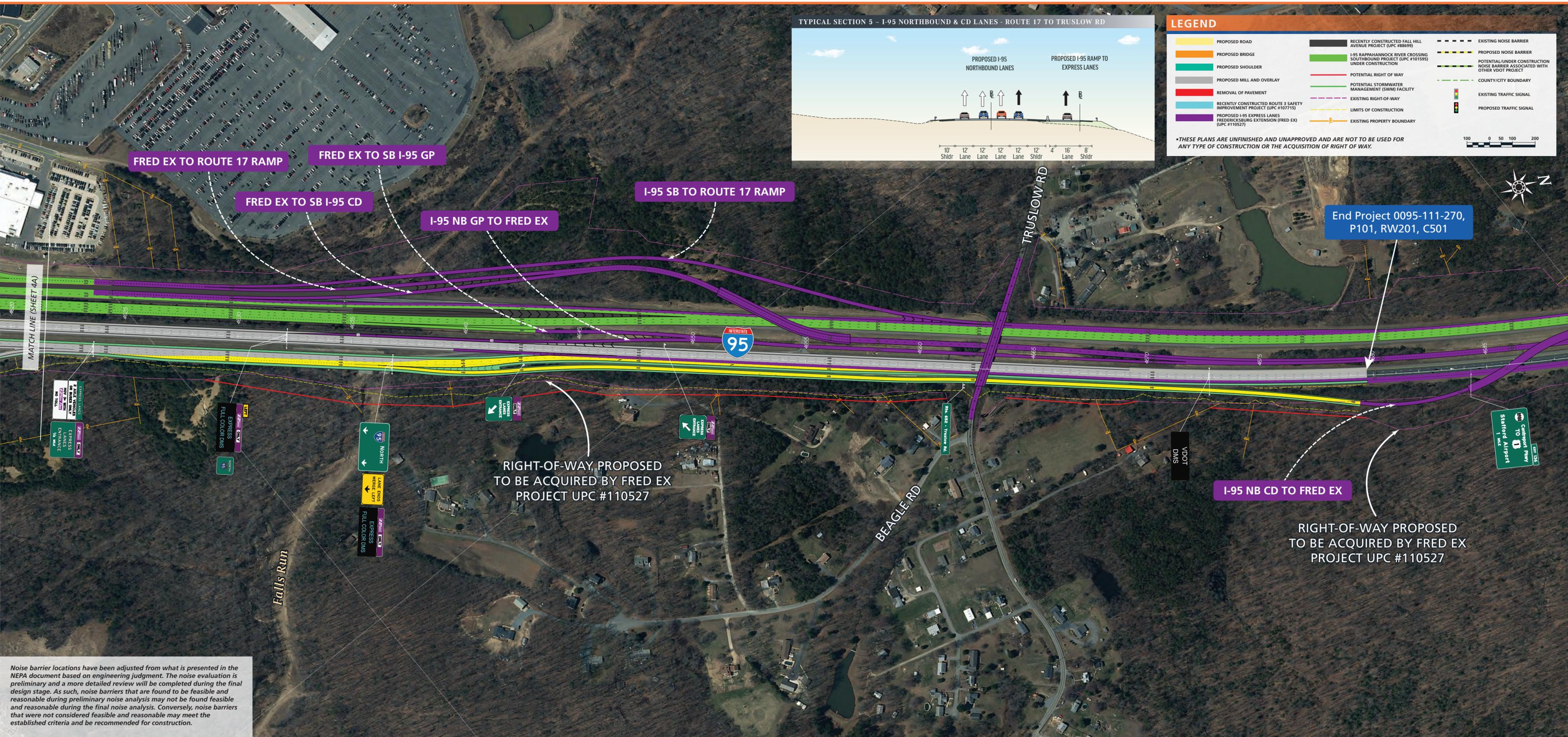
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POTENTIAL ROUTE 17 ROADWAY AND SIGNAL IMPROVEMENTS BY OTHERS

HORNETS NEST LN

RV PKWY

# I-95 Rappahannock River Crossing Northbound Project



**LEGEND**

PROPOSED ROAD	RECENTLY CONSTRUCTED FALL HILL AVENUE PROJECT (UPC #88699)	EXISTING NOISE BARRIER
PROPOSED BRIDGE	I-95 RAPPAHANNOCK RIVER CROSSING SOUTHBOUND PROJECT (UPC #101595) UNDER CONSTRUCTION	PROPOSED NOISE BARRIER
PROPOSED SHOULDER	POTENTIAL RIGHT OF WAY	POTENTIAL/UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
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REMOVAL OF PAVEMENT	EXISTING RIGHT-OF-WAY	EXISTING TRAFFIC SIGNAL
RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)	LIMITS OF CONSTRUCTION	PROPOSED TRAFFIC SIGNAL
PROPOSED I-95 EXPRESS LANES, FREDERICKSBURG EXTENSION (FRED EX) (UPC #110527)	EXISTING PROPERTY BOUNDARY	

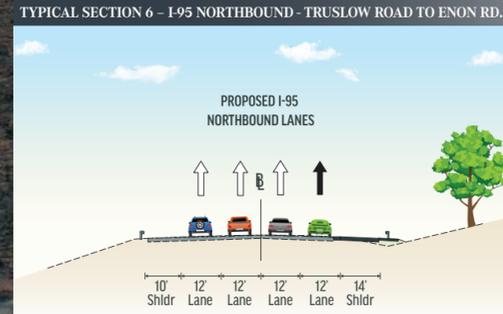
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# I-95 Rappahannock River Crossing Northbound Project

## BID OPTION A — EXTEND I-95 NORTHBOUND AUXILIARY LANE TO CENTREPORT PARKWAY RAMP



**LEGEND**

- PROPOSED ROAD
- PROPOSED BRIDGE
- PROPOSED SHOULDER
- PROPOSED MILL AND OVERLAY
- REMOVAL OF PAVEMENT
- RECENTLY CONSTRUCTED ROUTE 3 SAFETY IMPROVEMENT PROJECT (UPC #107715)
- PROPOSED I-95 EXPRESS LANES FREDERICKSBURG EXTENSION (FRED EX) (UPC #110527)
- RECENTLY CONSTRUCTED FALL HILL AVENUE PROJECT (UPC #88699)
- I-95 RAPPAHANNOCK RIVER CROSSING SOUTHBOUND PROJECT (UPC #101555) UNDER CONSTRUCTION
- POTENTIAL RIGHT OF WAY
- POTENTIAL STORMWATER MANAGEMENT (SWM) FACILITY
- EXISTING RIGHT-OF-WAY
- LIMITS OF CONSTRUCTION
- EXISTING PROPERTY BOUNDARY
- EXISTING NOISE BARRIER
- PROPOSED NOISE BARRIER
- POTENTIAL UNDER CONSTRUCTION NOISE BARRIER ASSOCIATED WITH OTHER VDOT PROJECT
- COUNTY/CITY BOUNDARY
- EXISTING TRAFFIC SIGNAL
- PROPOSED TRAFFIC SIGNAL

\*THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR THE ACQUISITION OF RIGHT OF WAY.

100 0 50 100 200

Begin Bid Option A

POTENTIAL NOISE BARRIER  
UPC #110527

SWM

SWM

SWM

PROPOSED SWM  
BY FRED EX PROJECT  
UPC #110527

End Bid Option A

I-95 SB ON-RAMP FROM  
CENTREPORT PARKWAY

I-95 NB OFF-RAMP TO  
CENTREPORT PARKWAY

Noise barrier locations have been adjusted from what is presented in the NEPA document based on engineering judgment. The noise evaluation is preliminary and a more detailed review will be completed during the final design stage. As such, noise barriers that are found to be feasible and reasonable during preliminary noise analysis may not be found feasible and reasonable during the final noise analysis. Conversely, noise barriers that were not considered feasible and reasonable may meet the established criteria and be recommended for construction.

## 5. ROADWAY GEOMETRY

### 5.1 DESIGN CRITERIA

The proposed project design was established in accordance with AASHTO, FHWA, and VDOT design guidelines. The following documents were used in the development of the design criteria for the I-95 Rappahannock River Crossing Northbound project:

- AASHTO, A Policy on Geometric Design of Highways and Streets, 6<sup>th</sup> Edition, 2011
- AASHTO, A Policy on Design Standards – Interstate System, May 2016
- AASHTO, Roadside Design Guide, 4th Edition, 2011
- VDOT, Road Design Manual, Issued January 2005, Rev. January 2019
- VDOT, Manual of the Structure and Bridge Division, Volume V, Part 2, 2011, revised 2018
- VDOT, Drainage Manual, Issued April 2002, Rev. March 2019
- VDOT, Guardrail Installation Training Manual, August 2017 Revised January 2019
- VDOT, Instructional and Informational Memoranda

An overview of the criteria shown in **Table 5-1** reflects the selected standards for each roadway classification.

**Table 5-1: Design Criteria - I-95 Rappahannock River Crossing Northbound Project**

Criteria	Northbound I-95 Mainline Lanes Over Rappahannock River	Existing Northbound I-95 / Future I-95 NB C-D Road Over Rappahannock River	Route 17/Warrenton Road	I-95 Interchange Ramps
<b>Functional Classification</b>	Interstate GS-INT	Interstate GS-INT	Urban Principal Arterial GS-5	Interchange Ramp GS-R
<b>Average Daily Traffic (ADT) 2042 Design Year</b>	47,000	44,100	103,800	2,700 – 28,200
<b>Design Speed</b>	75 MPH	70 MPH	45 MPH	25 - 50 MPH
<b>Design Vehicle</b>	WB-67	WB-67	WB-67	WB-67
<b>Lane Width</b>	12 ft	12 ft	11 ft or 12 ft	16 ft (One Lane Ramp) 24 ft (Two Lane Ramp plus curve widening)
<b>Paved Shoulder Width</b>	4 ft – 12 ft	10 ft (Existing)	8 ft or Curb and Gutter	8 ft Right – 4 ft Left
<b>Superelevation Standard, Max Rate</b>	TC-5.11R, 8% Max	TC-5.11R 8% Max	TC-5.11U, 4% Max	TC-5.11R, 8% Max
<b>Min. Vertical Clearance</b>	16.5 ft	16.5 ft	16.5 ft	16.5 ft
<b>Max. Vertical Grade</b>	4%	4%	7%	7% at 30 MPH 4% at 50 MPH

## 5.2 RIGHT-OF-WAY AND LIMITED ACCESS REQUIREMENTS

The I-95 corridor through Fredericksburg is a moderately developed area with varying opportunities for outside widening of the existing roadway. Some locations have ample right of way for widening while others have been heavily developed limiting opportunities for widening.

For the majority of the project limits, the Build Alternative relocates the I-95 northbound mainline lanes into the I-95 median while repurposing the existing I-95 northbound lanes as the northbound C-D lanes. The Build Alternative optimizes the available existing right of way and minimizes impacts to the surrounding existing infrastructure to the extent possible by relocating the I-95 northbound mainline lanes within the median where possible.

**Table 5-2** summarizes the right of way impacts for the I-95 Rappahannock River Crossing Northbound project.

**Table 5-2: Right of Way Impacts**

Right of Way	Required Value
<b>Partial Acquisitions</b>	
Residential	8.74 acres
Commercial	3.37 acres
Agricultural	0.21 acres
<b>Total</b>	<b>12.32 acres</b>

Should Bid Option A be exercised for the auxiliary lane along northbound I-95 between Route 17 and Centreport Parkway, an additional 0.02 acres of residential property would need to be acquired.

The limited access line is being relocated throughout the project limits wherever the right of way is being expanded; however, no additional accesses to non-limited access public roads or private property is proposed as part of the Build Alternative.

## 5.3 GEOMETRIC CONFIGURATION

The alternatives considered during the design process and details of the preferred Build Alternative are discussed in detail in **Chapter 4**.

## 5.4 DESIGN WAIVERS

The Modified Build Alternative was developed using current design guidelines including the AASHTO *A Policy on the Geometric Design of Highways and Streets, 6<sup>th</sup> Edition, 2011* (Green Book) and the VDOT *Road Design Manual*. Based on these requirements, design waivers were developed in situations where the Build Alternative did not meet the specific design standards.

Two design waivers are required as summarized in **Table 5-3** for the I-95 Rappahannock River Crossing Northbound project. No design exceptions are anticipated. As noted, if Bid Option B – Replacement of the C-D Road Bridge Over Route 17 is incorporated into the project, the design waiver for reduced left and

right shoulder widths will not be required. Safety and mitigation strategies pertaining to the usage of design waivers are discussed in their respective reports.

**Table 5-3: Summary of Design Waivers**

Design Waivers	Location	Required Value	Value Provided
Design Waiver: Reduced left and right shoulder widths  <i>Required only for Base project; not required for Bid Option B</i>	Existing C-D lanes bridge over Route 17	Left: 4 ft Paved 6 ft Total  Right: 10 ft Paved 12 ft Total	Left: 4 ft Paved 4 ft Total  Right: 10 ft Paved 10 ft Total
Design Waiver: Reduced left and right shoulder widths	Ramp connection from C-D lanes to Fred Ex under Truslow Road bridge	Left: 4 ft Paved 6 ft Total  Right: 8 ft Paved 10 ft Total	Left: 4 ft Paved 4 ft Total  Right: 8 ft Paved 8 ft Total

## 5.5 CONCEPTUAL SIGNING PLAN AND PAVEMENT MARKING PLAN

**Appendix D** contains a conceptual signing and pavement marking plan for the Build Alternative. The conceptual signing and pavement marking plan was developed using current design standards and guidelines including the *2009 Manual on Uniform Traffic Control Devices (MUTCD)* and the *2011 Virginia Supplement to the MUTCD, Revision 1*. The following is a brief summary of some key design features of the Build Alternative signing:

- Sign panels were designed in accordance with the latest edition of the *MUTCD* and *2011 Virginia Supplement to the MUTCD, Revision 1*.
- The location, age, anticipated construction impacts, and significant increase in the size of sign panels prevent the re-use of existing sign structures; therefore, new sign structures are generally proposed.
- Overhead arrow-per-lane signs are proposed for the I-95 Mainline Lanes / C-D Lane split located north of Route 3 since an interior option lane serving both movements is proposed.
- Due to the length of the C-D lane system, additional advance guide signs and interchange sequence style signs are provided on the C-D lane system for the Route 17 interchange and 95 North.
- The Fred Ex project proposes two entrances at the north end of the I-95 Rappahannock River Crossing Northbound project. The signing for the Fred Ex entrances has been modified to address construction impacts and operational changes proposed by the I-95 Rappahannock River Crossing Northbound project.
- Signs are proposed or existing signs are to be relocated along the I-95 mainline lanes and C-D lanes for the Fred Ex project.
- It is not ideal to provide supplemental destination and specific service signs for the Route 17 interchange in advance of the C-D lane split due to the number of destinations and services and the proximity of the Route 3 interchange. The existing supplemental and specific services signs would generally remain in their existing location; however, some of those signs may be impacted by construction and would need to be relocated or replaced. An additional sign would be provided to

alert C-D lane users that additional destinations and services are located farther north on the C-D lane system at the Route 17 interchange.

The conceptual signing and pavement marking plan will be included in the Request for Proposals (RFP) to potential Design-Build teams. The technical requirements document that will be issued to the offerors prohibits the Design-Build teams from deviating from the concept plan without approval by VDOT.

## 6. TRAFFIC VOLUMES

### 6.1 ANALYSIS YEARS

Traffic volumes were developed for the following scenarios as discussed in **Section 2.2 and Section 2.3**:

- Existing conditions (2016)
- Opening year (2022)
  - No Build Conditions (see **Section 4.2** for included projects)
  - Build Alternative (including the No Build projects plus the proposed improvements associated with the I-95 Rappahannock River Crossing Northbound project)
- Design year (2042)
  - No Build Conditions (see **Section 4.2** for included projects)
  - Build Alternative (including the No Build projects plus the proposed improvements associated with the I-95 Rappahannock River Crossing Northbound project)

### 6.2 EXISTING 2016 TRAFFIC VOLUMES AND PATTERNS

#### 6.2.1 Travel Patterns

I-95 is the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C. and serves local, commuter, and regional traffic. Within the study area, I-95 suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. The peak period congestion is caused by a combination of through traffic along I-95 and traffic utilizing the Route 17 and Route 3 interchanges including a large portion of the traffic traveling along I-95 between Route 17 and Route 3.

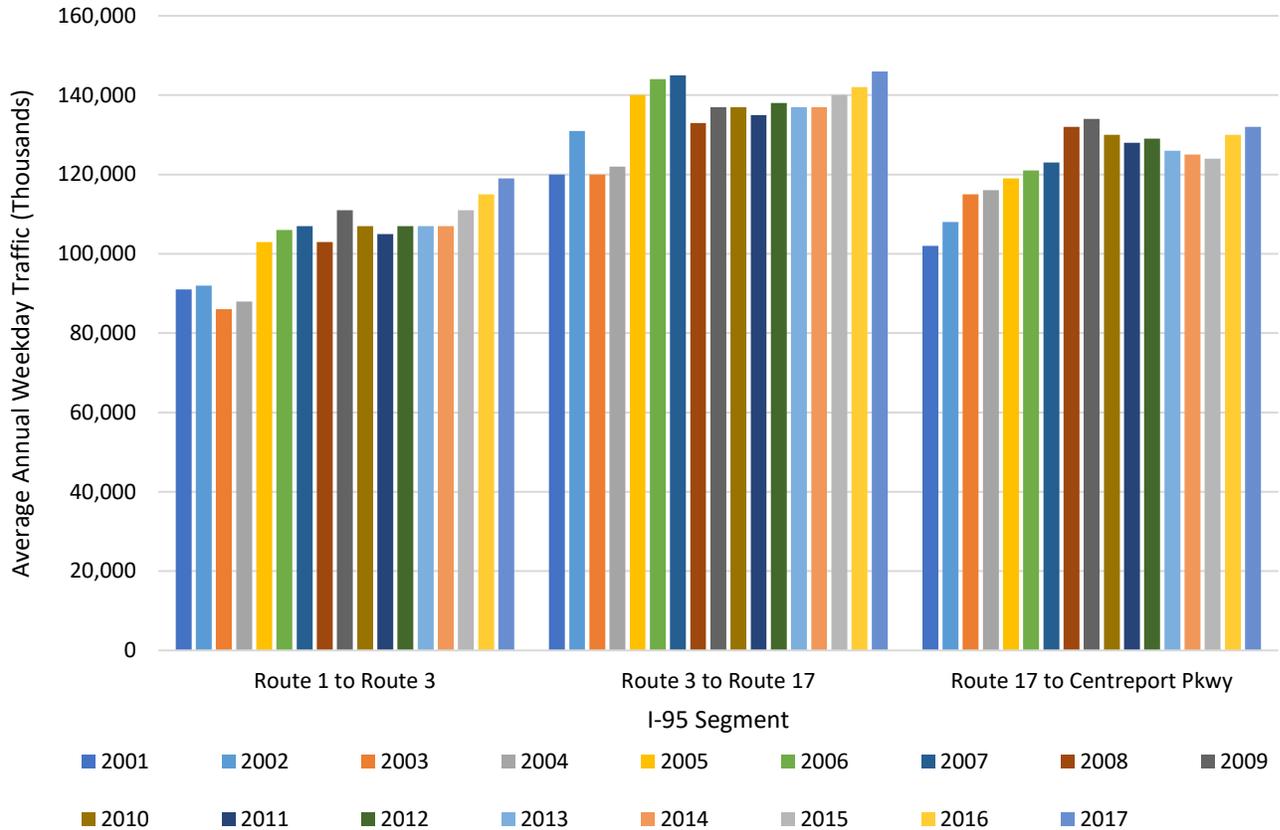
**Figure 6-1** depicts historical average annual weekday traffic volumes (AAWDT) obtained from the VDOT Traffic Data publications. AAWDT traffic volumes are shown for 2001 through 2017 along I-95 within the study area. As shown, daily traffic volumes along I-95 corridor segments between Route 1 and Route 3 as well as between Route 17 and Centreport Parkway have increased by approximately 30% since 2001 (2% annually). Between Route 3 and Centreport Parkway, traffic volumes have grown approximately 22% (1% annually) since 2001.

#### 6.2.2 Traffic Data Collection

Traffic volume data collected for the Fred Ex IJR was used to establish baseline traffic conditions. An extensive data collection effort was undertaken in September, November, and December 2016 including automatic ramp counts, intersection turning movement counts, and VDOT's permanent count stations. Ramp counts were conducted for a minimum of 48 consecutive hours on non-holiday Tuesdays, Wednesdays, and Thursdays during typical school and non-holiday periods. Turning movement counts were also conducted on a typical, non-holiday Tuesday, Wednesday, or Thursday when schools were in session for a twelve-hour period. In addition to the data collected as part of the Fred Ex IJR, VDOT provided turning movement counts at the intersections of Route 17 at Falls Run Drive, Route 17 at McLane Drive, and Route 3 at Central Park Boulevard, which were not previously included in the Fred Ex IJR.

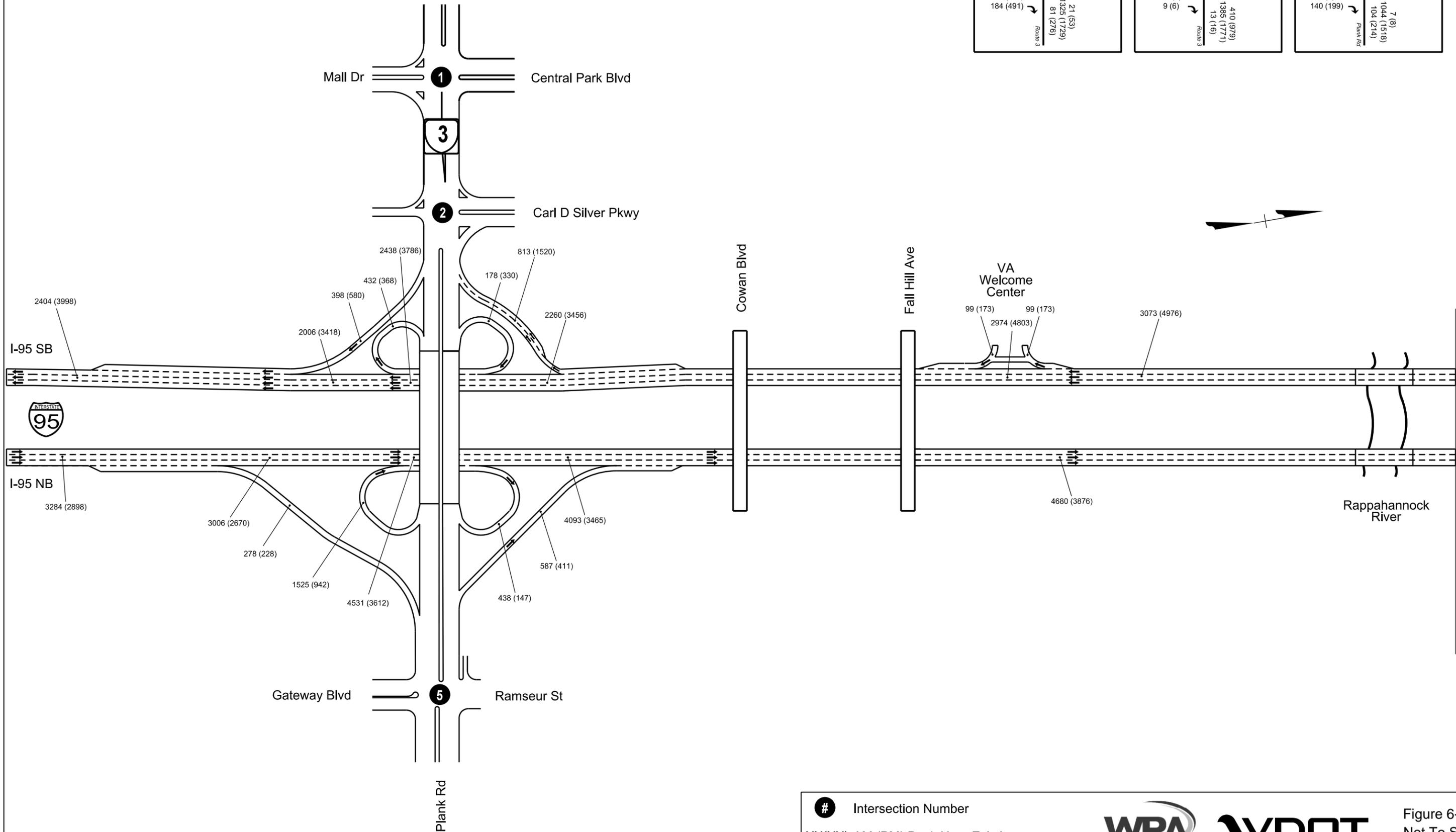
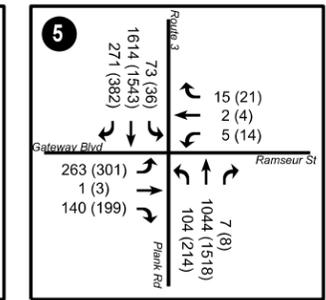
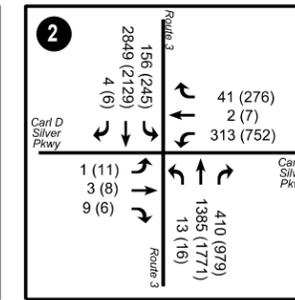
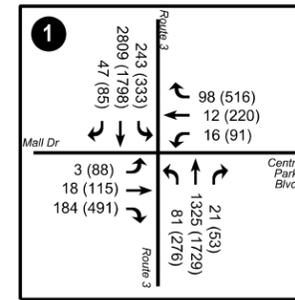
Traffic data at Route 17 Business and Olde Forge Drive was obtained from the Route 3 and Route 17 Business Corridor STARS Study. Existing traffic data is included in **Appendix B**.

**Figure 6-1: I-95 Historical Average Weekday Traffic Volumes**



### 6.2.3 Summary of Peak Hour Traffic Volumes

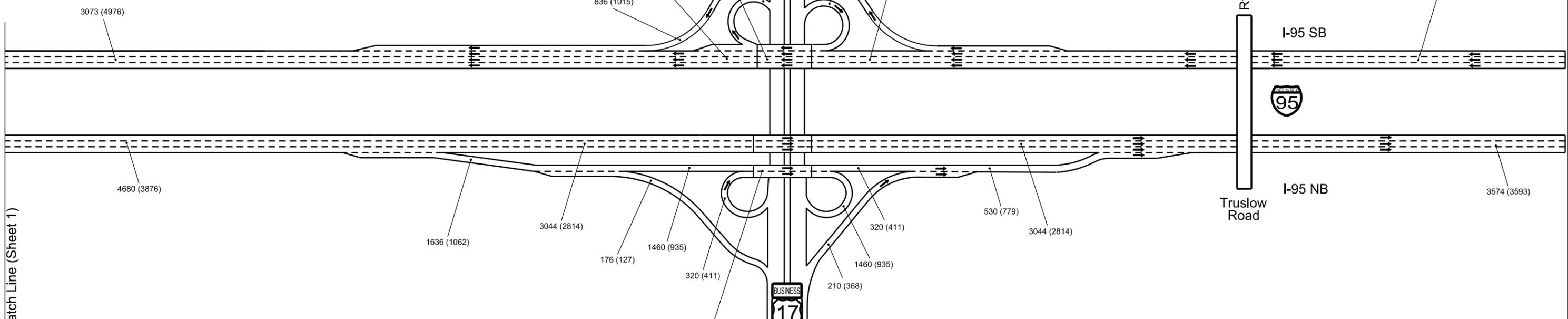
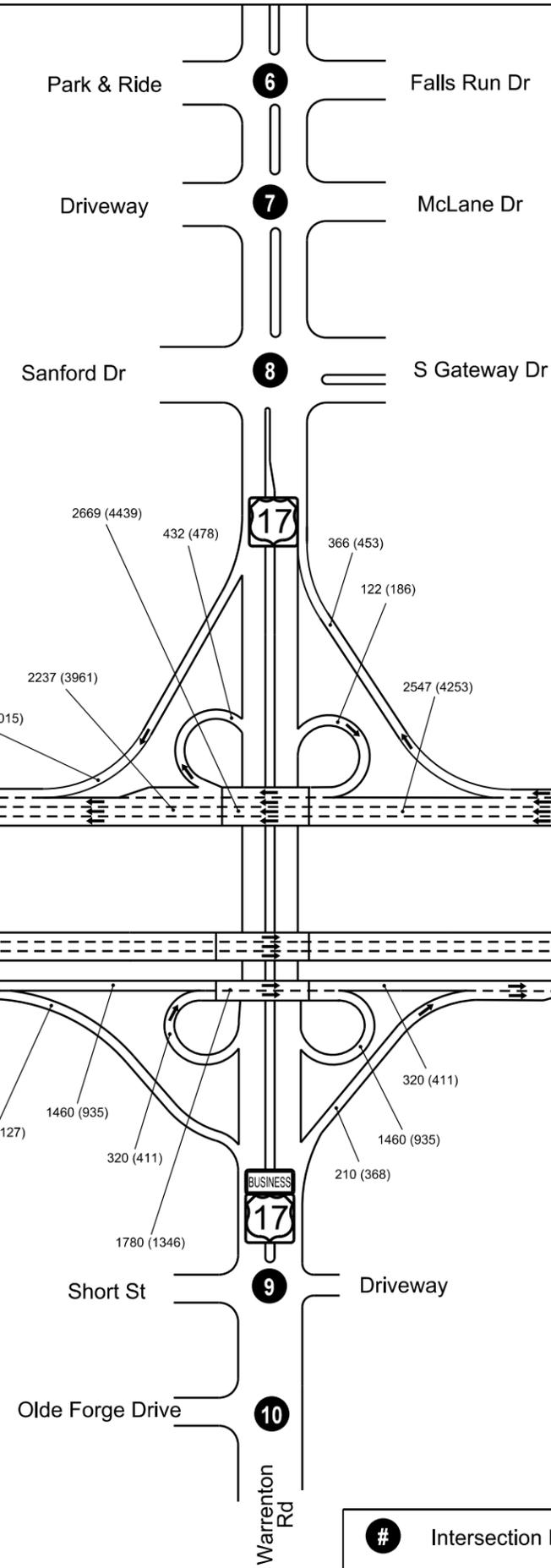
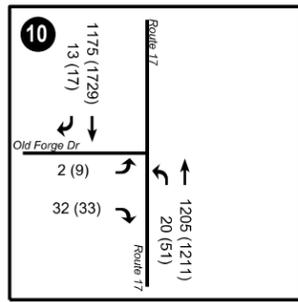
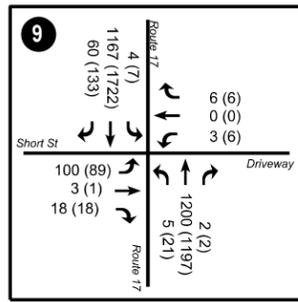
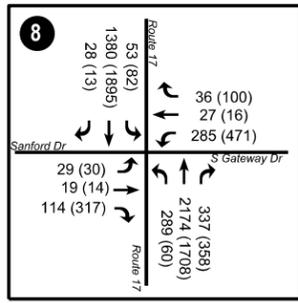
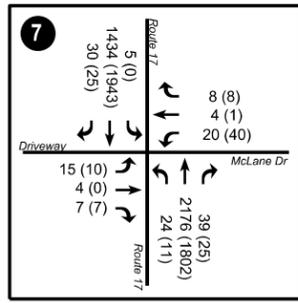
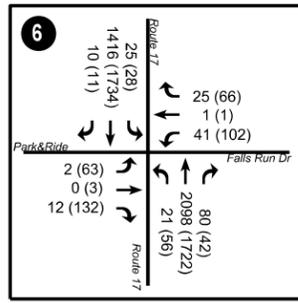
**Figure 6-2** depicts existing (2016) AM and PM peak hour traffic volumes within the study area along the northbound and southbound I-95 mainline and C-D lanes as well as intersection turning movement counts along Route 3 and Route 17. During the AM peak hour, northbound I-95 volumes increase from 3,280 vehicles per hour (vph) south of Route 3 to 4,680 vph between Route 3 and Route 17 due to traffic entering the corridor from Route 3. North of Route 17, northbound volumes decrease to 3,570 vph due to traffic exiting to Route 17. During the PM peak hour, northbound I-95 traffic volumes follow similar trends as the AM peak hour. Northbound volumes increase from 2,900 vph south of Route 3 to 3,880 vph north of Route 3 and then decrease to 3,590 vph north of Route 17. The higher northbound I-95 volumes between Route 3 and Route 17 is partially due to vehicles utilizing I-95 to travel from Route 3 to Route 17.



# Intersection Number  
 XX(XX) AM (PM) Peak Hour Existing



Figure 6-2  
 Not To Scale  
 SHEET 1



# Intersection Number  
XX(XX) AM (PM) Peak Hour Existing



Figure 6-2  
Not To Scale  
SHEET 2

## 6.3 FUTURE TRAFFIC VOLUMES

### 6.3.1 Future Year Forecasts

An overview of the methodology used to develop the future year forecasts is included in **Section 2.3**.

### 6.3.2 Summary of Daily Traffic Volumes

2022 and 2042 Build weekday forecasted daily traffic volumes for northbound and southbound I-95 mainline, C-D lanes, and Express Lanes as well as interchange ramps and arterials are summarized in **Table 6-1**. When comparing 2022 and 2042 traffic forecasts to existing (2016) traffic volumes, certain trends are observed. Along the northbound I-95 mainline, C-D lanes, and Express Lanes, daily traffic volumes throughout the corridor are forecasted to increase by 32 percent to 49 percent between 2016 and 2042 and by 16 percent between 2022 and 2042. Along the southbound I-95 mainline, C-D lanes, and Express Lanes, daily traffic volumes throughout the corridor are forecasted to increase by 31 percent to 48 percent between 2016 and 2042 and by 16 percent between 2022 and 2042.

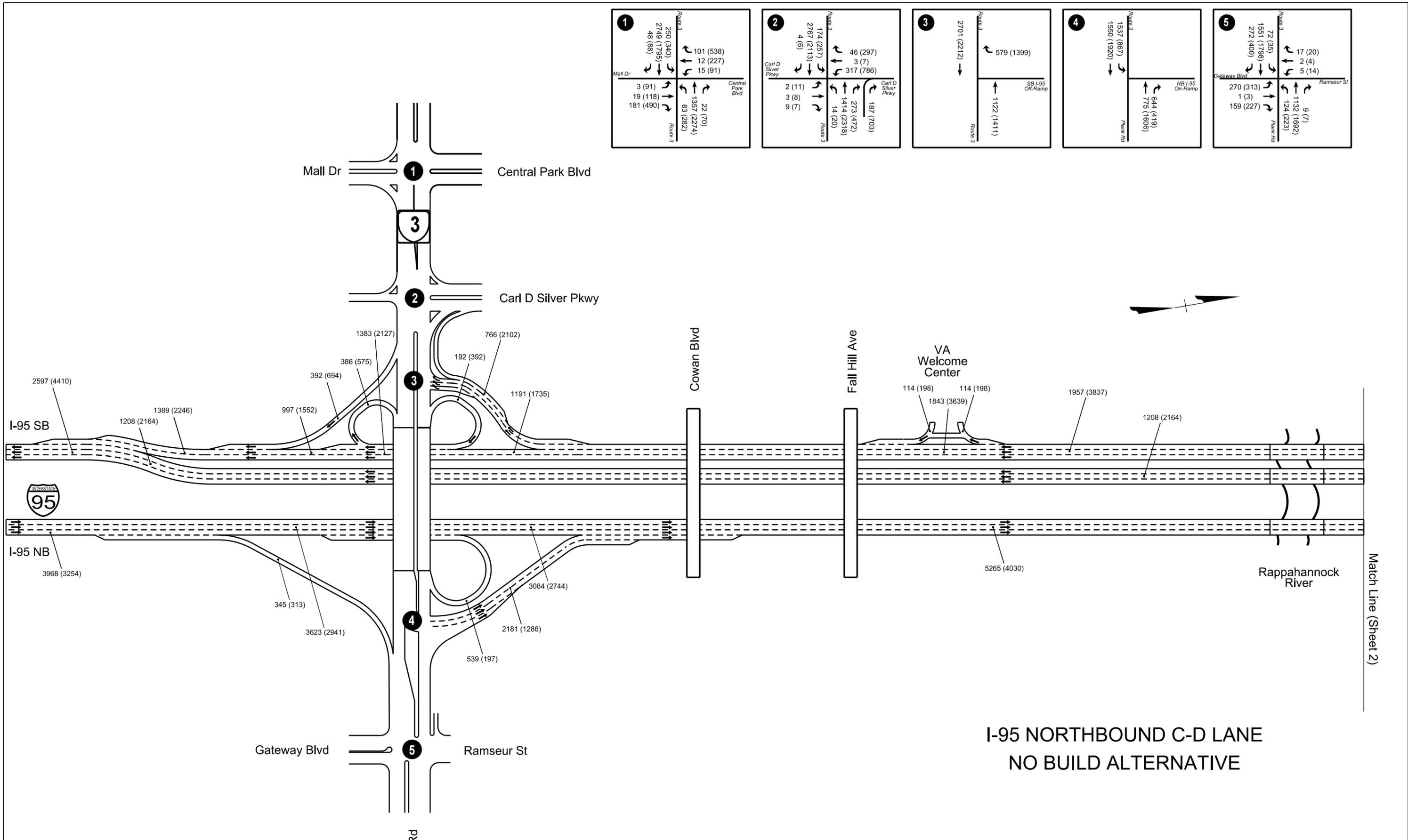
All I-95 ramps at the Route 3 and Route 17 interchanges experience total growth of 6 percent to 104 percent between 2016 and 2042, with the exception of 8 percent decrease in growth on the southbound I-95 off-ramp to eastbound Route 3. Daily traffic volumes along Route 3 and Route 17 are forecasted to increase by 12 percent to 79 percent from 2016 to 2042.

**Table 6-1: Future Year Daily Traffic Forecasts**

Road	Description	2022		2042	
		No Build	Build	No Build	Build
I-95 Mainline NB	South of Route 3	66,600	66,600	77,400	77,400
	South of Route 17	78,400	40,300	91,100	47,000
	North of Route 17	65,600	65,600	76,200	76,200
I-95 Mainline SB	South of Route 3	67,700	67,700	78,600	78,600
	South of Route 17	32,000	32,000	43,000	43,000
	North of Route 17	58,900	58,900	68,400	68,400
I-95 C-D Road NB	South of Route 17	N/A	38,100	N/A	44,100
I-95 C-D Road SB	South of Route 17	44,500	44,500	46,000	46,000
I-95 Express Lanes NB	North of Route 17	11,400	11,400	13,300	13,300
I-95 Express Lanes SB	North of Route 17	11,400	11,400	13,200	13,200
Route 3 WB	West of Ramps	43,900	43,900	53,700	53,700
	East of Ramps	25,300	25,300	29,500	29,500
Route 3 EB	West of Ramps	47,600	47,600	47,300	47,300
	East of Ramps	29,200	29,200	34,800	34,800
Route 17 WB	West of Ramps	47,300	47,300	58,100	58,100
	East of Ramps	25,200	25,200	32,400	32,400
Route 17 EB	West of Ramps	36,600	36,600	45,700	45,700
	East of Ramps	27,300	27,300	34,700	34,700
Route 3 Interchange Ramps	I-95 SB to Route 3 WB	17,800	17,800	20,700	20,700
	Route 3 WB to I-95 SB	3,800	3,800	4,400	4,400
	I-95 NB to Route 3 WB	7,300	7,300	8,400	8,400
	Route 3 to I-95 NB	24,300	24,300	28,200	28,200
	I-95 SB to Route 3 EB	5,000	5,000	5,700	5,700
	Route 3 EB to I-95 SB	10,000	10,000	11,600	11,600
	I-95 NB to Route 3 EB	5,300	5,300	6,100	6,100
Route 17 Interchange Ramps	I-95 SB to Route 17 WB	7,200	7,200	8,400	8,400
	Route 17 WB to I-95 SB	2,300	2,300	2,700	2,700
	I-95 NB to Route 17 EB	2,500	19,600	2,800	22,700
	I-95 NB to Route 17 WB	17,100		19,900	
	Route 17 WB to I-95 NB	8,400	8,400	9,700	9,700
	I-95 SB to Route 17 EB	7,100	7,100	8,300	8,300
	Route 17 EB to I-95 SB	18,400	18,400	21,400	21,400
	Route 17 EB to I-95 NB	9,800	9,800	11,400	11,400
Centreport Parkway Interchange Ramps	I-95 NB to Centreport Parkway	6,200	6,200	7,200	7,200
	Centreport Parkway to I-95 SB	5,500	5,500	6,300	6,300

### 6.3.3 Summary of Peak Hour Traffic Volumes

The following figures depict the forecasted AM and PM peak hour traffic volumes for 2022 and 2042 No Build and Build conditions for the preferred alternative.



**1**

Route 3	250 (340)	101 (538)	Central Park Blvd
Mall Dr	2749 (1795)	12 (227)	
	48 (88)	15 (91)	
Route 3	3 (91)	22 (70)	
	19 (118)	1357 (2274)	
	181 (490)	83 (282)	

**2**

Route 3	174 (257)	46 (297)	Carl D Silver Pkwy
Carl D Silver Pkwy	2767 (2113)	3 (7)	
	4 (6)	317 (786)	
Route 3	2 (11)	187 (703)	
	3 (8)	273 (472)	
	9 (7)	1414 (2318)	
		14 (20)	

**3**

Route 3	2701 (2212)	579 (1399)	SB I-95 Off-Ramp
		1122 (1411)	

**4**

Route 3	1537 (987)	644 (419)	NB I-95 On-Ramp
Plank Rd	1550 (1920)	775 (1606)	

**5**

Route 3	72 (35)	17 (20)	Ramseur St
Gateway Blvd	1551 (1798)	2 (4)	
	272 (400)	5 (14)	
Route 3	270 (313)	9 (7)	
	1 (3)	1132 (1692)	
	159 (227)	124 (223)	



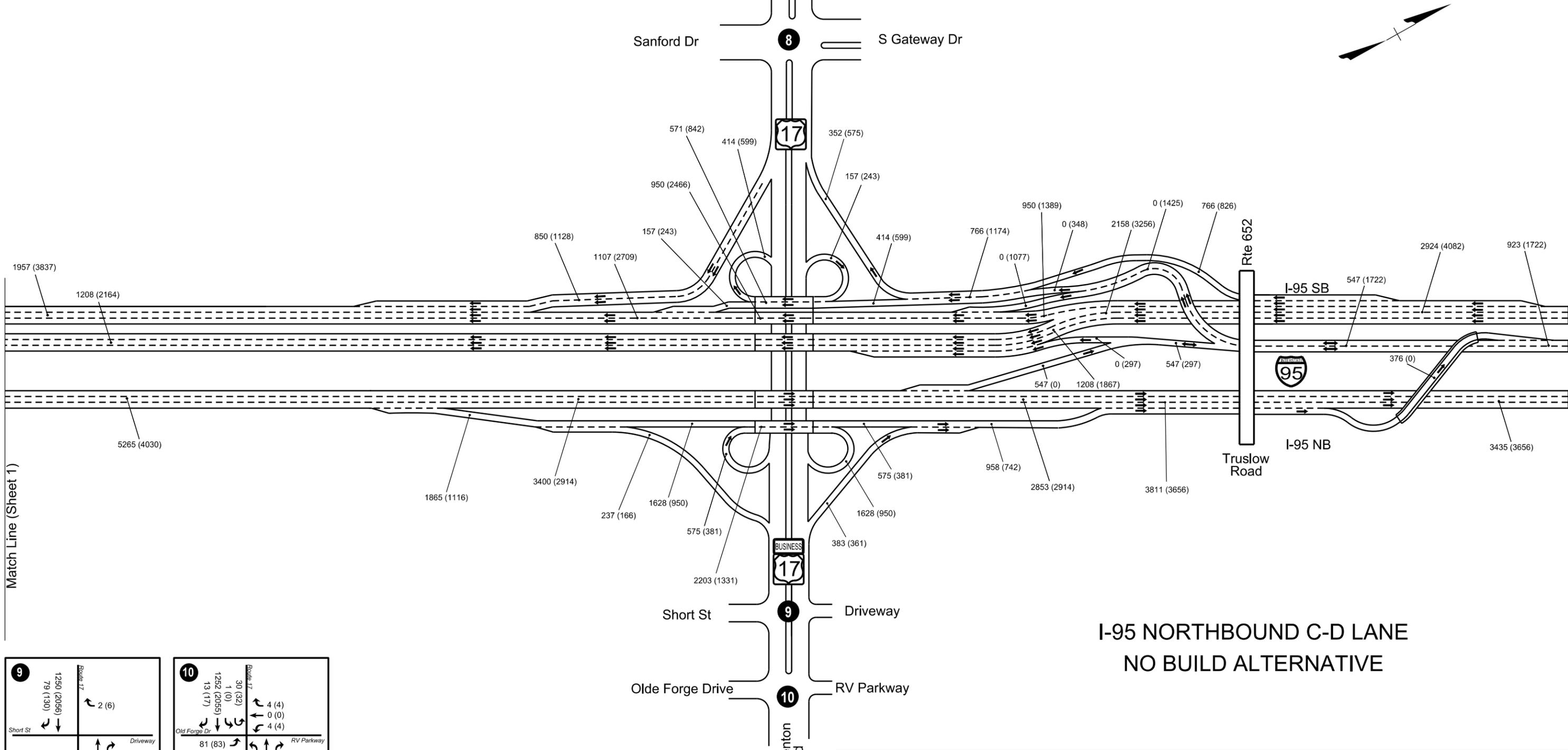
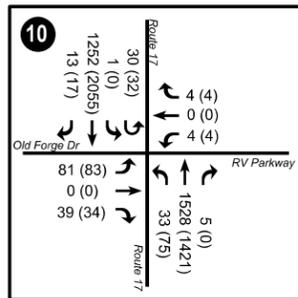
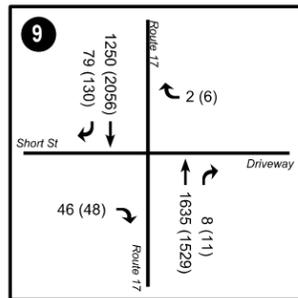
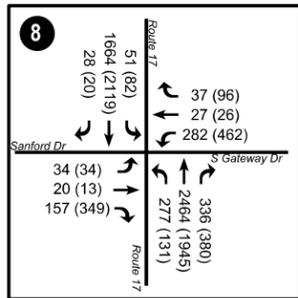
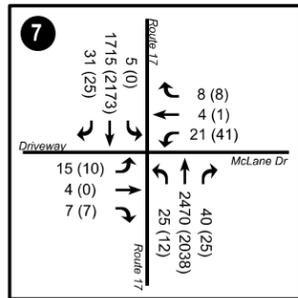
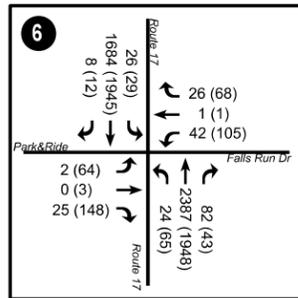
I-95 NORTHBOUND C-D LANE  
NO BUILD ALTERNATIVE

# Intersection Number  
XX(XX) AM (PM) Peak Hour  
2022 Design Year No Build



Figure 6-3  
Not To Scale  
SHEET 1

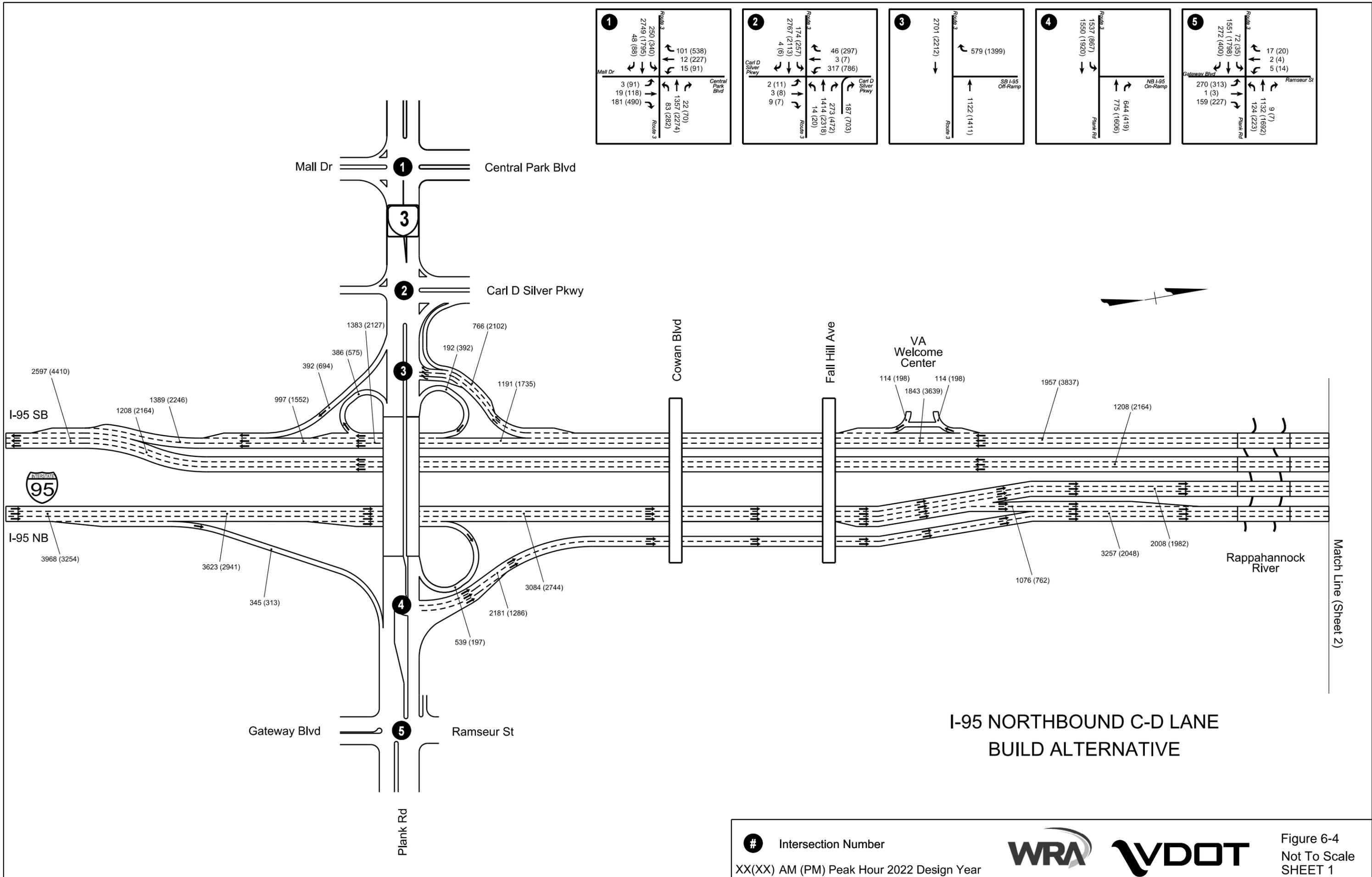
Match Line (Sheet 2)



# Intersection Number  
 XX(XX) AM (PM) Peak Hour  
 2022 Design Year No Build



Figure 6-3  
 Not To Scale  
 SHEET 2



**1**

Route 3 250 (340) 2749 (1795) 48 (88)	101 (538) 12 (227) 15 (91)	Central Park Blvd
Mall Dr	3 (91) 19 (118) 181 (490)	Route 3
	22 (70) 1357 (2274) 83 (282)	

**2**

Route 3 174 (257) 2767 (2113) 4 (6)	46 (297) 3 (7) 317 (786)	Carl D Silver Pkwy
Carl D Silver Pkwy	2 (11) 3 (8) 9 (7)	Route 3
	273 (472) 1414 (2318) 14 (20)	

**3**

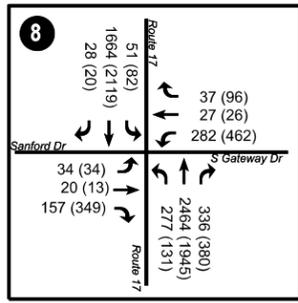
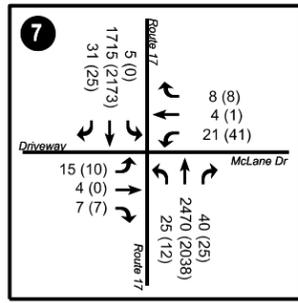
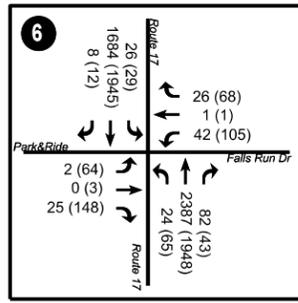
Route 3 2701 (2212)	579 (1399)	SB I-95 Off-Ramp
Route 3	1122 (1411)	

**4**

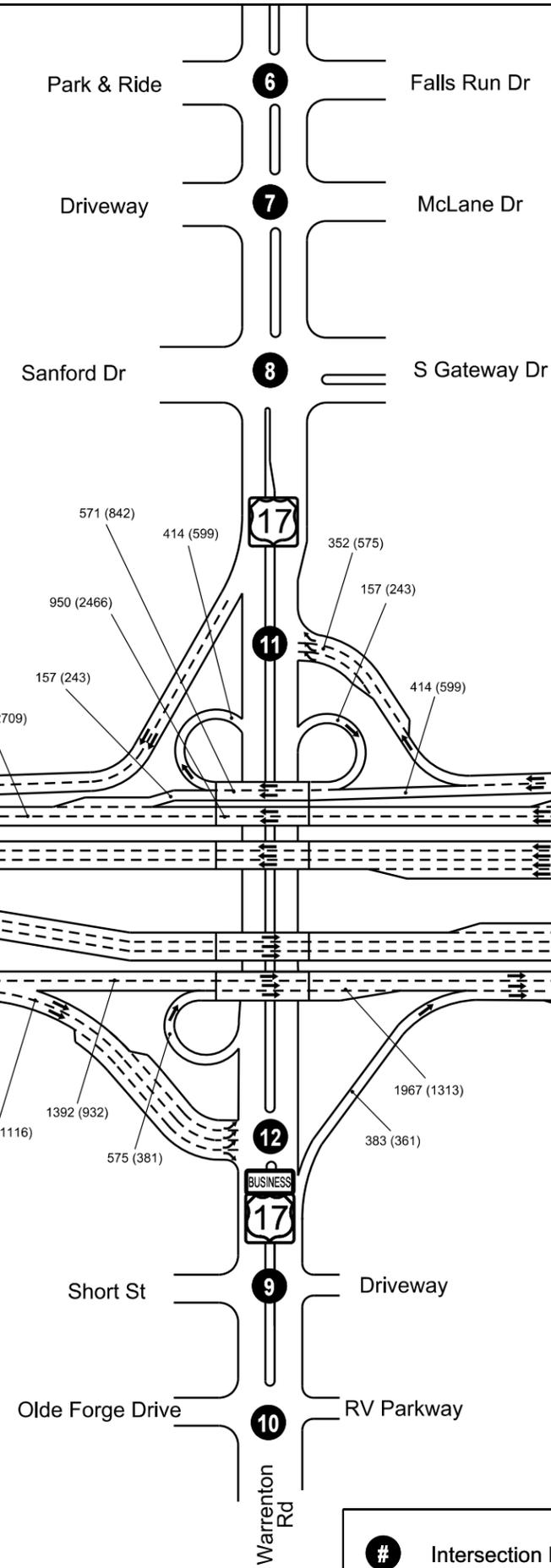
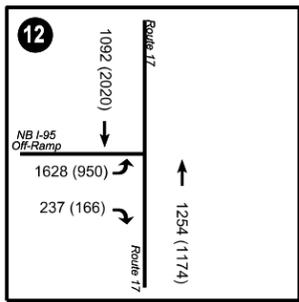
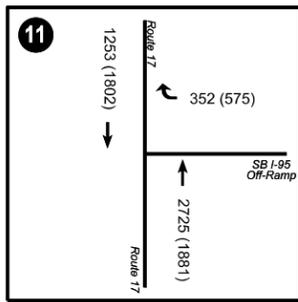
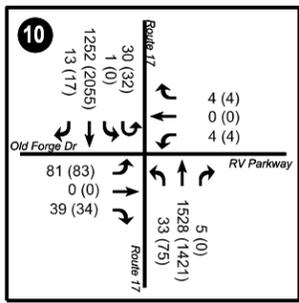
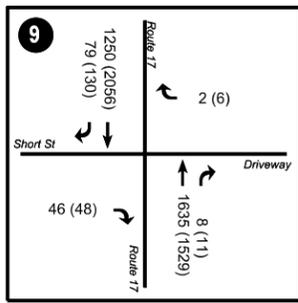
Route 3 1537 (867) 1550 (1920)		NB I-95 On-Ramp
Plank Rd	644 (419) 775 (1606)	

**5**

Route 3 72 (35) 1551 (1798) 272 (400)	17 (20) 2 (4) 5 (14)	Ramseur St
Gateway Blvd	270 (313) 1 (3) 159 (227)	Plank Rd
	9 (7) 1132 (1692) 124 (223)	



Match Line (Sheet 1)

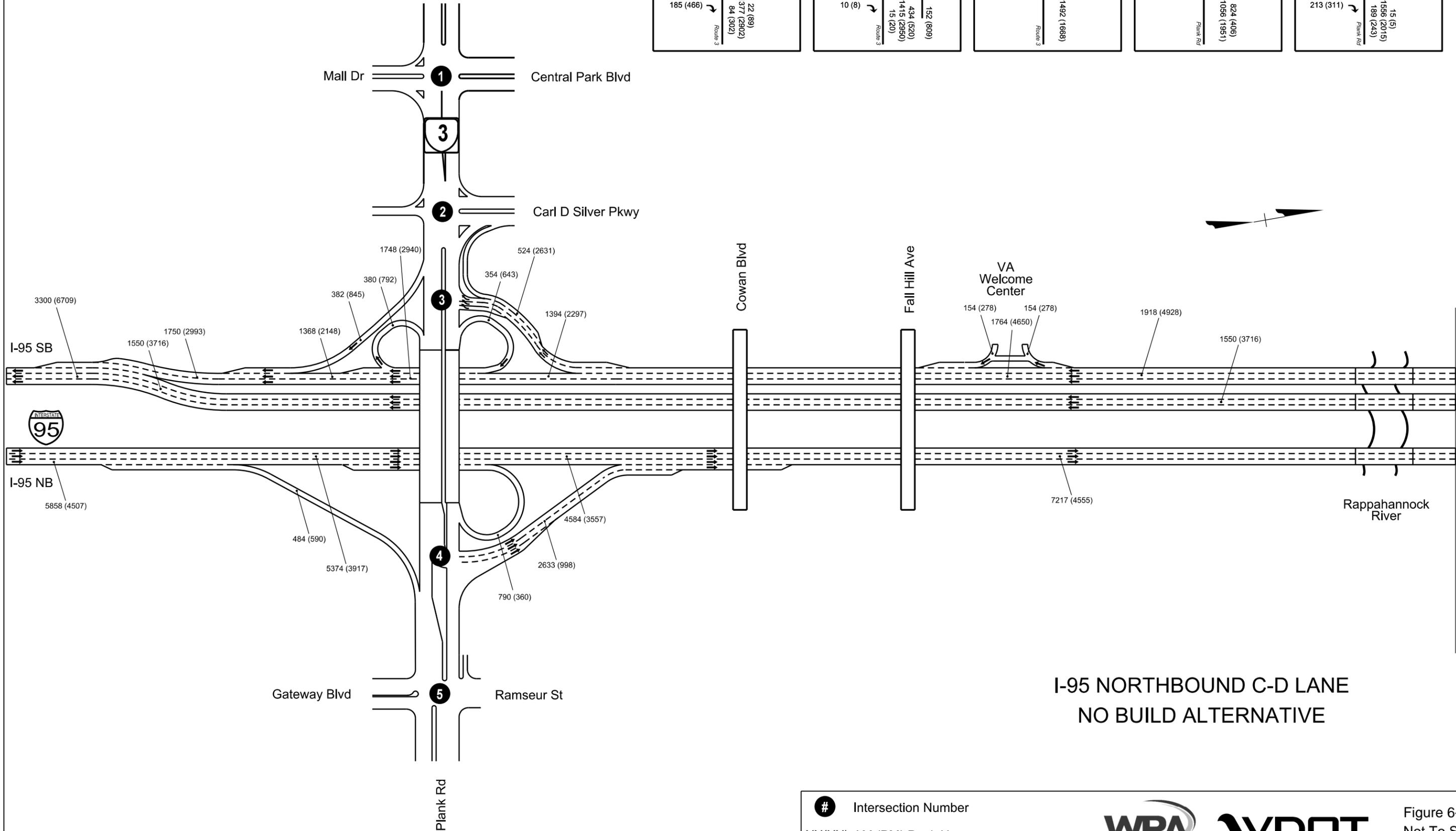
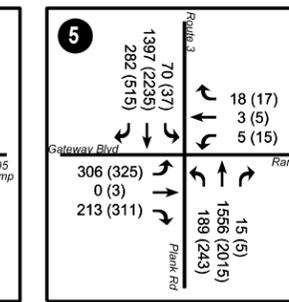
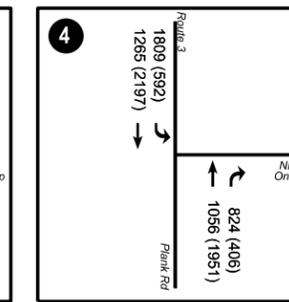
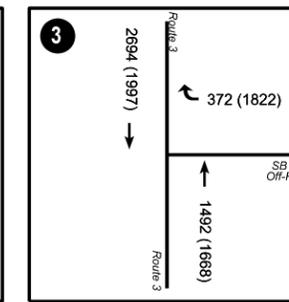
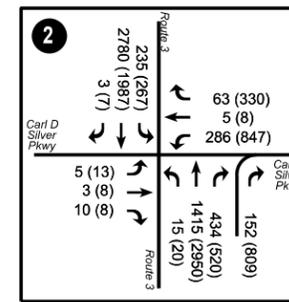
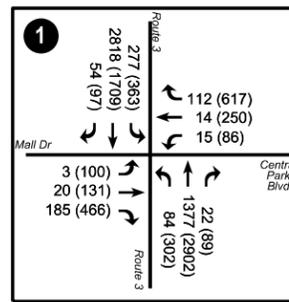


**I-95 NORTHBOUND C-D LANE  
BUILD ALTERNATIVE**

# Intersection Number  
XX(XX) AM (PM) Peak Hour 2022 Design Year



Figure 6-4  
Not To Scale  
SHEET 2



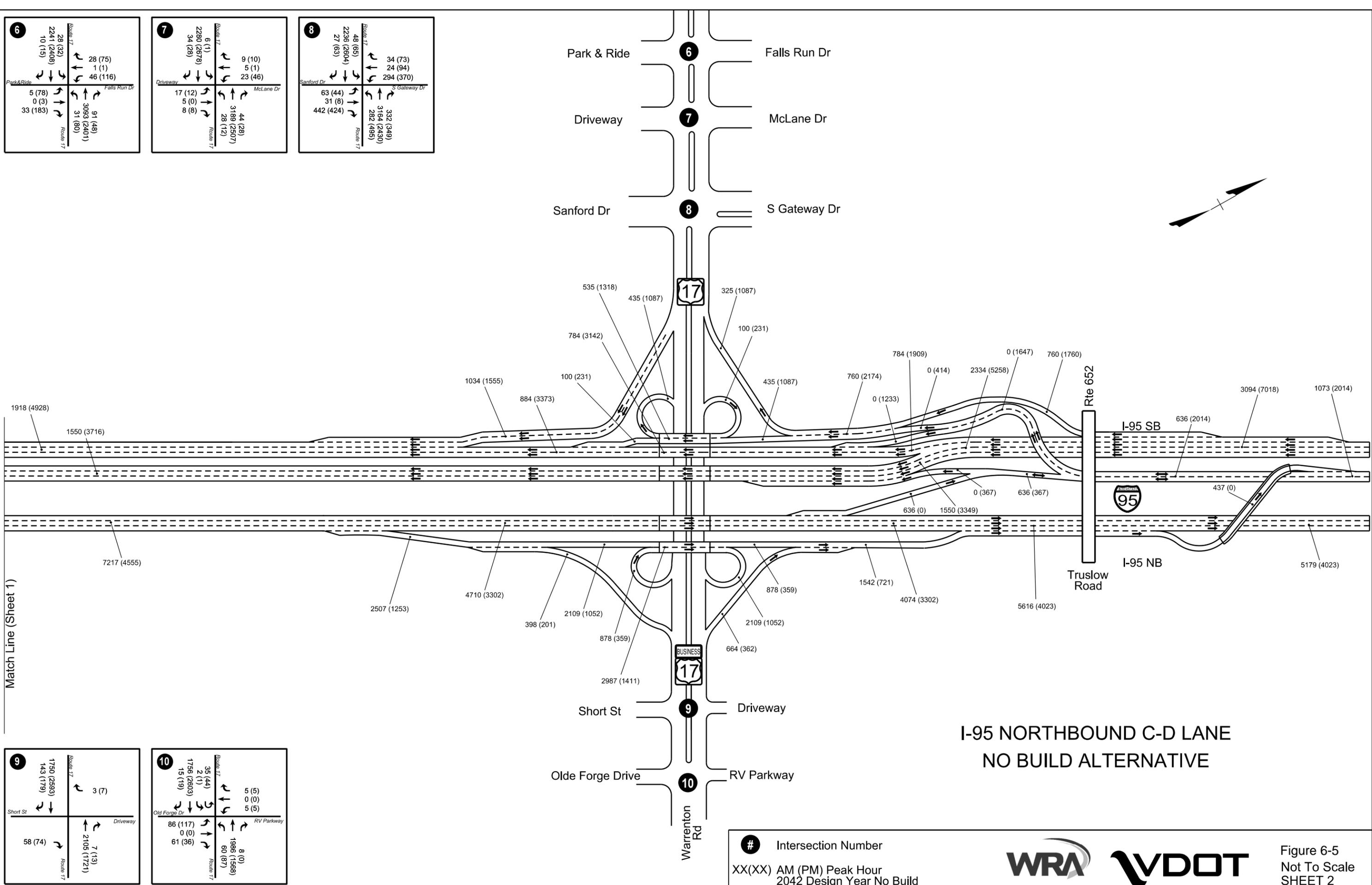
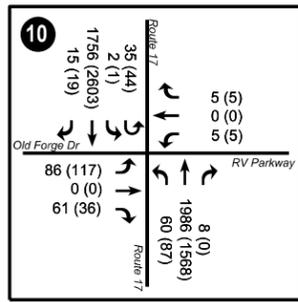
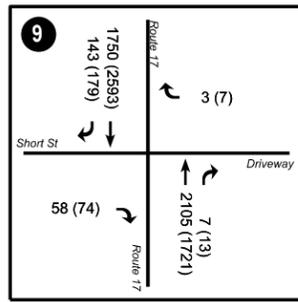
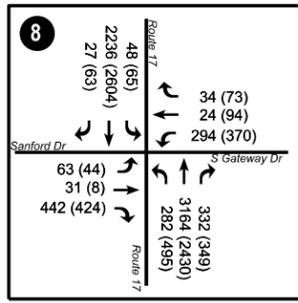
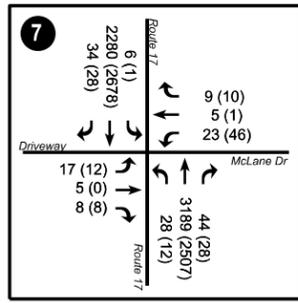
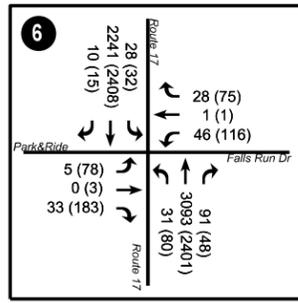
Match Line (Sheet 2)

I-95 NORTHBOUND C-D LANE  
NO BUILD ALTERNATIVE

# Intersection Number  
XX(XX) AM (PM) Peak Hour  
2042 Design Year No Build



Figure 6-5  
Not To Scale  
SHEET 1

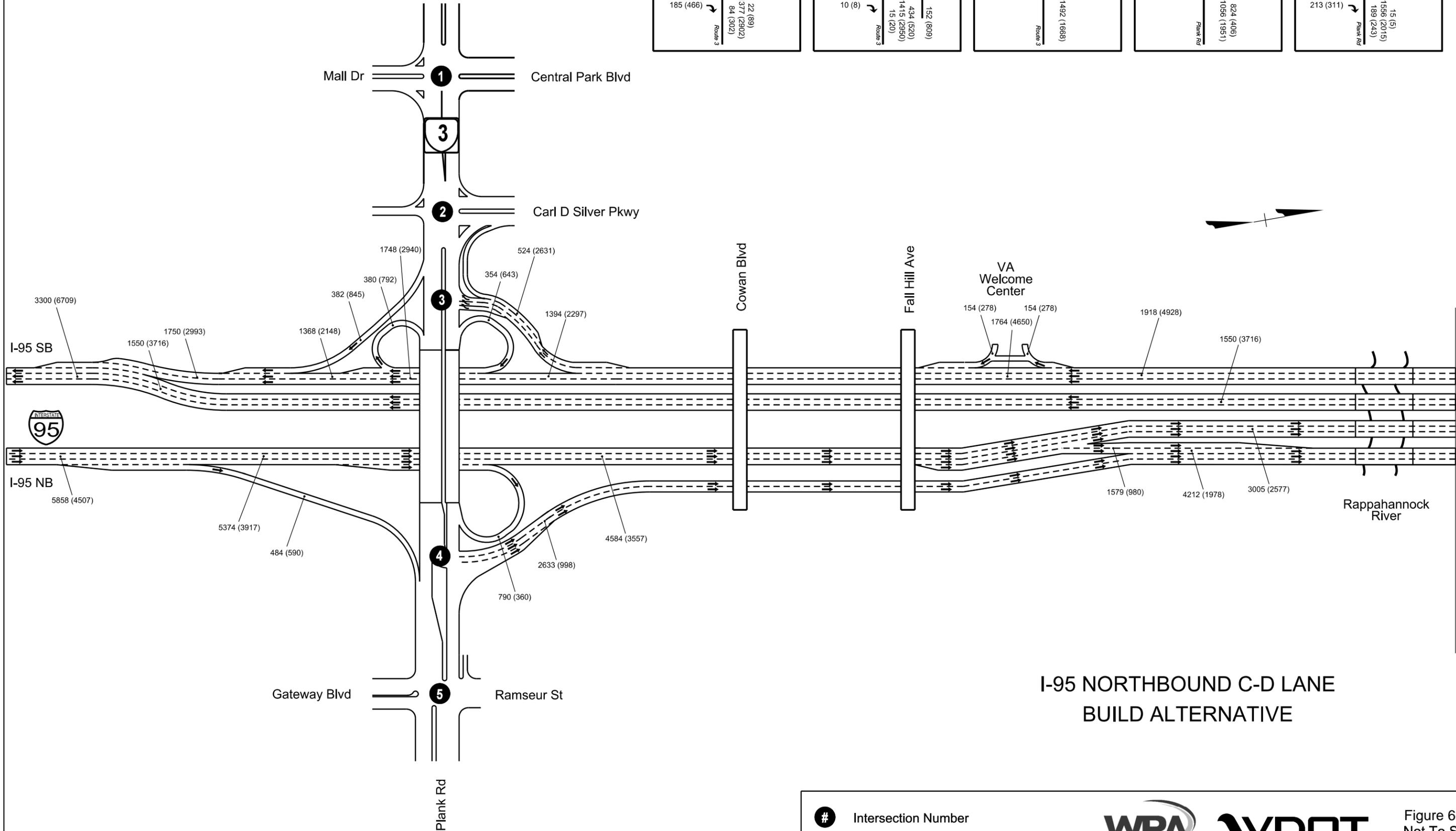
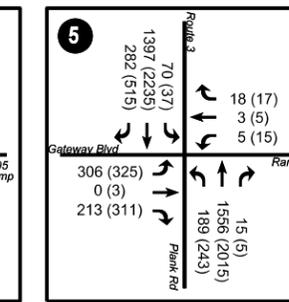
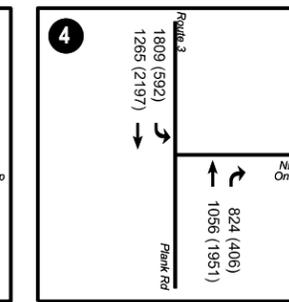
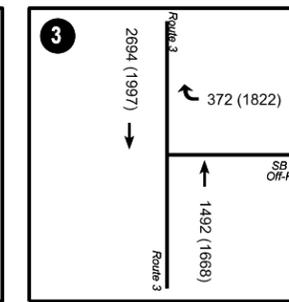
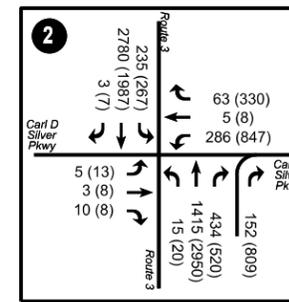
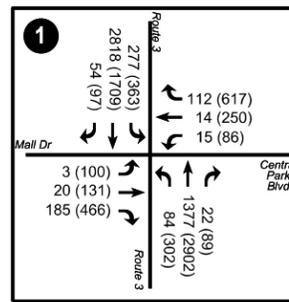


Match Line (Sheet 1)

# Intersection Number  
XX(XX) AM (PM) Peak Hour  
2042 Design Year No Build



Figure 6-5  
Not To Scale  
SHEET 2



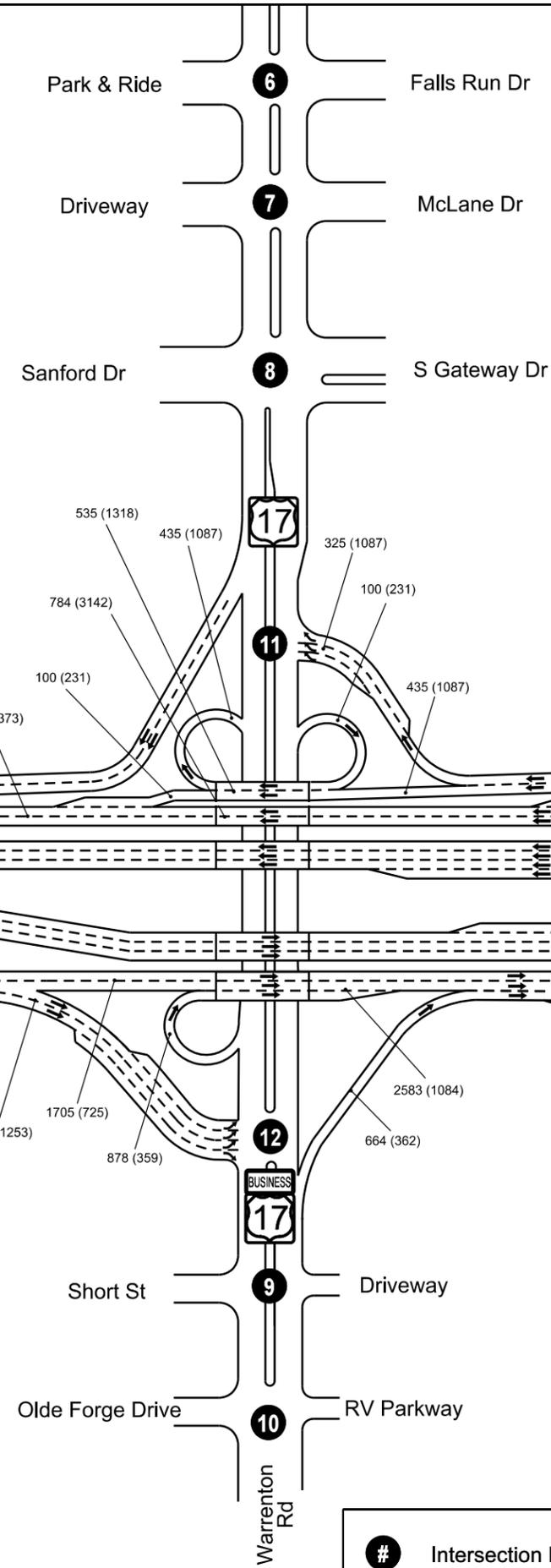
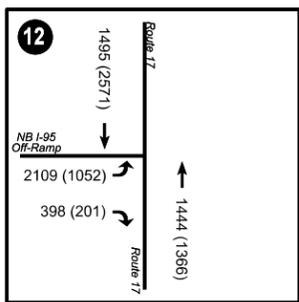
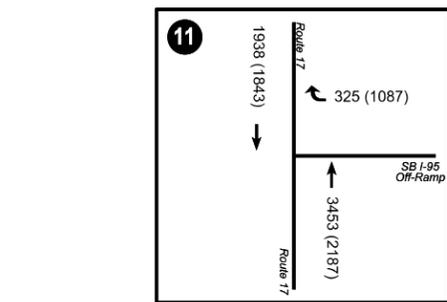
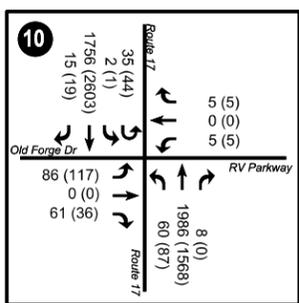
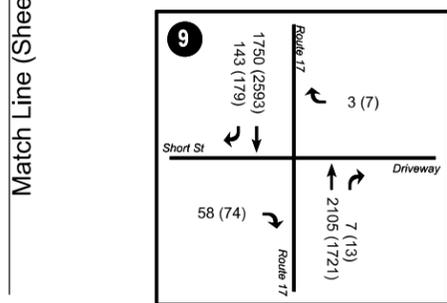
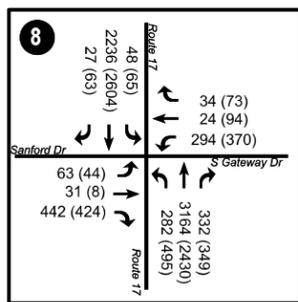
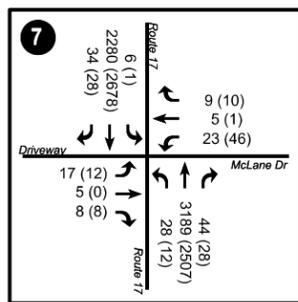
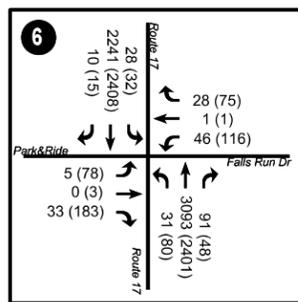
Match Line (Sheet 2)

I-95 NORTHBOUND C-D LANE  
BUILD ALTERNATIVE

# Intersection Number  
XX(XX) AM (PM) Peak Hour 2042 Design Year



Figure 6-6  
Not To Scale  
SHEET 1



**I-95 NORTHBOUND C-D LANE  
BUILD ALTERNATIVE**

# Intersection Number  
XX(XX) AM (PM) Peak Hour 2042 Design Year



Figure 6-6  
Not To Scale  
SHEET 2

## 7. TRAFFIC ANALYSIS

Traffic operations within the study area were evaluated for the AM and PM peak hours for existing (2016) conditions, 2022 No Build and Build conditions and 2042 No Build and Build conditions. The results of the VISSIM microsimulation are documented for the measures of effectiveness (MOEs) as specified in the IJR Framework Document and in **Section 2.4.7**.

Corridor and segment travel times, travel speeds, density, and volume input versus volume throughput are presented in this Chapter for northbound I-95 along the mainline lanes, C-D lanes and Express Lanes for the AM and PM peak hours. **Appendix E** contains VISSIM results summarizing volume inputs and throughputs, travel speeds by lane, and densities by lane along northbound and southbound I-95 for all peak hours as well as cumulative travel times by hour and intersection volume throughputs, delays, and queues by movement in accordance with the VDOT TOSAM. Based on the goals of the I-95 Rappahannock River Crossing Northbound project to improve operations along northbound I-95 and the area of impact of the project, traffic operations results along northbound I-95 in addition to the Route 3 and Route 17 corridors are presented and discussed in this chapter. All results for both northbound and southbound I-95 in addition to Route 3 and Route 17 are included in **Appendix E**.

As discussed in **Section 2.4.7**, operational conditions for the I-95 study corridor and arterial intersections were color-coded to reflect various congestion levels based on density and delay thresholds established in the *Highway Capacity Manual 2010* (HCM). **Tables 7-1 and 7-2** summarize the thresholds for freeway segments, weave/ramp segments, signalized intersections, and unsignalized intersections in accordance with the TOSAM. Level of service (LOS) was not used as a measure of effectiveness in accordance with the TOSAM.

**Table 7-1: Freeway Measures of Effectiveness**

Congestion Level	Freeways	Weaves/Ramps
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28
Moderate Traffic	>26 - 35	>28 - 35
Heavy Congestion	>35 - 45	>35 - 45
Severe Congestion	>45	>45

Source: VDOT TOSAM – Version 1.0 (page F-31)

**Table 7-2: Intersection Measures of Effectiveness**

Congestion Level	Intersections	
	Signalized	Unsignalized
	Average Delay (sec/veh)	Average Delay (sec/veh)
Light Traffic	≤ 35	≤ 25
Moderate Traffic	>35 - 55	>25 - 35
Heavy Congestion	>55 - 80	>35 - 50
Severe Congestion	>80	>50

## 7.1 EXISTING CONDITIONS TRAFFIC OPERATIONS

### 7.1.1 I-95 Travel Time Analysis

#### 7.1.1.1 AM Peak Hour

Figures 7-1 and 7-2 summarize cumulative travel times for the northbound I-95 mainline and C-D lanes during the AM peak hour under existing conditions between underpasses/bridges along the I-95 corridor from Route 620/Harrison Road located 2 miles south of Route 3 to Centreport Parkway. During the AM peak hour, the peak travel direction along I-95 is northbound toward Northern Virginia and the employment centers in and around the Washington, D.C. area. The existing corridor travel times along northbound I-95 during the AM peak hour are 7.1 minutes in the mainline lanes and 1.6 minutes in the C-D lanes.

Figure 7-1: AM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing)

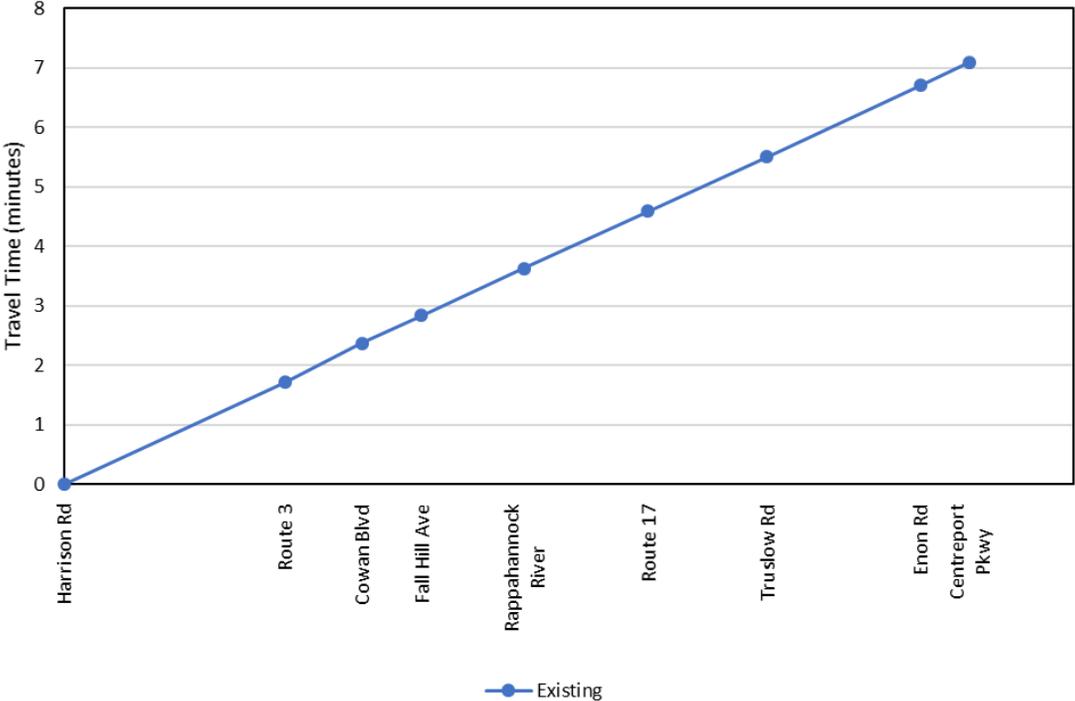
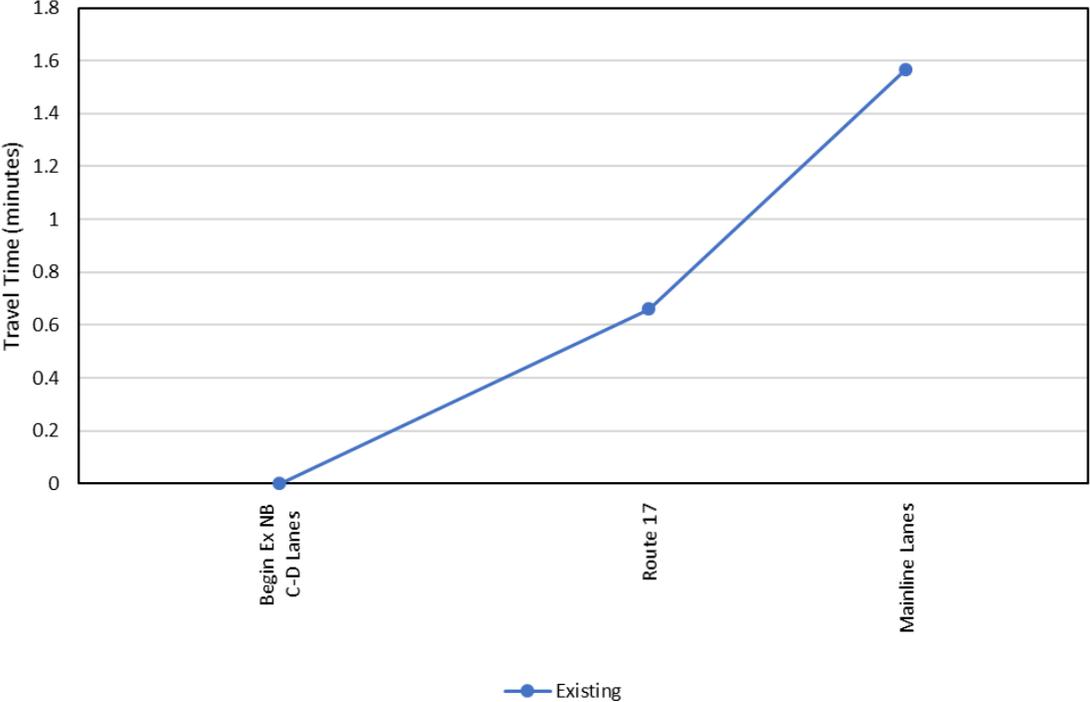


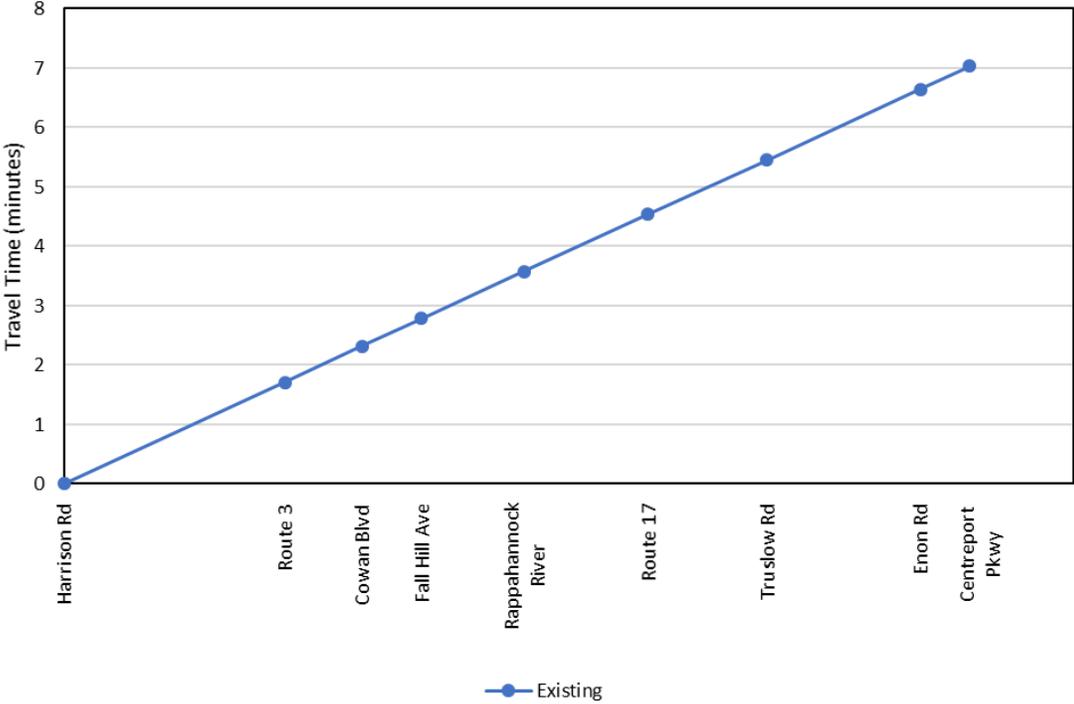
Figure 7-2: AM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing)

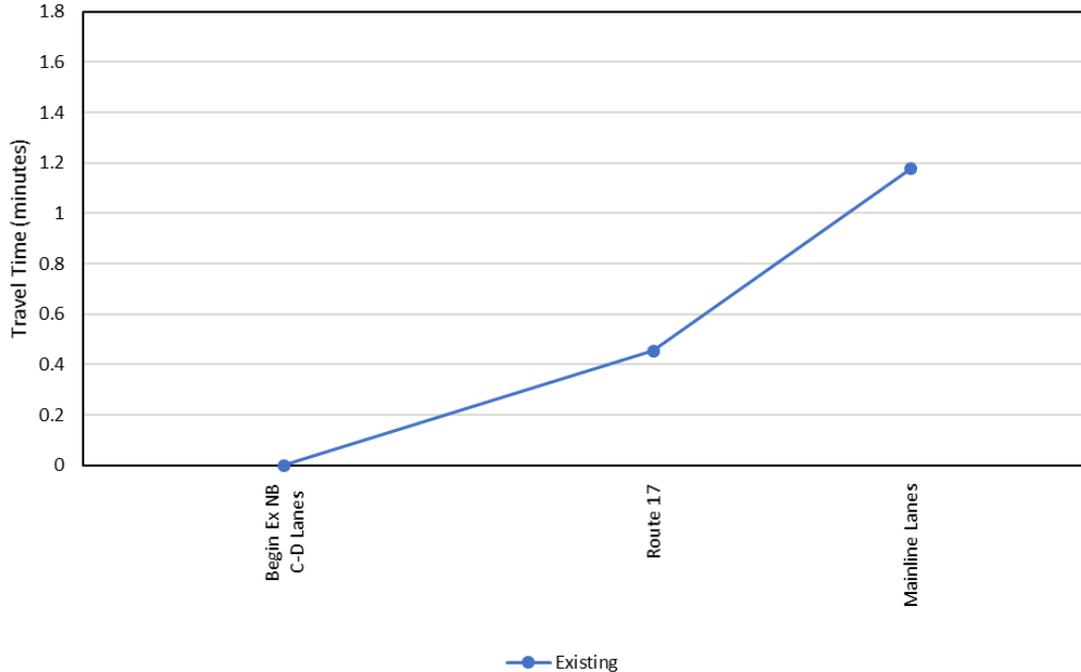


7.1.1.2 PM Peak Hour

Figures 7-3 and 7-4 summarize cumulative travel times for the northbound I-95 mainline and C-D lanes during the PM peak hour under existing conditions between underpasses/bridges along the I-95 corridor from Route 620/Harrison Road located 2 miles south of Route 3 to Centreport Parkway. During the PM peak hour, the peak direction along I-95 is southbound away from Washington, D.C. The existing corridor travel times along northbound I-95 for the PM peak hour are 7.0 minutes in the mainline lanes and 1.2 minutes in the C-D lanes. Northbound travel times are lower during the PM peak hour compared to the AM peak hour due to the lower travel volumes and because it is the off-peak travel direction.

Figure 7-3: PM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing)



**Figure 7-4: PM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing)**

## 7.1.2 I-95 Density and Speed Analysis

### 7.1.2.1 AM Peak Hour

**Tables 7-3a and 7-3b** depict existing travel speeds and densities along northbound I-95 mainline lanes and C-D lanes during the AM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along I-95. A comparison and discussion of traffic volume input versus throughput is presented in **Section 7.1.3**.

During the AM peak hour, northbound I-95 mainline and C-D lanes operate with light traffic conditions along the entire study corridor except for on the C-D lanes at Route 17. The northbound I-95 C-D lane weave within the Route 17 interchange operates with severe congestion and causes moderate traffic conditions upstream to the diverge to eastbound Route 17 Business. The off-ramp to westbound Route 17 from the northbound I-95 C-D lanes also operates under severe congestion as well as the northbound I-95 on-ramp from eastbound Route 3 and the northbound I-95 off-ramp to Centreport Parkway due to high traffic volumes along these ramps.

Along the northbound I-95 mainline lanes, average travel speeds between 61 MPH and 69 MPH occur throughout the corridor with reduced speeds of 50 MPH occurring in the weave at the Route 3 interchange. The northbound C-D lanes experience speeds between 48 MPH and 66 MPH with a reduced speed of 15 MPH within the weave between the two Route 17 loop ramps.

Table 7-3a: AM Peak Hour Northbound I-95 Mainline Speed and Density (Existing)

2016 Existing AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	18716	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	3284	1082	3268		69	69	16	16
2	18716				1130			70		16	
3	18716				1056			70		15	
1	640	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	3284	194	3244	-1%	67	68	3	12
2	640				1162			67		17	
3	640				987			68		15	
4	640				902			69		13	
1	1177	I-95 NB Mainline between diverge to EB Route 3 and merge from EB Route 3	Mainline	3006	1071	2960	-2%	68	69	16	14
2	1177				981			69		14	
3	1177				908			69		13	
1	790	I-95 NB Mainline weave between on-ramp from EB Route 3 and off-ramp to WB Route 3	Weave	4531	671	4520		34	50	20	23
2	790				1270			46		28	
3	790				1403			58		24	
4	790				1175			63		19	
1	1104	I-95 NB Mainline between diverge to WB Route 3 and merge from WB Route 3	Mainline	4093	1135	4077		60	61	19	22
2	1104				1384			61		23	
3	1104				1558			63		25	
1	1208	I-95 NB Mainline merge at on-ramp from WB Route 3	Merge	4680	119	4666		49	62	2	18
2	1208				1341			64		21	
3	1208				1599			66		24	
4	1208				1607			69		23	
1	10714	I-95 NB Mainline between merge from WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	4680	1608	4665		67	68	24	23
2	10714				1569			68		23	
3	10714				1488			69		22	
1	866	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	4680	1290	4650	-1%	66	66	20	18
2	866				886			63		14	
3	866				1219			67		18	
4	866				1255			68		18	
1	6190	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	3044	797	3073		70	69	11	15
2	6190				1133			69		16	
3	6190				1143			69		17	
1	1601	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	3574	90	3621		68	69	1	13
2	1601				1235			69		18	
3	1601				1281			69		19	
4	1601				1014			69		15	
1	7313	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	3574	1482	3623		68	69	22	18
2	7313				1183			69		17	
3	7313				959			70		14	
1	792	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3574	778	3614		66	68	12	13
2	792				809			68		12	
3	792				1058			69		15	
4	792				969			68		14	
1	2136	I-95 NB Mainline off-ramp to EB Route 3	Ramp	278	287	287		39	39	7	7
1	1635	I-95 NB Mainline on-ramp from EB Route 3	Ramp	1525	1560	1560		23	23	68	68
1	1157	I-95 NB Mainline off-ramp to WB Route 3	Ramp	438	440	440		27	27	16	16
1	1554	I-95 NB Mainline on-ramp from WB Route 3	Ramp	587	585	585		34	34	17	17
1	540	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1636	1593	1593	-3%	64	64	25	25
1	1264	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	530	545	545		66	66	8	8
1	2111	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	970	963	963	-1%	22	22	45	45

**Table 7-3b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (Existing)**

2016 Existing AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	540	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	1636	1593	1593	-3%	64	64	25	25
1	699	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	1636	138	1589	-3%	68	66	2	12
2	699				1450			64		23	
1	1070	I-95 NB CD Lanes between diverge to EB Route 17 and merge from EB Route 17	Mainline	1460	1412	1412	-3%	48	48	30	30
1	545	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	1780	971	1726	-3%	15	15	66	59
2	545				755			15		51	
1	1110	I-95 NB CD Lanes between diverge to WB Route 17 and merge from WB Route 17	Mainline	320	326	326		53	53	6	6
1	804	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	530	37	544		42	51	1	5
2	804				507			60		8	
1	1264	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	530	545	545		66	66	8	8
1	1545	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	176	176	176		35	35	5	5
1	1248	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	320	325	325		29	29	11	11
1	1189	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	1460	1397	1397	-4%	23	23	60	60
1	1550	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	210	216	216		34	34	6	6

### 7.1.2.2 PM Peak Hour

**Tables 7-4a and 7-4b** depict existing travel speeds and densities along the northbound I-95 mainline lanes and C-D lanes during the PM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along I-95. A comparison and discussion of traffic volume input versus throughput is presented in **Section 7.1.3**.

Based on the segment densities, under existing conditions in the PM peak hour, the northbound I-95 mainline and C-D lanes operate with light traffic conditions along the entire study corridor. The northbound C-D lane weave at Route 17 has better operations during the PM peak hour compared to the AM peak hour because the weave volume is approximately 400 vehicles less during the PM peak hour.

Along the northbound I-95 mainline lanes, average travel speeds between 64 MPH and 70 MPH occur throughout the corridor with reduced speeds of 60 MPH occurring in the weave at the Route 3 interchange. The majority of the northbound C-D lanes experience speeds between 51 MPH and 69 MPH. Although the weave within the Route 17 interchange operates with light traffic conditions, vehicles still experience reduced speeds of 34 MPH.

**Table 7-4a: PM Peak Hour Northbound I-95 Mainline Speed and Density (Existing)**

2016 Existing PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserviced	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ft)	Average Density (vp/ft)
1	18716	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	2898	942	2897		69	70	14	14
2	18716				1012			70		15	
3	18716				944			70		14	
1	615	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	2898	152	2892		66	68	2	11
2	615				935			68		14	
3	615				946			69		14	
4	615				860			70		12	
1	1177	I-95 NB Mainline between diverge to EB Route 3 and merge from EB Route 3	Mainline	2670	867	2671		68	69	13	13
2	1177				944			69		14	
3	1177				861			69		12	
1	790	I-95 NB Mainline weave between on-ramp from EB Route 3 and off-ramp to WB Route 3	Weave	3612	311	3616		47	60	7	15
2	790				1046			58		18	
3	790				1286			66		20	
4	790				973			69		14	
1	1086	I-95 NB Mainline between diverge to WB Route 3 and merge from WB Route 3	Mainline	3465	1026	3467		66	67	16	17
2	1086				1247			66		19	
3	1086				1194			68		18	
1	1208	I-95 NB Mainline merge at on-ramp from WB Route 3	Merge	3876	69	3881		50	64	1	14
2	1208				1171			67		18	
3	1208				1392			68		20	
4	1208				1248			70		18	
1	10714	I-95 NB Mainline between merge from WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	3876	1338	3886		68	69	20	19
2	10714				1324			69		19	
3	10714				1224			69		18	
1	866	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	3876	853	3882		68	69	12	14
2	866				850			67		13	
3	866				1096			69		16	
4	866				1083			70		15	
1	6190	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	2814	790	2826		69	69	11	14
2	6190				1032			69		15	
3	6190				1004			69		14	
1	1601	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	3593	99	3597		69	69	1	13
2	1601				1307			69		19	
3	1601				1194			69		17	
4	1601				996			70		14	
1	7313	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	3593	1237	3597		68	69	18	17
2	7313				1250			69		18	
3	7313				1110			69		16	
1	792	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3593	169	3594		70	70	2	13
2	792				1074			69		16	
3	792				1220			70		17	
4	792				1131			70		16	
1	2136	I-95 NB Mainline off-ramp to EB Route 3	Ramp	228	225	225	-1%	39	39	6	6
1	1635	I-95 NB Mainline on-ramp from EB Route 3	Ramp	942	943	943		24	24	40	40
1	1157	I-95 NB Mainline off-ramp to WB Route 3	Ramp	147	150	150		32	32	5	5
1	1555	I-95 NB Mainline on-ramp from WB Route 3	Ramp	411	408	408	-1%	34	34	12	12
1	540	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1062	1064	1064		66	66	16	16
1	1264	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	779	769	769	-1%	66	66	12	12
1	2106	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	217	214	214	-1%	28	28	8	8

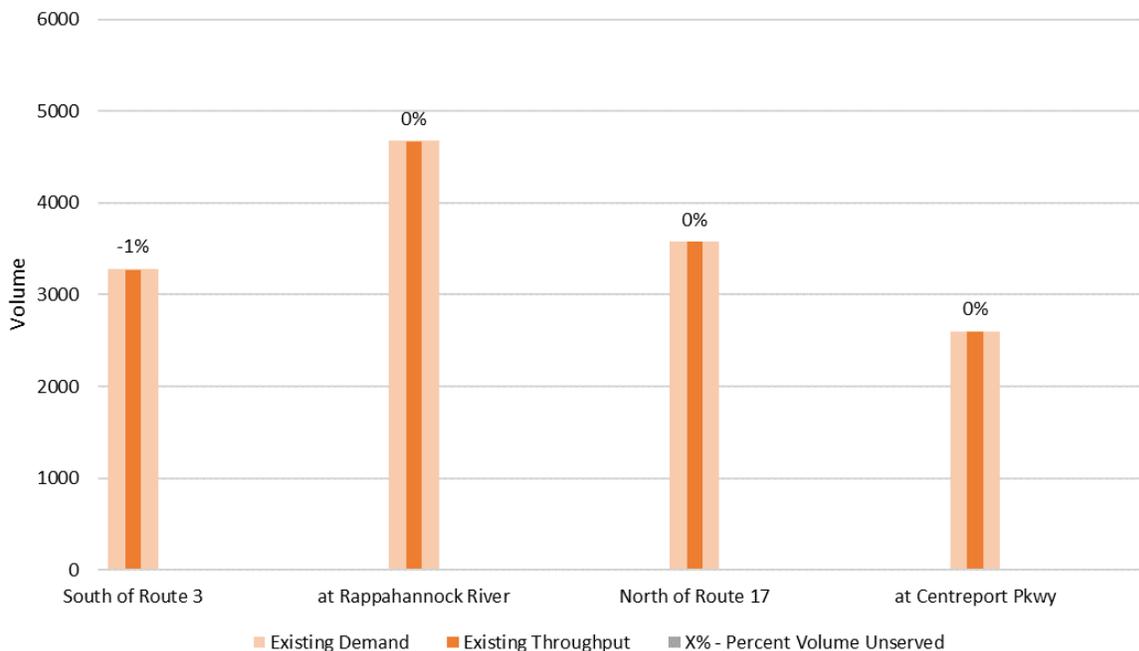
**Table 7-4b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (Existing)**

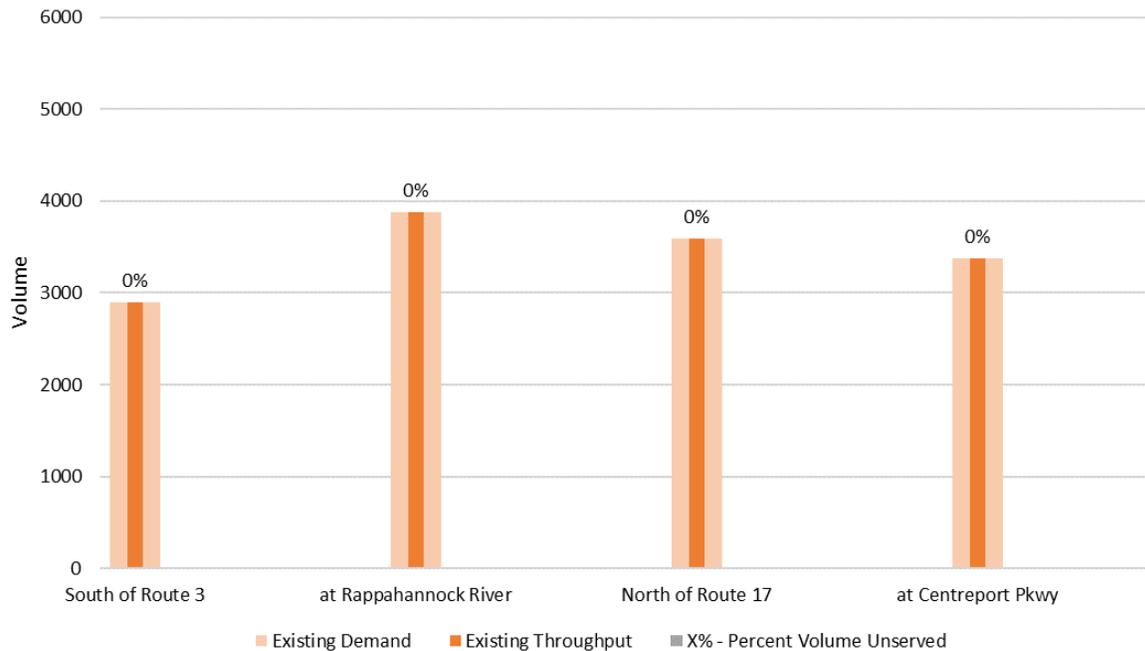
2016 Existing PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	540	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	1062	1064	1064		66	66	16	16
1	699	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	1062	97	1062		69	69	1	8
2	699				965			69		14	
1	1070	I-95 NB CD Lanes between diverge to EB Route 17 and merge from EB Route 17	Mainline	935	939	939		67	67	14	14
1	545	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	1346	743	1330	-1%	32	34	23	20
2	545				587			35		17	
1	1110	I-95 NB CD Lanes between diverge to WB Route 17 and merge from WB Route 17	Mainline	411	397	397	-3%	58	58	7	7
1	804	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	779	60	768	-1%	42	51	1	7
2	804				708			60		12	
1	1264	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	779	769	769	-1%	66	66	12	12
1	1545	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	127	125	125	-2%	35	35	4	4
1	1248	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	411	388	388	-6%	29	29	13	13
1	1189	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	935	939	939		26	26	36	36
1	1552	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	368	373	373		34	34	11	11

**7.1.3 Traffic Volume Throughput Comparison**

Volume throughputs were analyzed at four locations along the I-95 corridor from south of Route 3 to Centreport Parkway. **Figures 7-5 and 7-6** show the existing AM and PM peak hour traffic volume demand, throughput, and percent volume unserved at each location along northbound I-95 including all mainline lanes and C-D lanes. During the AM peak hour, there is 1% unserved demand just south of the Route 3 interchange while all demand is served along the remainder of the corridor. During the PM peak hour, all traffic volume demand is served.

**Figure 7-5: Northbound I-95 Existing AM Peak Hour Volume Throughputs**



**Figure 7-6: Northbound I-95 Existing PM Peak Hour Volume Throughputs**

#### 7.1.4 Arterial Intersection Operations

**Table 7-5** depicts overall intersection delay for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for existing conditions. It should be noted that the existing conditions analysis does not include the recent intersection improvements completed along Route 3 associated with the I-95 Safety Improvements at Route 3 project that was completed in January 2019 following the collection of traffic data and development of the calibrated existing conditions VISSIM model. **Appendix E** contains detailed VISSIM results for intersection volume throughputs, delays, and queues by movement, approach, and for the overall intersections.

**AM Peak Hour:** During the AM peak hour, all signalized and unsignalized intersections operate with average intersection delays of 30 seconds or less. Although the intersections operate with overall average delays considered to be light traffic conditions, several individual turning movements at all of the signalized intersections along Route 3 and the signalized intersections along Route 17 west of I-95 have heavy or severe congestion with delays up to 1.5 minutes and queues that extend beyond existing storage lengths.

**PM Peak Hour:** During the PM peak hour, five of the signalized and unsignalized intersections operate with light traffic conditions and average intersection delays of 30 seconds or less. The signalized intersections of Route 3 at Central Park Boulevard/Mall Drive and Route 3 at Carl D. Silver Parkway operate with moderate traffic conditions with average intersection delays between 35 and 45 seconds. The signalized intersection of Route 17 at Sanford Drive/Gateway Drive operates with heavy congestion with all of the movements on the northbound Sanford Drive and southbound Gateway Drive approaches to the intersection operating with severe congestion and the northbound right-turn and southbound right-turn movements exceeding existing storage lane lengths. Queues on the northbound Sanford Drive approach to Route 17 extend up to 1,500 feet partially due to congestion along eastbound Route 17 approaching the

ramp to southbound I-95 which makes it difficult for motorists to turn right onto eastbound Route 17. Similar to the AM peak hour, several individual turning movements at all of the signalized intersections along Route 3 and the signalized intersections along Route 17 west of I-95 have heavy or severe congestion and queues that extend beyond existing storage lengths.

**Table 7-5: Intersection Delay Summary (Existing Conditions)**

Intersection	Existing Intersection Control	Existing Average Delay (seconds)	
		AM Peak Hour	PM Peak Hour
Route 3 at Central Park Boulevard/ Mall Drive	Signalized	16	35
Route 3 at Carl D. Silver Parkway	Signalized	27	43
Route 3 at Gateway Boulevard	Signalized	14	20
Route 17 at Falls Run Drive	Signalized	5	23
Route 17 at McLane Drive	Signalized	3	7
Route 17 at Sanford Drive/ Gateway Drive	Signalized	22	75
Route 17 at Short Street	Signalized	4	5
Route 17 at Olde Forge Drive	Stop	1	1

## 7.2 2022 NO BUILD AND BUILD CONDITIONS TRAFFIC OPERATIONS

As discussed in **Section 2.4**, the VISSIM files developed for the Fred Ex project were modified to reflect updates to No Build projects along the corridor as well as the proposed Build Alternative for I-95 Rappahannock River Crossing Northbound project to create the 2022 No Build and Build conditions VISSIM models.

### 7.2.1 I-95 Travel Time Analysis

#### 7.2.1.1 AM Peak Hour

A comparison of overall corridor travel times for existing conditions, 2022 No Build conditions, and 2022 Build conditions is summarized in **Figures 7-7 and 7-8** for the northbound I-95 mainline and C-D lanes during the AM peak hour.

#### *2022 No Build Conditions*

**Northbound I-95 Mainline:** Under 2022 No Build conditions, the northbound I-95 mainline total travel time is 8.6 minutes, which is 1.5 minutes greater than existing conditions. The highest increases in travel time occur between Fall Hill Avenue and the Rappahannock River bridge (41 second increase) and between the Rappahannock River and Route 17 (34 second increase). Longer travel times along these segments of the corridor can be attributed to slower speeds due to congestion in the northbound C-D lanes extending into the northbound I-95 mainline lanes.

**Northbound I-95 C-D Lanes:** Under 2022 No Build conditions, the northbound C-D lanes total travel time is 2.9 minutes which is 1.3 minutes greater than existing conditions. This is primarily due to a 75 second increase in travel time between the start of the C-D lanes and Route 17 caused by increased congestion in the weave between the Route 17 loop ramps.

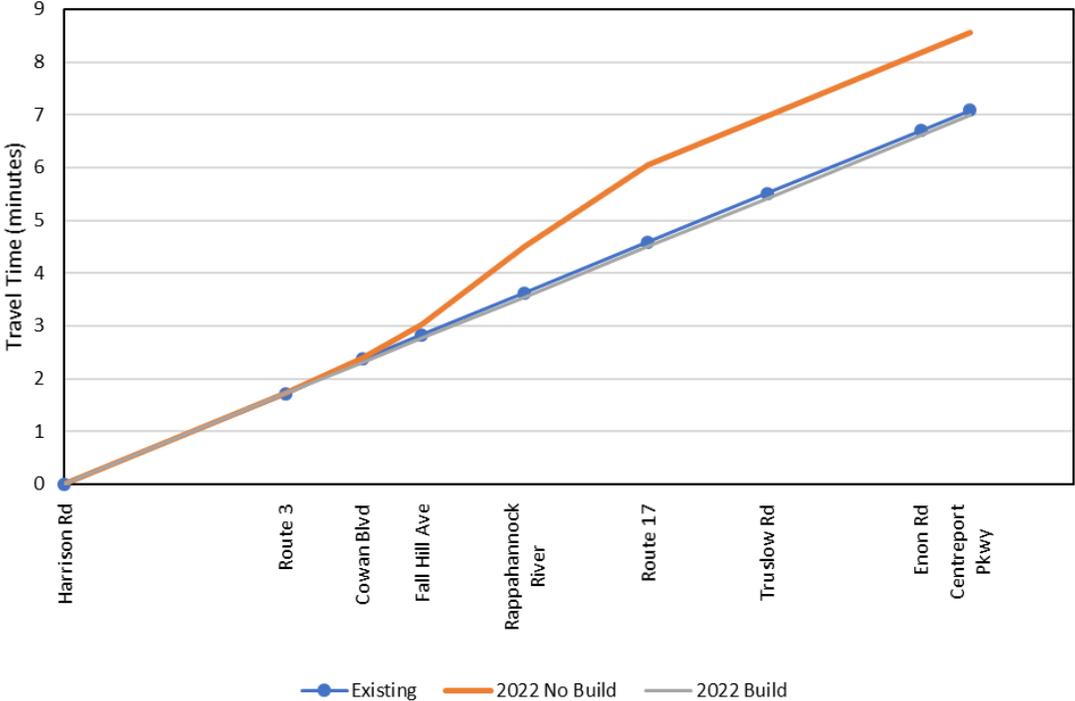
### ***2022 Build Conditions***

Lower travel times under 2022 Build conditions are attributed to improvements to the Route 17 interchange including the removal of the loop ramp from the northbound C-D lanes to westbound Route 17, thereby eliminating the weave which causes congestion under 2022 No Build conditions.

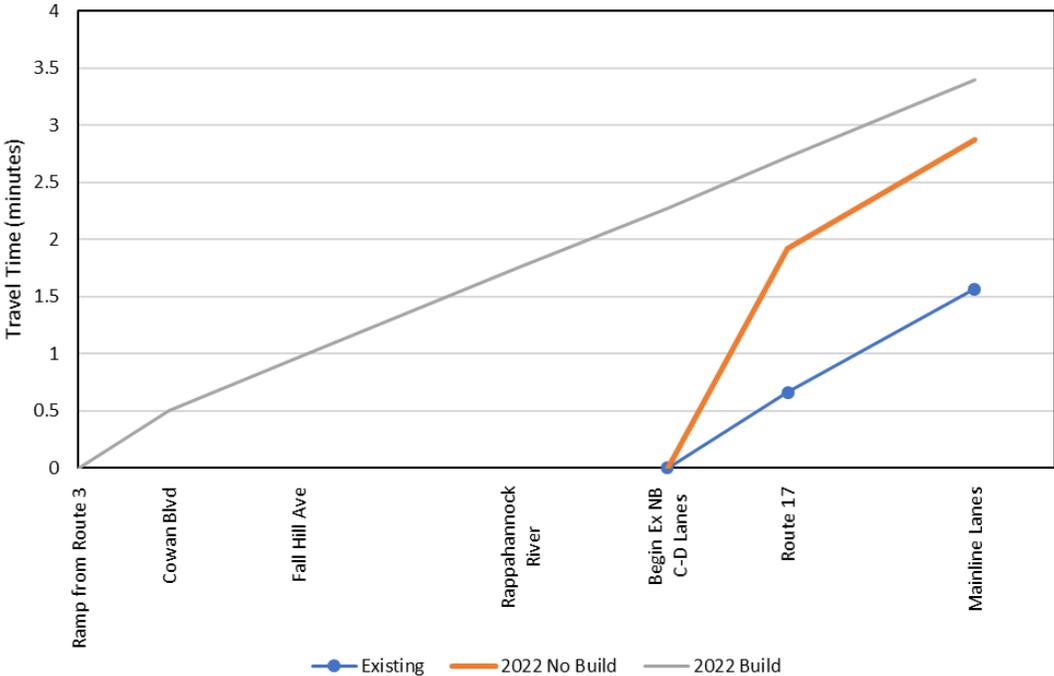
**Northbound I-95 Mainline:** Under 2022 Build conditions, the northbound I-95 mainline total travel time is 7.0 minutes, which is 1.6 minutes less (18% reduction) than No Build conditions. Travel time trends along the corridor under 2022 Build conditions are similar to existing conditions. Whereas under No Build conditions, the greatest increase in travel time occurs between Fall Hill Avenue and Route 17, the largest decrease in travel time under Build Conditions compared to No Build conditions occurs in the same area, between Fall Hill Avenue and Route 17 (1.3 minutes).

**Northbound I-95 C-D Lanes:** Under Build conditions, the northbound C-D lanes begin north of Route 3, as compared to just south of Route 17 under existing and No Build conditions. To make an equal comparison of travel time in the northbound C-D lanes between No Build and Build conditions, travel times between the location where the existing C-D lanes begin and the end of the C-D lanes were compared. Between the start of the existing C-D lanes and the end of the C-D lanes, the travel time under Build conditions is 1.8 minutes less (61% reduction) than No Build conditions, with the majority of travel time savings occurring south of Route 17.

**Figure 7-7: AM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing and 2022)**



**Figure 7-8: AM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing and 2022) <sup>1</sup>**



<sup>1</sup> Northbound C-D lanes corridor length is 3.7 miles under Build conditions compared to 1.3 miles under existing and No Build conditions

### 7.2.1.2 PM Peak Hour

A comparison of overall corridor travel times for existing conditions, 2022 No Build conditions, and 2022 Build conditions is summarized in **Figures 7-9 and 7-10** for the northbound I-95 mainline and C-D lanes during the PM peak hour.

#### *2022 No Build Conditions*

**Northbound I-95 Mainline:** Under 2022 No Build conditions, the northbound I-95 mainline total travel time is 7.0 minutes and is similar to existing conditions.

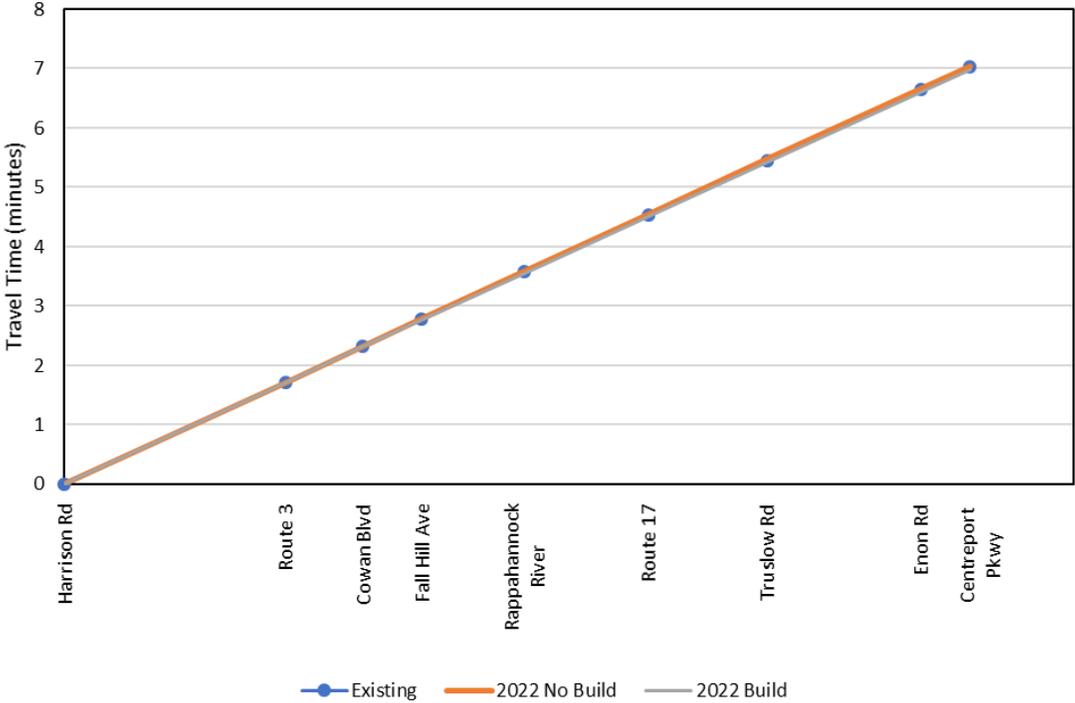
**Northbound I-95 C-D Lanes:** The northbound I-95 C-D lanes total travel time is 1.2 minutes and is equal to existing conditions.

#### *2022 Build Conditions*

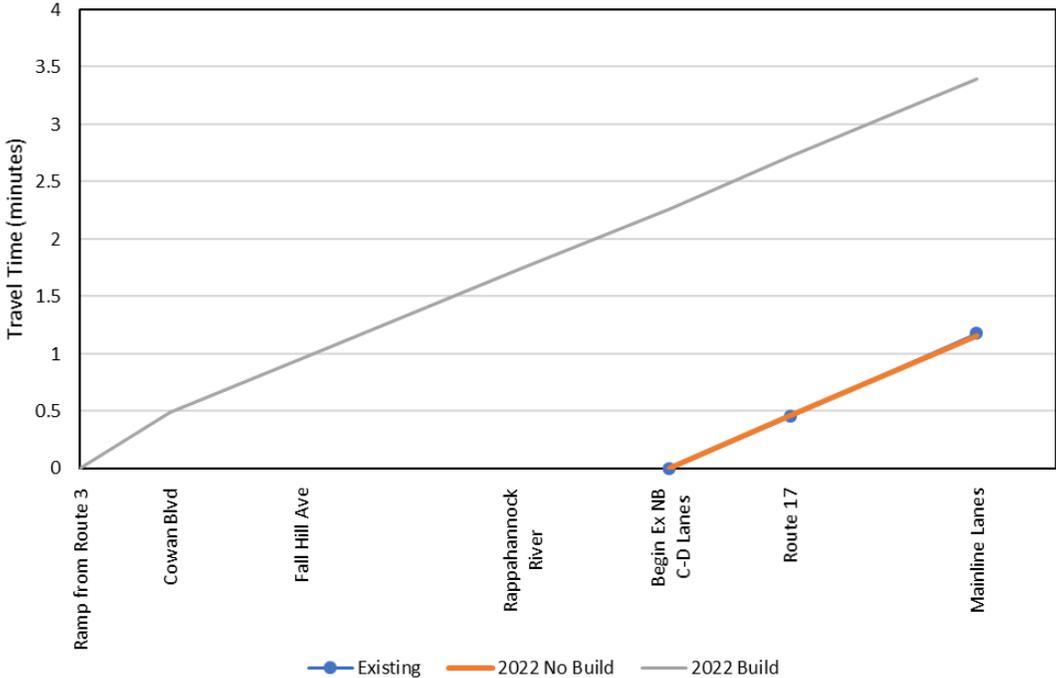
**Northbound I-95 Mainline:** Under 2022 Build conditions, the northbound I-95 mainline total travel time is 7.0 minutes and is similar to existing and No Build conditions.

**Northbound I-95 C-D Lanes:** Under Build conditions, the northbound C-D lanes begin north of Route 3, as compared to just south of Route 17 under existing and No Build conditions. To make an equal comparison of travel time in the northbound C-D lanes between No Build and Build conditions, travel times between the location where the existing C-D lanes begin and the end of the C-D lanes were compared. Between the start of the existing C-D lanes and the end of the C-D lanes, the travel time under Build conditions is similar to No Build conditions.

**Figure 7-9: PM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing and 2022)**



**Figure 7-10: PM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing and 2022) <sup>1</sup>**



<sup>1</sup> Northbound C-D lanes corridor length is 3.7 miles under Build conditions compared to 1.3 miles under existing and No Build conditions

## 7.2.2 I-95 Density and Speed Analysis

### 7.2.2.1 AM Peak Hour

Tables 7-6a, 7-6b, 7-6c, 7-7a, 7-7b, and 7-7c depict 2022 No Build and Build travel speeds and densities along the northbound I-95 mainline, C-D lanes, and Express Lanes during the AM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along northbound I-95. A comparison and discussion of traffic volume input versus throughput is presented in Section 7.2.3.

#### *2022 No Build Conditions*

Based on the segment densities, under 2022 No Build conditions in the AM peak hour, the northbound I-95 mainline operates with light traffic conditions with the exception of the approach to the diverge to the northbound I-95 C-D lanes at Route 17. The northbound I-95 mainline diverge to the C-D lanes operates with severe congestion which causes heavy congestion upstream to the merge from the Route 3 on-ramp. The severe congestion in the northbound I-95 C-D lanes also causes reduced speeds of 22 MPH in the mainline diverge to the C-D lanes and 44 MPH between the merge from the Route 3 on-ramp and the diverge to the C-D lanes. Travel speeds along the remainder of the northbound I-95 mainline lanes range from 55 MPH to 69 MPH.

Along the northbound I-95 C-D lanes, segments south of and within the Route 17 weave operate with heavy or severe congestion while segments north of the weave operate with light traffic conditions due to the metering effect of the congestion within the Route 17 weave as well as congestion in the downstream weave on westbound Route 17 extending upstream into the I-95 C-D lanes. Average travel speeds are 10 MPH within the weave and 15 MPH to 34 MPH upstream of the weave while vehicles downstream of the weave experience travel speeds of 49 MPH to 64 MPH. While the Route 17 weave along the northbound I-95 C-D lanes also operates with severe congestion under existing conditions, the impacts of the severe congestion along the C-D lanes extend farther upstream and impact the northbound I-95 mainline lanes more substantially during 2022 No Build conditions.

The northbound Express Lanes, which begin north of Route 17 and extend beyond the northern limits of the study area, operate with light traffic conditions and average travel speeds of 67 MPH to 72 MPH.

Table 7-6a: AM Peak Hour Northbound I-95 Mainline Speed and Density (2022 No Build)

2022 No Build AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput	Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ml)	Average Density (vp/ml)	
1	18708	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	3968	3951		69	69	19	19	
2	18708						69		20		
3	18708						69		18		
1	638	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	3968	3929	-1%	69	69	4	14	
2	638						68		20		
3	638						69		17		
4	638						69		16		
1	1180	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	3623	3589	-1%	68	69	19	17	
2	1180						69		17		
3	1180						69		16		
1	774	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	3623	3587	-1%	70	69	6	13	
2	774						69		13		
3	774						70		17		
4	774						70		16		
1	1159	I-95 NB Mainline between diverge to WB Route 3 and merge from Route 3	Mainline	3084	3041	-1%	69	69	12	15	
2	1159						69		16		
3	1159						69		16		
1	872	I-95 NB Mainline merge at on-ramp from Route 3	Merge	5265	5232	-1%	49	59	10	18	
2	872						1018		19		
3	872						1273		21		
4	872						1339		21		
5	872						1127		17		
1	1333	I-95 NB Mainline merge between on-ramp from Route 3 and diverge to I-95 NB CD Lanes (4 lanes)	Merge	5265	5211	-1%	46	55	6	24	
2	1333						1806		34		
3	1333						1751		31		
4	1333						1510		26		
1	9575	I-95 NB Mainline between merge from Route 3 and diverge to I-95 NB CD Lanes (3 lanes)	Mainline	5265	5021	-5%	39	44	49	43	
2	9575						1665		42		
3	9575						1672		36		
1	933	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	5265	4808	-9%	17	22	75	65	
2	933						740		82		
3	933						1115		58		
4	933						1779		45		
1	5396	I-95 NB Mainline between diverge to I-95 NB CD Lanes and diverge to I-95 NB Express Lanes	Mainline	3400	3169	-7%	67	67	11	16	
2	5396						1048		16		
3	5396						1387		21		
1	164	I-95 NB Mainline diverge at off-ramp to I-95 NB Express Lanes	Diverge	3400	3175	-7%	68	55	13	14	
2	164						886		19		
3	164						1243		16		
4	164						746		8		
1	604	I-95 NB Mainline between diverge to I-95 NB Express Lanes and on-ramp from I-95 NB CD Lanes	Mainline	2853	2673	-6%	68	68	13	13	
2	604						1136		17		
3	604						618		9		
1	3126	I-95 NB Mainline Weave between on-ramp from I-95 NB CD Lanes and off-ramp to I-95 NB Express Lanes	Weave	3811	3645	-4%	69	69	10	13	
2	3126						664		16		
3	3126						1137		18		
4	3126						1224		9		
1	5780	I-95 NB Mainline between off-ramp to I-95 NB Express Lanes and diverge to Centreport Pkwy	Mainline	3435	3287	-4%	68	69	22	16	
2	5780						1030		15		
3	5780						770		11		
1	814	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3435	3287	-4%	61	66	13	13	
2	814						760		11		
3	814						753		14		
4	814						951		12		
1	2128	I-95 NB Mainline off-ramp to EB Route 3	Ramp	345	343	343		39	39	9	9
1	1134	I-95 NB Mainline off-ramp to WB Route 3	Ramp	539	542	542		32	32	17	17
1	516	I-95 NB Mainline on-ramp from Route 3	Ramp	2181	2196		36	43	31	31	
2	516						1103		31		
1	703	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1865	1587	1587	-15%	23	23	72	72
1	4374	I-95 NB Mainline off-ramp to I-95 NB Express Lanes (left)	Ramp	547	505	505	-8%	67	67	8	8
1	1335	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	958	965	965		64	64	15	15
1	5030	I-95 NB Mainline off-ramp to I-95 NB Express Lanes (right)	Ramp	376	367	367	-2%	59	59	6	6
1	2100	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	1009	933	933	-8%	21	21	48	48

**Table 7-6b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2022 No Build)**

2022 No Build AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	703	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	1865	1587	1587	-15%	23	23	72	72
1	484	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	1865	165	1591	-15%	48	34	3	41
2	484				1425			19		78	
1	1095	I-95 NB CD Lanes between diverge to EB Route 17 and on-ramp from EB Route 17	Mainline	1628	1375	1375	-16%	15	15	94	94
1	545	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	2203	974	1935	-12%	9	10	104	99
2	545				961			10		94	
1	1132	I-95 NB CD Lanes between off-ramp to WB Route 17 and merge from WB Route 17	Mainline	575	579	579		50	50	12	12
1	742	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	958	83	962		41	49	2	9
2	742				879			58		15	
1	1335	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	958	965	965		64	64	15	15
1	1693	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	237	204	204	-14%	32	32	6	6
1	1245	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	575	576	576		22	22	27	27
1	1244	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	1628	1353	1353	-17%	18	18	76	76
1	1577	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	383	386	386		34	34	11	11

**Table 7-6c: AM Peak Hour Northbound I-95 Express Lanes Speed and Density (2022 No Build)**

2022 No Build AM I-95 Northbound Express Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	4374	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (1 lane)	Mainline	547	505	505	-8%	67	67	8	8
1	4275	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (2 lanes)	Mainline	547	417	505	-8%	70	72	6	4
2	4275				88			74		1	
1	943	I-95 NB Express Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	923	406	874	-5%	70	71	6	4
2	943				407			71		6	
3	943				61			70		1	
1	25354	I-95 NB Express Lanes between merge from I-95 NB CD Lanes and Courthouse Rd	Mainline	923	448	873	-5%	70	70	6	6
2	25354				425			71		6	
1	5030	I-95 NB Express Lanes on-ramp from I-95 NB Mainline (left)	Ramp	376	367	367	-2%	59	59	6	6

**2022 Build Conditions**

Based on the segment densities, under 2022 Build conditions in the AM peak hour, all northbound I-95 mainline, C-D lanes, and Express Lanes segments operate with light traffic conditions. Congestion within the northbound I-95 C-D lanes is eliminated due to the removal of the weave between the Route 17 loop ramps. Under Build conditions, motorists traveling from northbound I-95 to westbound Route 17 exit onto the same off-ramp as the traffic traveling to eastbound Route 17 Business. Removing the weave along the northbound I-95 C-D lanes provides more opportunities for vehicles from eastbound Route 17 to merge into the northbound C-D lanes as well as providing vehicles exiting to westbound Route 17 from the C-D lanes a smoother transition to the off-ramp without lane-changing friction between the two existing weaving movements.

Average travel speeds range from 56 MPH to 70 MPH on the northbound I-95 mainline, 56 MPH to 69 MPH in the northbound I-95 C-D lanes, and 67 MPH to 72 MPH in the northbound Express Lanes.

**Table 7-7a: AM Peak Hour Northbound I-95 Mainline Speed and Density (2022 Build)**

2022 Build AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	18703	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	3968	1335	3951		69	69	19	19
2	18703				1356			69		20	
3	18703				1260			69		18	
1	642	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	3968	260	3935	-1%	69	69	4	14
2	642				1337			68		20	
3	642				1217			69		18	
4	642				1121			69		16	
1	1147	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	3623	1267	3587	-1%	68	69	19	17
2	1147				1207			69		17	
3	1147				1114			69		16	
1	794	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	3623	453	3583	-1%	69	69	7	13
2	794				850			69		12	
3	794				1176			70		17	
4	794				1104			70		16	
1	6185	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	3084	949	3044	-1%	69	69	14	15
2	6185				1155			69		17	
3	6185				941			70		14	
1	1319	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	3084	259	3036	-2%	71	70	4	11
2	1319				1254			69		18	
3	1319				783			70		11	
4	1319				740			70		11	
1	11839	I-95 NB Mainline between diverge to I-95 NB CD Lanes and diverge to I-95 NB Express Lanes	Mainline	2008	504	1988	-1%	70	70	7	9
2	11839				732			70		10	
3	11839				753			69		11	
1	167	I-95 NB Mainline diverge at off-ramp to I-95 NB Express Lanes	Diverge	2008	500	1952	-3%	70	56	7	8
2	167				773			69		11	
3	167				471			49		10	
4	167				208			38		5	
1	1096	I-95 NB Mainline between diverge to I-95 NB Express Lanes and merge from I-95 NB CD Lanes	Mainline	1646	517	1624	-1%	70	70	7	8
2	1096				739			70		11	
3	1096				368			69		5	
1	1000	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (5 lanes)	Merge	3435	211	3459		68	70	3	10
2	1000				1344			69		19	
3	1000				773			70		11	
4	1000				784			70		11	
5	1000				347			71		5	
1	3150	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (4 lanes)	Merge	3435	943	3462		68	70	14	12
2	3150				1194			69		17	
3	3150				951			70		14	
4	3150				374			71		5	
1	4266	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Parkway	Mainline	3435	1701	3462		67	69	25	17
2	4266				1068			70		15	
3	4266				694			71		10	
1	804	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3435	798	3457		60	66	14	13
2	804				845			65		13	
3	804				1010			68		15	
4	804				804			69		12	
1	2132	I-95 NB Mainline off-ramp to EB Route 3	Ramp	345	344	344		39	39	9	9
1	1110	I-95 NB Mainline off-ramp to WB Route 3	Ramp	539	542	542		33	33	17	17
1	625	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1076	859	1045	-3%	70	69	12	8
2	625				185			69		3	
1	4372	I-95 NB Mainline off-ramp to I-95 NB Express Lanes	Ramp	362	358	358	-1%	67	67	5	5
1	709	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1789	853	1829		69	69	12	13
2	709				975			69		14	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	1009	985	985	-2%	17	17	61	61

**Table 7-7b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2022 Build)**

2022 Build AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ft)	Average Density (vp/ft)
1	7812	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	2181	1096	2198		65	65	17	17
2	7812				1102			65		17	
1	1298	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	3257	1072	3237	-1%	69	69	16	12
2	1298				1104			69		16	
3	1298				1047			69		15	
4	1298				14			69		0	
1	5579	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	3257	1003	3230	-1%	68	68	15	16
2	5579				1253			68		18	
3	5579				975			69		14	
1	1168	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	1392	655	1413		67	68	10	10
2	1168				758			69		11	
1	951	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	1967	106	1985		42	56	3	11
2	951				927			61		15	
3	951				952			67		14	
1	755	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	1967	1025	1989		66	67	16	15
2	755				964			68		14	
1	403	I-95 NB CD Lanes between on-ramp from WB Route 17 and diverge to I-95 NB Express Lanes	Mainline	2350	562	2378		53	62	11	13
2	403				857			65		13	
3	403				959			69		14	
1	1057	I-95 NB CD Lanes diverge to I-95 NB Express Lanes	Diverge	2350	455	2386		67	68	7	9
2	1057				310			65		5	
3	1057				677			68		10	
4	1057				943			69		14	
1	368	I-95 NB CD Lanes merge between off-ramp to I-95 NB Express Lanes and I-95 NB Mainline Lanes (3 lanes)	Merge	1789	11	1826		47	62	0	9
2	368				843			69		12	
3	368				971			69		14	
1	709	I-95 NB CD Lanes between diverge to I-95 NB Express Lanes and I-95 NB Mainline Lanes (2 lanes)	Mainline	1789	853	1829		69	69	12	13
2	709				975			69		14	
1	625	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	1076	859	1045	-3%	70	69	12	8
2	625				185			69		3	
1	409	I-95 NB CD Lanes off-ramp to Route 17	Ramp	1865	915	1803	-3%	49	49	19	19
2	409				888			48		18	
1	1246	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	575	575	575		29	29	20	20
1	1583	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	383	391	391		34	34	11	11
1	3807	I-95 NB CD Lanes off-ramp to I-95 NB Express Lanes	Ramp	561	559	559		69	69	8	8

**Table 7-7c: AM Peak Hour Northbound I-95 Express Lanes Speed and Density (2022 Build)**

2022 Build AM I-95 Northbound Express Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ft)	Average Density (vp/ft)
1	4372	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (1 lane)	Mainline	362	358	358	-1%	67	67	5	5
1	4275	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (2 lanes)	Mainline	362	305	358	-1%	70	72	4	3
2	4275				53			74		1	
1	943	I-95 NB Express Lanes merge at on-ramp from I-95 NB CD Lanes	Merge	923	321	912	-1%	70	70	5	4
2	943				502			70		7	
3	943				89			70		1	
1	25354	I-95 NB Express Lanes between merge from I-95 NB CD Lanes and Courthouse Rd	Mainline	923	454	915	-1%	71	70	6	7
2	25354				462			70		7	
1	4877	I-95 NB Express Lanes on-ramp from I-95 NB CD Lanes	Ramp	561	556	556	-1%	59	59	9	9

### 7.2.2.2 PM Peak Hour

**Tables 7-8a, 7-8b, 7-9a, and 7-9b** depict 2022 No Build and Build travel speeds and densities along the northbound I-95 mainline and C-D lanes during the PM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along I-95. A comparison and discussion of traffic volume input versus throughput is presented in **Section 7.2.3**. During the PM peak hour, the Express Lanes operate in the southbound direction only; therefore, northbound Express Lanes results are not applicable during the PM peak hour.

#### *2022 No Build Conditions*

Based on the segment densities, under 2022 No Build conditions in the PM peak hour, all of the northbound I-95 mainline and C-D lanes segments operate with light traffic conditions. The severe congestion which occurs in the C-D lanes at Route 17 under 2022 No Build conditions during the AM peak hour does not occur during the PM peak hour due to lower volumes (approximately 40% less traffic volume demand in the weave between the Route 17 loop ramps).

Average travel speeds range from 54 MPH to 70 MPH in the northbound I-95 mainline lanes and 40 MPH to 68 MPH in the northbound I-95 C-D lanes.

**Table 7-8a: PM Peak Hour Northbound I-95 Mainline Speed and Density (2022 No Build)**

2022 No Build PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unreserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ml)	Average Density (vp/ml)
1	18694	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	3254	1081	3253		69	69	16	16
2	18694				1124			69		16	
3	18694				1048			69		15	
1	639	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	3254	235	3250		69	69	3	12
2	639				1018			69		15	
3	639				1055			70		15	
4	639				942			70		13	
1	1162	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	2941	958	2935		69	69	14	14
2	1162				1047			69		15	
3	1162				930			69		13	
1	784	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	2941	164	2934		70	70	2	10
2	784				813			70		12	
3	784				1034			70		15	
4	784				923			70		13	
1	1169	I-95 NB Mainline between diverge to WB Route 3 and merge from Route 3	Mainline	2744	793	2736		69	69	12	13
2	1169				1029			69		15	
3	1169				914			69		13	
1	876	I-95 NB Mainline merge at on-ramp from Route 3	Merge	4030	14	4034		30	54	0	13
2	876				698			50		14	
3	876				1084			59		18	
4	876				1197			65		18	
5	876				1041			67		15	
1	1325	I-95 NB Mainline merge between on-ramp from Route 3 and diverge to I-95 NB CD Lanes (4 lanes)	Merge	4030	42	4028		61	64	1	15
2	1325				1375			64		21	
3	1325				1363			65		21	
4	1325				1249			67		19	
1	9571	I-95 NB Mainline between merge from Route 3 and diverge to I-95 NB CD Lanes (3 lanes)	Mainline	4030	1408	4023		67	68	21	20
2	9571				1361			68		20	
3	9571				1254			69		18	
1	935	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	4030	919	4046		67	68	14	15
2	935				838			67		13	
3	935				1130			69		16	
4	935				1159			70		17	
1	6200	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	2914	810	2916		69	69	12	14
2	6200				1060			69		15	
3	6200				1045			69		15	
1	1574	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	3656	137	3642		69	69	2	13
2	1574				1267			69		18	
3	1574				1212			69		17	
4	1574				1026			70		15	
1	7322	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	3656	1261	3647		68	69	18	18
2	7322				1267			69		18	
3	7322				1119			69		16	
1	808	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3656	206	3644		70	70	3	13
2	808				1085			69		16	
3	808				1221			70		18	
4	808				1132			70		16	
1	2137	I-95 NB Mainline off-ramp to EB Route 3	Ramp	313	312	312		39	39	8	8
1	1150	I-95 NB Mainline off-ramp to WB Route 3	Ramp	197	204	204		34	34	6	6
1	499	I-95 NB Mainline on-ramp from Route 3	Ramp	1286	219	1307		27	26	8	26
2	499				1088			25		43	
1	705	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1116	1127	1127		65	65	17	17
1	1340	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	742	732	732	-1%	65	65	11	11
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	264	257	257	-3%	26	26	10	10

**Table 7-8b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2022 No Build)**

2022 No Build PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	705	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	1116	1127	1127		65	65	17	17
1	488	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	1116	120	1129		66	67	2	8
2	488				1010			67		15	
1	1102	I-95 NB CD Lanes between diverge to EB Route 17 and on-ramp from EB Route 17	Mainline	950	967	967		68	68	14	14
1	549	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	1331	730	1340		36	40	20	17
2	549				610			44		14	
1	1148	I-95 NB CD Lanes between off-ramp to WB Route 17 and merge from WB Route 17	Mainline	381	377	377	-1%	58	58	6	6
1	739	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	742	66	732	-1%	44	52	2	6
2	739				666			60		11	
1	1340	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	742	732	732	-1%	65	65	11	11
1	1696	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	166	166	166		36	36	5	5
1	1246	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	381	377	377	-1%	29	29	13	13
1	1254	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	950	962	962		26	26	38	38
1	1565	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	361	357	357	-1%	34	34	10	10

**2022 Build Conditions**

Based on the segment densities, under 2022 Build conditions in the PM peak hour, all northbound I-95 mainline and C-D lane segments operate with light traffic conditions. Average travel speeds along the corridor range from 69 MPH to 70 MPH in the northbound I-95 mainline lanes and 56 MPH to 69 MPH in the C-D lanes. Under Build conditions, the lowest travel speeds increased by 15 MPH in the northbound I-95 mainline lanes and 16 MPH in the C-D lanes compared to No Build conditions. This can be attributed to the increased capacity along both the northbound I-95 mainline lanes and C-D lanes north of Route 3 under Build conditions.

**Table 7-9a: PM Peak Hour Northbound I-95 Mainline Speed and Density (2022 Build)**

2022 Build PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserviced	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	18683	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	3254	1081	3253		69	69	16	16
2	18683				1124			69		16	
3	18683				1047			69		15	
1	643	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	3254	235	3242		69	69	3	12
2	643				1018			69		15	
3	643				1054			70		15	
4	643				935			70		13	
1	1161	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	2941	962	2939		69	69	14	14
2	1161				1044			69		15	
3	1161				934			69		14	
1	790	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	2941	186	2939		69	70	3	11
2	790				786			70		11	
3	790				1041			70		15	
4	790				927			70		13	
1	6178	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	2744	880	2736		69	69	13	13
2	6178				1031			69		15	
3	6178				825			70		12	
1	1322	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	2744	183	2732		71	70	3	10
2	1322				1079			69		16	
3	1322				772			69		11	
4	1322				698			70		10	
1	13145	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	1982	571	1977		70	70	8	9
2	13145				739			70		11	
3	13145				667			70		10	
1	985	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (5 lanes)	Merge	3656	73	3645		67	69	1	10
2	985				1304			69		19	
3	985				825			70		12	
4	985				777			70		11	
5	985				666			70		9	
1	3156	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (4 lanes)	Merge	3656	890	3650		69	69	13	13
2	3156				1073			69		16	
3	3156				969			70		14	
4	3156				718			70		10	
1	4268	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	3656	1403	3647		68	69	21	18
2	4268				1258			69		18	
3	4268				985			70		14	
1	805	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3656	204	3641		69	69	3	13
2	805				1160			68		17	
3	805				1215			69		18	
4	805				1062			70		15	
1	2147	I-95 NB Mainline off-ramp to EB Route 3	Ramp	313	312	312		39	39	8	8
1	1139	I-95 NB Mainline off-ramp to WB Route 3	Ramp	197	204	204		34	34	6	6
1	621	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	762	639	756	-1%	69	69	9	5
2	621				117			68		2	
1	713	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1674	580	1670		68	68	9	12
2	713				1090			69		16	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	264	257	257	-3%	26	26	10	10

**Table 7-9b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2022 Build)**

2022 Build PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	7808	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	1286	647	1299		66	66	10	10
2	7808				652			66		10	
1	1303	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	2048	610	2034	-1%	69	69	9	7
2	1303				660			69		10	
3	1303				754			70		11	
4	1303				10			69		0	
1	5580	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	2048	599	2044		67	68	9	10
2	5580				756			68		11	
3	5580				689			68		10	
1	1181	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	932	457	939		66	67	7	7
2	1181				483			67		7	
1	947	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	1313	57	1322		39	56	1	7
2	947				603			61		10	
3	947				662			67		10	
1	757	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	1313	626	1322		68	68	9	10
2	757				696			69		10	
1	1880	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	1674	172	1675		58	65	3	8
2	1880				738			68		11	
3	1880				766			70		11	
1	713	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	1674	580	1670		68	68	9	12
2	713				1090			69		16	
1	621	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	762	639	756	-1%	69	69	9	5
2	621				117			68		2	
1	435	I-95 NB CD Lanes off-ramp to Route 17	Ramp	1116	529	1125		45	46	12	12
2	435				596			47		13	
1	1247	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	381	381	381		29	29	13	13
1	1577	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	361	358	358	-1%	34	34	10	10

### 7.2.3 Traffic Volume Throughput Comparison

Volume throughputs were analyzed at four locations along the I-95 corridor from south of Route 3 to Centreport Parkway. **Figures 7-11 and 7-12** show existing, 2022 No Build, and 2022 Build AM and PM peak hour traffic volume demand, throughput, and percent volume unserved at each location along northbound I-95 including all mainline lanes, C-D lanes, and Express Lanes.

#### 2022 No Build Conditions

**AM Peak Hour:** In the AM peak direction, northbound I-95 has 6 percent unserved demand over the Rappahannock River due to congestion from the C-D lanes extending upstream into the mainline lanes. This congestion in the northbound I-95 mainline lanes meters traffic traveling northbound, causing 5 percent unserved demand north of Route 17 and 3 percent unserved demand at Centreport Parkway.

**PM Peak Hour:** In the PM peak hour, northbound I-95 serves all traffic demand at the four locations analyzed.

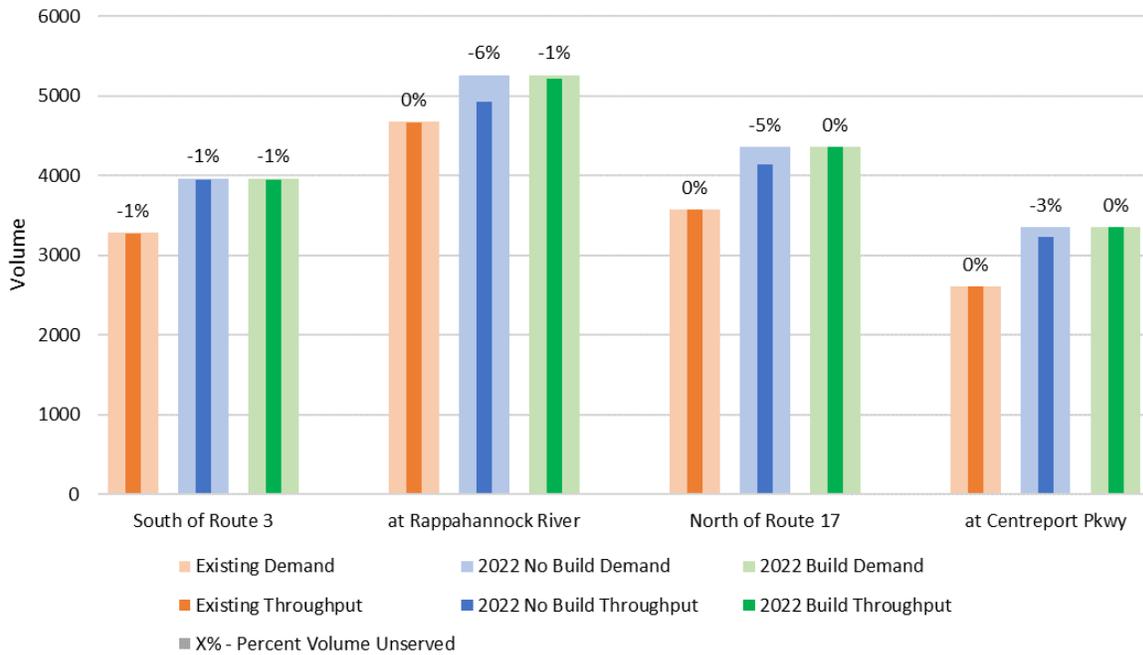
#### 2022 Build Conditions

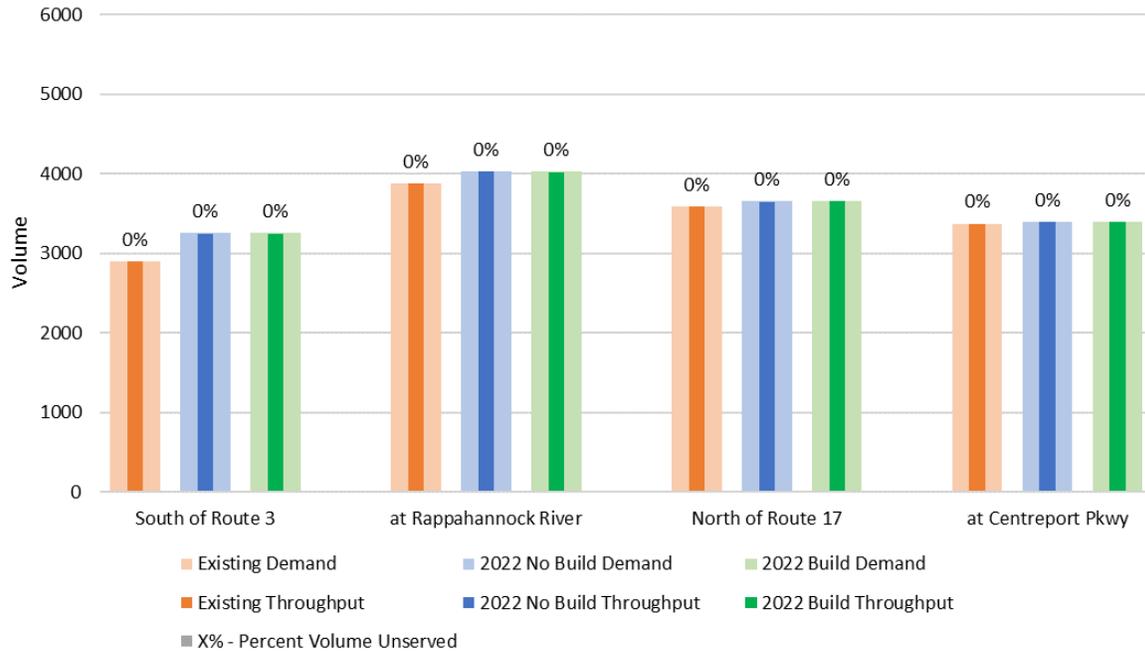
During both the AM and PM peak hours on northbound I-95, the percent volume served increases or remains the same for all segments throughout the corridor under Build conditions compared to No Build conditions. The greatest increase in throughput is over the Rappahannock River during the AM peak hour with 290 more vehicles served and 6 percent more traffic served.

**AM Peak Hour:** In the AM peak direction under 2022 Build conditions, northbound I-95 unserved demand percentages decrease. However, there is 1 percent unserved demand south of Route 3 and over the Rappahannock River.

**PM Peak Hour:** In the PM peak hour under 2022 Build conditions, northbound I-95 serves all traffic demand.

**Figure 7-11: Northbound I-95 2022 AM Peak Hour Volume Throughputs**



**Figure 7-12: Northbound I-95 2022 PM Peak Hour Volume Throughputs**

## 7.2.4 Arterial Intersection Operations

**Table 7-10** depicts overall intersection delay for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for 2022 No Build and Build conditions. It should be noted that both the No Build and Build analysis includes the recent intersection improvements completed along Route 3 associated with the I-95 Safety Improvements at Route 3 project that was completed in January 2019. **Appendix E** contains detailed VISSIM results for intersection volume throughputs, delays, and queues by movement, approach, and for the overall intersections.

### *2022 No Build Conditions*

**AM Peak Hour:** During the AM peak hour under 2022 No Build conditions, all of the intersections operate with light or moderate traffic conditions and overall intersection average delays less than 40 seconds with one exception. The signalized intersection of Route 17 at Sanford Drive/Gateway Drive operates with heavy congestion due to severe congestion on the Route 17 westbound approach and heavy congestion on the Gateway Drive southbound approach. The Route 17 westbound approach to the intersection experiences severe congestion largely due to the high delay in the left-turn lane. The westbound left-turn movement also experiences maximum queue lengths that exceed the existing storage lane. At times, the maximum queue length on westbound Route 17 extends upstream through the northeast quadrant loop ramp at the I-95 interchange and contributes to the congestion on the northbound I-95 C-D lanes. Westbound Route 17 also experiences severe congestion due to the weave between the southbound I-95 off-ramp to westbound Route 17 and the signalized intersection at Sanford Drive/Gateway Drive. Vehicles traveling from the southbound I-95 off-ramp destined to turn left onto Sanford Drive must weave across the three travel lanes on Route 17 while vehicles on Route 17 destined to turn right onto Gateway Drive must make lane changes

to the right side of Route 17 where the vehicles from southbound I-95 are trying to merge in westbound Route 17 traffic.

**PM Peak Hour:** During the PM peak hour, all of the study intersections operate with light or moderate traffic conditions. The substantial reductions in delay at the Route 17 at Sanford Drive/Gateway Drive intersection compared to existing conditions can be attributed to the improvements associated with the I-95 Rappahannock River Crossing Southbound project which is included in No Build conditions. This project will increase capacity along southbound I-95 thereby reducing delays along eastbound Route 17 approaching I-95 and at the Route 17 at Sanford Drive/Gateway Drive, especially turning movements to eastbound Route 17. Similarly, overall intersection delays at the Route 3 at Carl D. Silver Parkway intersection are reduced due to the capacity improvements associated with the I-95 Safety Improvements at Route 3 project.

### ***2022 Build Conditions***

Under Build conditions during both the AM and PM peak hours, all intersections operate with light or moderate traffic conditions. The two new signalized intersections on Route 17 at the northbound and southbound I-95 ramps operate with light traffic conditions as shown in **Tables 7-10a, 7-10b, 7-10c, and 7-10d**.

**AM Peak Hour:** During the AM peak hour, the signalized intersection of Route 17 at Sanford Drive/Gateway Drive improves from heavy congestion under No Build conditions to light traffic conditions under Build conditions. This is primarily due to a 72 second decrease in delay on the westbound approach and an improvement on the westbound approach from severe congestion to light traffic conditions. The addition of a second westbound left-turn lane from westbound Route 17 onto Sanford Drive as well as the elimination of the westbound Route 17 weave under Build conditions contributes to the reduction in westbound delay. Under No Build conditions, the maximum queue length on westbound Route 17 extends upstream through the northeast quadrant loop ramp at the I-95 interchange and contributes to the congestion on the northbound I-95 C-D lanes. However, under Build conditions, the westbound Route 17 weave between the I-95 ramps and Sanford Drive is eliminated because vehicles exiting from northbound I-95 onto westbound Route 17 and from southbound I-95 onto westbound Route 17 are signal controlled. As a result of the additional westbound left-turn lane onto Sanford Drive and the elimination of the westbound Route 17 weaves within the interchange and approaching Sanford Drive, the westbound Route 17 maximum queue length no longer extends to the northwest or northeast quadrant loop ramps. As shown in **Tables 7-10a and 7-10b**, average intersection delays at the two new signalized intersections along Route 17 at the I-95 Southbound Off-Ramp and the I-95 Northbound Off-Ramp are approximately 20 seconds or less with queues that do not extend beyond the turn lanes. The maximum northbound left-turn queue for the triple left turn from northbound I-95 to westbound Route 17 is approximately 400 feet which does not extend onto the northbound I-95 C-D lanes.

**PM Peak Hour:** During the PM peak hour, all signalized and unsignalized intersections operate with light or moderate traffic conditions, similar to No Build conditions. As shown in **Tables 7-10c and 7-10d**, average intersection delays at the two new signalized intersections along Route 17 at the I-95 Southbound Off-Ramp and the I-95 Northbound Off-Ramp are approximately 20 seconds or less with queues that do not extend beyond the turn lanes. The maximum northbound left-turn queue for the triple left turn from

northbound I-95 to westbound Route 17 is approximately 365 feet which does not extend onto the northbound I-95 C-D lanes.

**Table 7-10: Intersection Delay Summary (2022 Conditions)**

Intersection	Intersection Control	Average Delay (seconds)			
		2022 No Build		2022 Build	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Route 3 at Central Park Boulevard/ Mall Drive	Signalized	14	30	13	30
Route 3 at Carl D. Silver Parkway	Signalized	15	35	15	35
Route 3 at I-95 Southbound Off-Ramp	Signalized	9	27	15	27
Route 3 at I-95 Northbound On-Ramp	Signalized	36	28	38	30
Route 3 at Gateway Boulevard	Signalized	19	22	18	22
Route 17 at Falls Run Drive	Signalized	6	14	8	14
Route 17 at McLane Drive	Signalized	4	3	4	4
Route 17 at Sanford Drive/ Gateway Drive	Signalized	57	22	20	23
Route 17 at I-95 Southbound Off-Ramp	Signalized	N/A	N/A	9	13
Route 17 at I-95 Northbound Off-Ramp	Signalized	N/A	N/A	21	19
Route 17 at Short Street	Stop	2	7	1	4
Route 17 at Olde Forge Drive	Signalized	13	14	15	15

**Table 7-10a: AM Peak Hour Route 17 at I-95 Northbound Off-Ramp Intersection Delay Summary (2022 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
NB	25.3	NB Left	1628	1585	-43	-3%	27.1	90	402	1590	21.0
		NB Right	237	232	-5	-2%	13.0	104	424	1590	
EB	21.4	EB Through	1092	1063	-29	-3%	21.4	49	301		
WB	14.4	WB Through	1254	1232	-22	-2%	14.4	43	311		

**Table 7-10b: AM Peak Hour Route 17 at I-95 Southbound Off-Ramp Intersection Delay Summary (2022 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
SB	28.1	SB Right	352	328	-24	-7%	28.1	29	145	1490	9.4
WB	7.1	WB Through	2725	2662	-63	-2%	7.1	19	309		

**Table 7-10c: PM Peak Hour Route 17 at I-95 Northbound Off-Ramp Intersection Delay Summary  
(2022 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
NB	39.1	NB Left	950	971			42.3	101	365	1590	19.1
		NB Right	166	166			20.9	112	379	1590	
EB	14.4	EB Through	2020	2022			14.4	50	389		
WB	7.6	WB Through	1174	1164	-10	-1%	7.6	21	235		

**Table 7-10d: PM Peak Hour Route 17 at I-95 Southbound Off-Ramp Intersection Delay Summary  
(2022 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
SB	26.7	SB Right	575	574	-1		26.7	38	197	1490	13.4
WB	9.4	WB Through	1881	1891			9.4	20	211		

## 7.3 2042 NO BUILD AND BUILD CONDITIONS TRAFFIC OPERATIONS

As discussed in **Section 2.4**, the VISSIM files developed for the Fred Ex project were modified to reflect updates to No Build projects along the corridor as well as the proposed Build Alternative for I-95 Rappahannock River Crossing Northbound project to create the 2042 No Build and Build conditions VISSIM models.

### 7.3.1 I-95 Travel Time Analysis

#### 7.3.1.1 AM Peak Hour

A comparison of overall corridor travel times for existing conditions, 2042 No Build conditions, and 2042 Build conditions is summarized in **Figures 7-13 and 7-14** for the northbound I-95 mainline and C-D lanes during the AM peak hour.

#### *2042 No Build Conditions*

**Northbound I-95 Mainline:** Under 2042 No Build conditions, the northbound I-95 mainline total travel time is 19.6 minutes, which is 12.6 minutes greater than existing conditions. The highest increase in travel time occurs between Route 620/Harrison Road and Route 3 (4.8 minute increase) with travel increases of 1 to 3 minutes between every bridge/underpass south of Route 17. Longer travel times along these segments of the corridor can be attributed to slower speeds due to congestion in the northbound C-D lanes extending upstream into the northbound I-95 mainline lanes and south of the Route 3 interchange.

**Northbound I-95 C-D Lanes:** Under 2042 No Build conditions, the northbound I-95 C-D lanes total travel time is 3.3 minutes which is 1.5 minutes greater than existing conditions. All of the travel time increase occurs between the start of the C-D lanes and Route 17 due to congestion in the weave between the Route 17 loop ramps as well as downstream congestion along westbound Route 17 extending upstream through the northeast quadrant loop ramp at the I-95 interchange and into the northbound I-95 C-D lanes.

#### *2042 Build Conditions*

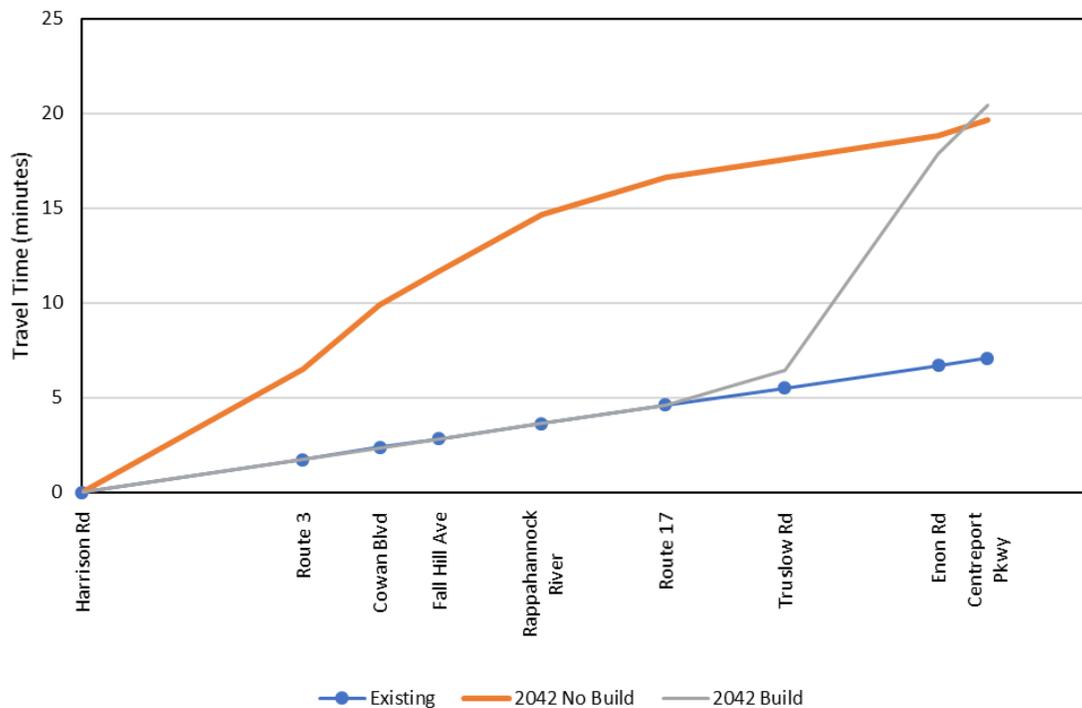
Lower travel times under 2042 Build conditions within the project limits are attributed to improvements to the Route 17 interchange including the removal of the loop ramp from the northbound C-D lanes to westbound Route 17, eliminating the weave which causes congestion under 2042 No Build conditions. Travel time improvements are also a result of additional northbound capacity with the addition of the I-95 C-D lanes beginning north of Route 3.

**Northbound I-95 Mainline:** Under 2042 Build conditions, the northbound I-95 mainline total travel time within the study area is 20.4 minutes, which is 47 seconds greater (4% increase) than No Build conditions. However, the northbound I-95 mainline travel time within the limits of the proposed improvements between Route 620/Harrison Road and Truslow Road is 6.5 minutes, which is 11.1 minutes less (63% decrease) than No Build conditions. Whereas under No Build conditions, the greatest increase in travel time occurs between Route 620/Harrison Road and Route 3, the largest decrease in travel times (4.8 minutes) under Build conditions compared to No Build conditions occurs in the same area, between Route 620/Harrison Road and Route 3.

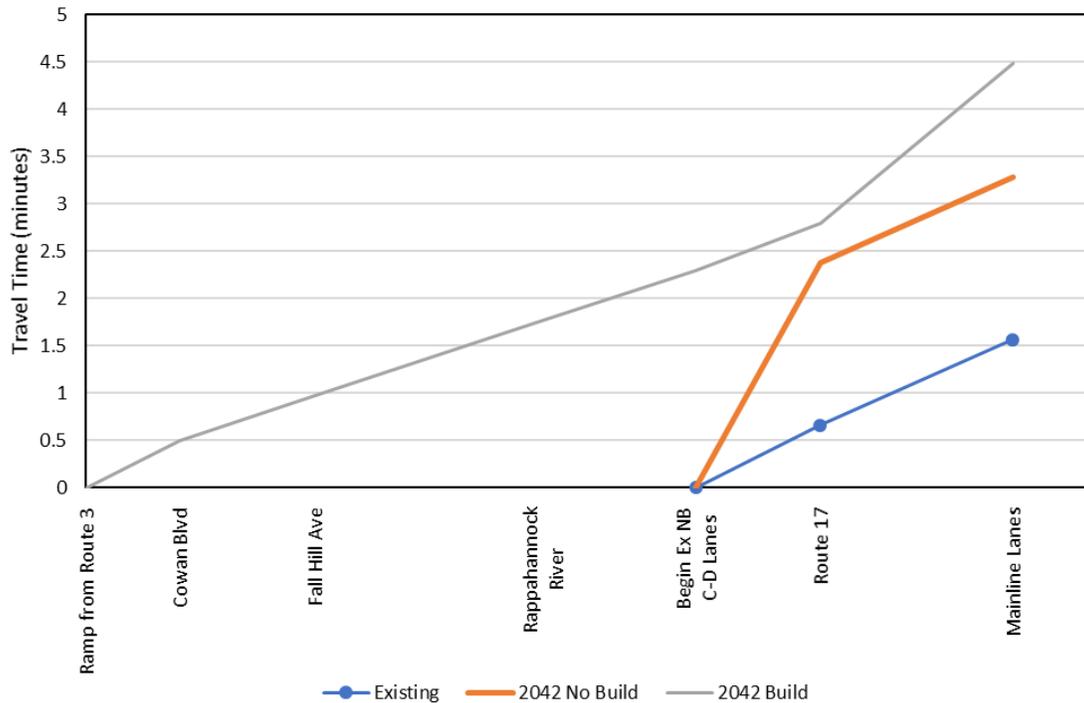
It should be noted that under Build conditions, the travel time increases by 11.9 minutes between Truslow Road and Centreport Parkway due to congestion north of the study area extending upstream beyond Truslow Road. The average travel time under Build conditions increases at the north end of the study area compared to No Build conditions because northbound I-95 mainline traffic is metered under No Build conditions south of the Route 17 interchange due to congestion along the C-D lanes. Under Build conditions, the metering effect at the diverge to the C-D lanes at Route 17 is eliminated, resulting in greater throughput downstream north of Truslow Road. While additional capacity improvements along I-95 north of the project area are needed to accommodate the 2042 design year traffic volumes, improvements to this area are outside the scope of the I-95 Rappahannock River Crossing Northbound project. However, the I-95 Corridor Improvement Plan which is currently underway will identify key problem areas along the I-95 corridor and identify potential solutions and areas for additional review and study including improvements to address weekday and weekend congestion along I-95 north of the study area.

**Northbound I-95 C-D Lanes:** Under Build conditions, the northbound C-D lanes begin north of Route 3, as compared to just south of Route 17 under existing and No Build conditions. To make an equal comparison of travel time in the northbound C-D lanes between No Build and Build conditions, travel times between where the existing C-D lanes begin and the end of the C-D lanes were compared. Between the start of the existing C-D lanes and the end of the C-D lanes, the travel time under Build conditions is 65 seconds less than under No Build conditions, with the majority of the travel time savings occurring south of Route 17.

**Figure 7-13: AM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing and 2042)**



**Figure 7-14: AM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing and 2042) <sup>1</sup>**



<sup>1</sup> Northbound C-D lanes corridor length is 3.7 miles under Build conditions compared to 1.3 miles under existing and No Build conditions

### 7.3.1.2 PM Peak Hour

A comparison of overall corridor travel times for existing conditions, 2042 No Build conditions, and 2042 Build conditions is summarized in **Figures 7-15 and 7-16** for the northbound I-95 mainline and C-D lanes during the PM peak hour.

#### *2042 No Build Conditions*

**Northbound I-95 Mainline:** Under 2042 No Build conditions, the northbound I-95 mainline total travel time is 47.1 minutes which is 40.1 minutes longer than existing conditions. The largest increase in travel time of 16.5 minutes occurs on the approach to Route 3 while segment travel times increase between 2 minutes and 8 minutes between Route 3 and Route 17. Longer travel times along these segments of the corridor can be attributed to slower speeds due to congestion in the northbound C-D lanes extending upstream into the northbound I-95 mainline lanes and beyond the Route 3 interchange.

**Northbound I-95 C-D Lanes:** Under 2042 No Build conditions, the northbound I-95 C-D lanes total travel time is 12.4 minutes which is 11.3 minutes greater than existing conditions. The majority of the travel time increase occurs between the start of the C-D lanes and Route 17 due to congestion in the weave between the Route 17 loop ramps.

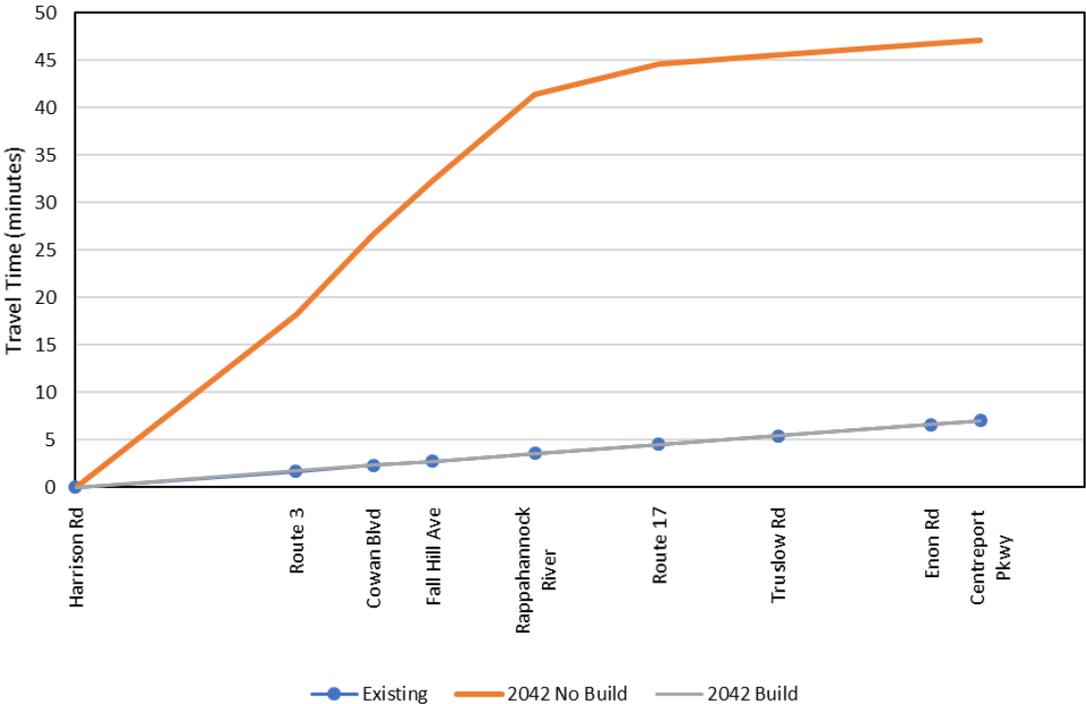
#### *2042 Build Conditions*

Lower travel times under 2042 Build conditions are attributed to improvements to the Route 17 interchange including the removal of the loop ramp from the northbound C-D lanes to westbound Route 17, eliminating the weave which causes congestion under 2042 No Build conditions. Travel time improvements are also a result of additional northbound capacity with the addition of the I-95 C-D lanes beginning north of Route 3.

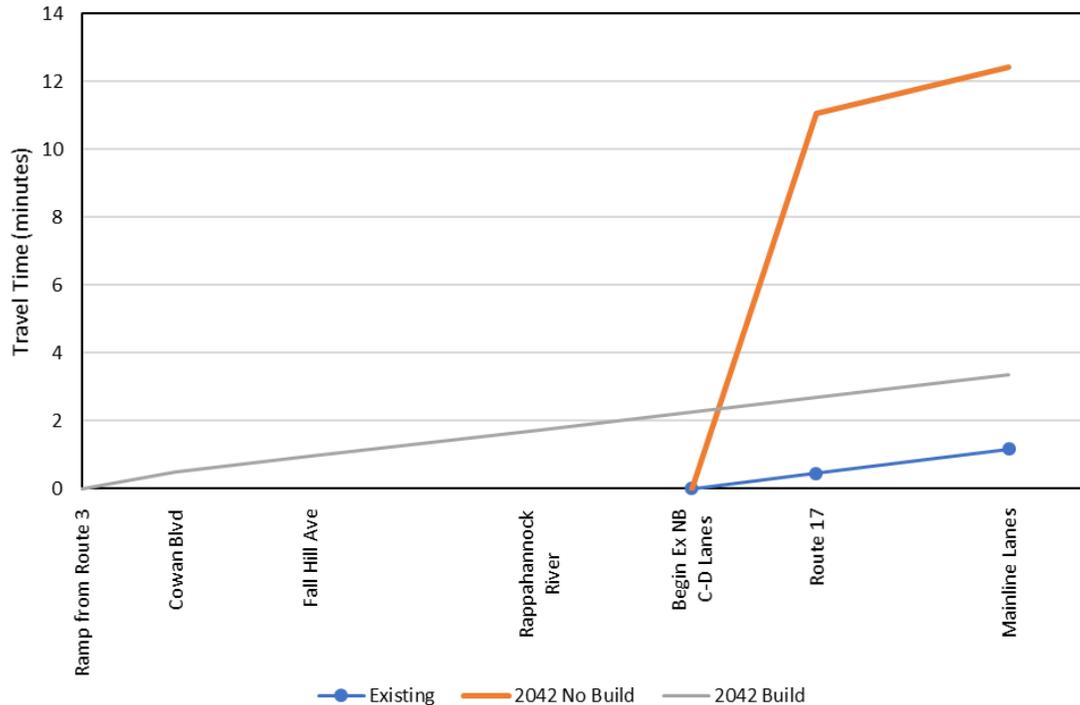
**Northbound I-95 Mainline:** Under 2042 Build conditions, the northbound I-95 mainline total travel time is 7.0 minutes, which is 40.1 minutes less than No Build conditions and similar to existing conditions. Whereas under No Build conditions, the greatest increase in travel time occurs between Route 620/Harrison Road and Route 3, the largest decrease in travel times (16.4 minutes) under Build conditions compared to No Build conditions occurs in the same area, between Route 620/Harrison Road and Route 3. Other substantial travel time savings occur between Route 3 and Route 17 with minor changes in travel time north of Route 17.

**Northbound I-95 C-D Lanes:** The corridor distance is longer due to the northbound C-D lanes beginning north of Route 3 under Build conditions, as compared to just south of Route 17 under existing and No Build conditions. To make an equal comparison in travel time in the northbound C-D lanes between No Build and Build conditions, travel times between where the existing C-D lanes begin and the end of the C-D lanes corridor were compared. Between the start of the existing C-D lanes and the end of the C-D lanes, the travel time under Build conditions is 11.3 minutes less than under No Build conditions, with the majority of the travel time savings occurring south of Route 17.

**Figure 7-15: PM Peak Hour – Northbound I-95 Mainline Cumulative Travel Times (Existing and 2042)**



**Figure 7-16: PM Peak Hour – Northbound I-95 C-D Lanes Cumulative Travel Times (Existing and 2042) <sup>1</sup>**



<sup>1</sup> Northbound C-D lanes corridor length is 3.7 miles under Build conditions compared to 1.3 miles under existing and No Build conditions

## 7.3.2 I-95 Density and Speed Analysis

### 7.3.2.1 AM Peak Hour

Tables 7-11a, 7-11b, 7-11c, 7-12a, 7-12b, and 7-12c depict 2042 No Build and Build travel speeds and densities along the northbound I-95 mainline, C-D lanes, and Express Lanes during the AM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along northbound I-95. A comparison and discussion of traffic volume input versus throughput is presented in Section 7.3.3.

#### 2042 No Build Conditions

Under 2042 No Build conditions in the AM peak hour, the northbound I-95 mainline segments experience severe congestion from the south end of the study corridor (south of Route 3) to the diverge to the northbound I-95 C-D lanes at Route 17. The severe congestion in the northbound I-95 mainline lanes is due to congestion in the C-D lanes extending upstream into the mainline lanes. All northbound I-95 mainline segments north of the diverge to the C-D lanes at Route 17 operate with light traffic conditions due to the metering of downstream traffic at the diverge to the C-D lanes. In the northbound I-95 mainline segments south of the diverge to the C-D lanes, average vehicle speeds range from 9 MPH to 24 MPH. Vehicles on segments north of the diverge to the C-D lanes have average speeds between 44 MPH and 69 MPH.

Along the northbound I-95 C-D lanes, segments south of and within the Route 17 weave operate with severe congestion while segments north of the weave operate with light traffic conditions. Similar to the

northbound I-95 mainline lanes, traffic along the northbound I-95 C-D lanes is metered north of the Route 17 weave. Average travel speeds are 11 MPH within the weave and 12 MPH to 28 MPH upstream of the weave while vehicles downstream of the weave experience travel speeds of 45 MPH to 61 MPH.

The northbound Express Lanes, which begin north of Route 17 and extend beyond the northern limits of the study area, operate with light traffic conditions and average travel speeds of 65 MPH to 71 MPH.

Table 7-11a: AM Peak Hour Northbound I-95 Mainline Speed and Density (2042 No Build)

2042 No Build AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput	Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/ml)	Average Density (vp/ml)	
1	18708	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	5858	5292	-10%	22	24	80	76	
2	18708						23		77		
3	18708						28		72		
1	638	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	5858	5102	-13%	44	23	8	76	
2	638						14		100		
3	638						15		99		
4	638						19		96		
1	1180	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	5374	4692	-13%	14	15	108	105	
2	1180						13		107		
3	1180						18		100		
1	774	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	5374	4699	-13%	42	20	15	89	
2	774						8		126		
3	774						11		114		
4	774						18		101		
1	1159	I-95 NB Mainline between diverge to WB Route 3 and merge from Route 3	Mainline	4584	4009	-13%	7	12	138	117	
2	1159						11		116		
3	1159						19		98		
1	872	I-95 NB Mainline merge at on-ramp from Route 3	Merge	7217	5227	-28%	3	9	154	131	
2	872						4		154		
3	872						6		137		
4	872						11		114		
5	872						21		94		
1	1333	I-95 NB Mainline merge between on-ramp from Route 3 and diverge to I-95 NB CD Lanes (4 lanes)	Merge	7217	5234	-27%	6	13	113	109	
2	1333						8		128		
3	1333						15		104		
4	1333						22		90		
1	9575	I-95 NB Mainline between merge from Route 3 and diverge to I-95 NB CD Lanes (3 lanes)	Mainline	7217	5229	-28%	16	20	101	90	
2	9575						18		91		
3	9575						26		79		
1	933	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	7217	5213	-28%	10	17	105	91	
2	933						7		114		
3	933						15		83		
4	933						35		63		
1	5396	I-95 NB Mainline between diverge to I-95 NB CD Lanes and diverge to I-95 NB Express Lanes	Mainline	4710	3648	-23%	64	61	12	20	
2	5396						63		17		
3	5396						57		32		
1	164	I-95 NB Mainline diverge at off-ramp to I-95 NB Express Lanes	Diverge	4710	3606	-23%	63	44	16	23	
2	164						58		19		
3	164						24		24		
4	164						31		31		
1	602	I-95 NB Mainline between diverge to I-95 NB Express Lanes and on-ramp from I-95 NB CD Lanes	Mainline	3310	2177	-34%	67	65	14	11	
2	602						67		15		
3	602						62		5		
1	3125	I-95 NB Mainline Weave between on-ramp from I-95 NB CD Lanes and off-ramp to I-95 NB Express Lanes	Weave	4852	3710	-24%	69	69	17	13	
2	3125						69		16		
3	3125						69		15		
4	3125						71		6		
1	5780	I-95 NB Mainline between off-ramp to I-95 NB Express Lanes and diverge to Centreport Pkwy	Mainline	3352	2700	-19%	66	67	19	14	
2	5780						67		13		
3	5780						67		9		
1	814	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3352	2731	-19%	62	52	9	15	
2	814						47		17		
3	814						50		18		
4	814						49		16		
1	2128	I-95 NB Mainline off-ramp to EB Route 3	Ramp	484	416	416	-14%	37	37	11	11
1	1134	I-95 NB Mainline off-ramp to WB Route 3	Ramp	790	684	684	-13%	27	27	25	25
1	516	I-95 NB Mainline on-ramp from Route 3	Ramp	2633	1224	-54%	4	4	161	161	
2	516						4		161		
1	703	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	2507	1545	1545	-38%	18	18	90	90
1	4373	I-95 NB Mainline off-ramp to I-95 NB Express Lanes (left)	Ramp	1400	1455	1455		65	65	22	22
1	1335	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1542	1532	1532	-1%	61	61	25	25
1	5030	I-95 NB Mainline off-ramp to I-95 NB Express Lanes (right)	Ramp	1500	1016	1016	-32%	59	59	17	17
1	2100	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	855	678	678	-21%	28	28	25	25

**Table 7-11b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 No Build)**

2042 No Build AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	703	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	2507	1545	1545	-38%	18	18	90	90
1	484	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	2507	207	1559	-38%	43	28	5	52
2	484				1352			14		99	
1	1095	I-95 NB CD Lanes between diverge to EB Route 17 and on-ramp from EB Route 17	Mainline	2109	1313	1313	-38%	12	12	115	115
1	545	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	2987	1086	2180	-27%	10	11	107	102
2	545				1093			11		98	
1	1132	I-95 NB CD Lanes between off-ramp to WB Route 17 and merge from WB Route 17	Mainline	878	873	873	-1%	52	52	17	17
1	742	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	1542	185	1526	-1%	38	45	5	15
2	742				1342			53		25	
1	1335	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	1542	1532	1532	-1%	61	61	25	25
1	1693	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	398	244	244	-39%	30	30	8	8
1	1245	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	878	871	871	-1%	17	17	57	57
1	1244	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	2109	1311	1311	-38%	19	19	71	71
1	1577	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	664	655	655	-1%	34	34	19	19

**Table 7-11c: AM Peak Hour Northbound I-95 Express Lanes Speed and Density (2042 No Build)**

2042 No Build AM I-95 Northbound Express Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	4373	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (1 lane)	Mainline	1400	1455	1455		65	65	22	22
1	4275	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (2 lanes)	Mainline	1400	994	1457		69	71	14	10
2	4275				463			73		6	
1	943	I-95 NB Express Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	2900	1010	2474	-15%	69	70	15	12
2	943				1273			70		18	
3	943				191			69		3	
1	25354	I-95 NB Express Lanes between merge from I-95 NB CD Lanes and Courthouse Rd	Mainline	2900	1231	2477	-15%	69	69	18	18
2	25354				1246			69		18	
1	5030	I-95 NB Express Lanes on-ramp from I-95 NB Mainline (left)	Ramp	1500	1016	1016	-32%	59	59	17	17

### **2042 Build Conditions**

Based on the segment densities, under 2042 Build conditions in the AM peak hour, all northbound I-95 mainline, C-D lanes, and Express Lanes segments operate with light or moderate traffic conditions with the exception of the northbound I-95 mainline and C-D lanes at the northern end of the study area. Congestion along northbound I-95 from points north of the study area extends upstream and causes northbound I-95 mainline vehicles to experience severe congestion between the on-ramp from the northbound C-D lanes (north of Route 17) to the diverge to Centreport Parkway. The northbound I-95 mainline congestion extends upstream into the northbound C-D lanes and causes heavy and severe congestion between the diverge to the Express Lanes and the merge into the northbound mainline lanes.

Severe congestion within the northbound I-95 C-D lanes under No Build conditions will be substantially improved due to the removal of the weave along the northbound I-95 C-D lanes between the Route 17 loop ramps. Under Build conditions, motorists traveling from northbound I-95 to westbound Route 17 exit on the same off-ramp as traffic traveling to eastbound Route 17 Business. Removing the weave along the northbound I-95 C-D lanes provides more opportunities for vehicles from eastbound Route 17 to merge into the northbound C-D lanes as well as providing vehicles exiting to westbound Route 17 from the C-D lanes a smoother transition to the off-ramp without lane-changing friction between the two existing weaving movements. The effect of the elimination of the Route 17 weave is the removal of the metering of traffic traveling to the north end of the study area which results in increased congestion at the north end of the study area under Build conditions compared to No Build conditions.

Along the northbound I-95 mainline, vehicles travel at average speeds of 48 MPH to 69 MPH from the south end of the study area to the merge at the on-ramp from the northbound C-D lanes north of Route 17. Average travel speeds within the merge with the northbound I-95 C-D lanes are 30 MPH and speeds approaching the off-ramp to Centreport Parkway are between 7 MPH and 15 MPH due to downstream congestion north of the study area. Along the northbound I-95 C-D lanes, average speeds are between 52 MPH and 68 MPH with the exception of the north end of the C-D lanes. C-D lane vehicles experience average speeds of 38 MPH to 45 MPH between the diverge to the Express Lanes and the merge into the mainline lanes.

The northbound Express Lanes experience average speeds between 66 MPH and 71 MPH throughout the study limits.

It should be noted that although congestion is anticipated in the northbound I-95 mainline and C-D lanes at the northern end of the study area between Route 17 and Centreport Parkway, this congestion is a result of capacity constraints outside of the I-95 Rappahannock River Crossing Northbound project area. Additionally, the amount of traffic that will be in the northbound I-95 mainline lanes versus the Express Lanes between Route 17 and Centreport Parkway will be influenced by the variable toll rates in the Express Lanes and the level of downstream congestion within the mainline lanes. Therefore, the amount of congestion that will be experienced within the mainline lanes at the northern end of the study limits between Route 17 and Centreport Parkway will vary depending on the distribution of traffic volume between the two facilities (i.e., mainline lanes versus Express Lanes). As noted above, improvements north of Centreport Parkway are outside the scope of the project; however, the I-95 Corridor Improvement Plan which is currently underway will identify potential solutions to address weekday and weekend congestion along I-95 north of the study area.

**Table 7-12a: AM Peak Hour Northbound I-95 Mainline Speed and Density (2042 Build)**

2042 Build AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserviced	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)
1	18704	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	5858	1986	5851		67	68	30	29
2	18704				1967			68		29	
3	18704				1897			68		28	
1	642	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	5858	357	5829	-1%	67	66	5	22
2	642				1858			65		29	
3	642				1813			66		27	
4	642				1801			67		27	
1	1148	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	5374	1806	5377		67	67	27	27
2	1148				1791			68		26	
3	1148				1780			68		26	
1	793	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	5374	671	5368		68	68	10	20
2	793				1236			68		18	
3	793				1708			69		25	
4	793				1753			69		26	
1	6196	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	4584	1472	4596		68	68	22	22
2	6196				1655			68		24	
3	6196				1469			69		21	
1	1322	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	4584	520	4594		70	69	7	17
2	1322				1713			68		25	
3	1322				1177			68		17	
4	1322				1184			69		17	
1	11814	I-95 NB Mainline between diverge to I-95 NB CD Lanes and diverge to I-95 NB Express Lanes	Mainline	3005	707	3008		70	69	10	15
2	11814				1022			70		15	
3	11814				1279			66		19	
1	165	I-95 NB Mainline diverge at off-ramp to I-95 NB Express Lanes	Diverge	3005	661	2928	-3%	69	48	10	18
2	165				852			65		13	
3	165				534			27		20	
4	165				881			32		27	
1	1094	I-95 NB Mainline between diverge to I-95 NB Express Lanes and merge from I-95 NB CD Lanes	Mainline	1605	632	1609		65	64	10	8
2	1094				774			66		12	
3	1094				203			60		4	
1	998	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (5 lanes)	Merge	3352	220	3272	-2%	26	30	69	64
2	998				841			29		81	
3	998				766			31		67	
4	998				810			32		57	
5	998				635			33		45	
1	3151	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (4 lanes)	Merge	3352	441	3175	-5%	3	7	138	122
2	3151				641			5		133	
3	3151				816			7		118	
4	3151				1278			13		98	
1	4268	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	3352	1180	3144	-6%	10	8	122	133
2	4268				945			7		133	
3	4268				1019			7		146	
1	801	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	3352	692	3136	-6%	30	15	23	65
2	801				758			10		78	
3	801				783			10		79	
4	801				903			11		81	
1	2132	I-95 NB Mainline off-ramp to EB Route 3	Ramp	484	470	470	-3%	39	39	12	12
1	1108	I-95 NB Mainline off-ramp to WB Route 3	Ramp	790	781	781	-1%	32	32	25	25
1	626	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1579	1291	1580		69	41	19	12
2	626				289			68		4	
1	4372	I-95 NB Mainline off-ramp to I-95 NB Express Lanes	Ramp	1400	1390	1390	-1%	66	66	21	21
1	719	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1747	633	1692	-3%	39	34	57	53
2	719				1059			44		48	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	855	778	778	-9%	24	24	33	33

**Table 7-12b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 Build)**

2042 Build AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unservd	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	7815	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	2633	1307	2628		65	65	20	20
2	7815				1320			65		20	
1	1299	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	4212	1302	4201		68	68	19	15
2	1299				1411			69		21	
3	1299				1449			68		21	
4	1299				40			68		1	
1	5575	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	4212	1328	4200		65	65	20	21
2	5575				1591			65		24	
3	5575				1282			66		19	
1	1167	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	1705	750	1711		63	64	12	13
2	1167				961			65		15	
1	951	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	2583	179	2573		39	52	6	16
2	951				1241			56		23	
3	951				1153			63		19	
1	750	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	2583	1479	2572		59	61	28	24
2	750				1093			63		19	
1	403	I-95 NB CD Lanes between on-ramp from WB Route 17 and diverge to I-95 NB Express Lanes	Mainline	3247	1056	3216	-1%	45	53	29	25
2	403				1090			55		24	
3	403				1070			60		21	
1	1065	I-95 NB CD Lanes diverge to I-95 NB Express Lanes	Diverge	3247	1088	3195	-2%	43	45	35	29
2	1065				498			38		28	
3	1065				595			45		26	
4	1065				1014			52		28	
1	364	I-95 NB CD Lanes merge between off-ramp to I-95 NB Express Lanes and I-95 NB Mainline Lanes (3 lanes)	Merge	1747	47	1704	-2%	25	38	30	39
2	364				630			43		46	
3	364				1027			47		41	
1	719	I-95 NB CD Lanes between diverge to I-95 NB Express Lanes and I-95 NB Mainline Lanes (2 lanes)	Mainline	1747	633	1692	-3%	39	41	57	53
2	719				1059			44		48	
1	626	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	1579	1291	1580		69	68	19	12
2	626				289			68		4	
1	413	I-95 NB CD Lanes off-ramp to Route 17	Ramp	2507	1299	2490	-1%	40	40	33	31
2	413				1191			40		30	
1	1246	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	878	872	872	-1%	28	28	31	31
1	1583	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	664	658	658	-1%	32	32	21	21
1	3809	I-95 NB CD Lanes off-ramp to I-95 NB Express Lanes	Ramp	1500	1467	1467	-2%	66	66	22	22

**Table 7-12c: AM Peak Hour Northbound I-95 Express Lanes Speed and Density (2042 Build)**

2042 Build AM I-95 Northbound Express Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	4372	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB Mainline Lanes (1 lane)	Mainline	1400	1390	1390	-1%	66	66	21	21
1	4275	I-95 NB Express Lanes between I-95 NB Mainline Lanes and merge from I-95 NB	Mainline	1400	965	1391	-1%	69	71	14	10
2	4275				426			73		6	
1	882	I-95 NB Express Lanes merge at on-ramp from I-95 NB CD Lanes	Merge	2900	1049	2852	-2%	69	69	15	14
2	882				1515			70		22	
3	882				289			69		4	
1	25408	I-95 NB Express Lanes between merge from I-95 NB CD Lanes and Courthouse Rd	Mainline	2900	1423	2858	-1%	68	68	21	21
2	25408				1435			68		21	
1	4879	I-95 NB Express Lanes on-ramp from I-95 NB CD Lanes	Ramp	1500	1459	1459	-3%	58	58	25	25

### 7.3.2.2 PM Peak Hour

**Tables 7-13a, 7-13b, 7-14a and 7-14b** depict 2042 No Build and Build travel speeds and densities along the northbound I-95 mainline and C-D lanes during the PM peak hour. Also shown is the volume input versus the volume throughput (i.e., volume served based on the simulated outputs from VISSIM) at segments along I-95. A comparison and discussion of traffic volume input versus throughput is presented in **Section 7.3.3**. During the PM peak hour, the Express Lanes operate in the southbound direction only; therefore, northbound Express Lanes results are not applicable during the PM peak hour.

#### 2042 No Build Conditions

Under 2042 No Build conditions in the PM peak hour, congestion levels follow similar trends as during the AM peak hour. Northbound I-95 mainline segments experience severe congestion from the south end of the study corridor (south of Route 3) to the diverge to the northbound I-95 C-D lanes at Route 17. The severe congestion in the northbound I-95 mainline lanes is due to congestion in the C-D lanes extending upstream into the mainline lanes. All northbound I-95 mainline segments north of the diverge to the C-D lanes at Route 17 operate with light traffic conditions due to the metering of downstream traffic at the diverge to the C-D lanes. In the northbound I-95 mainline segments south of the diverge to the C-D lanes, average vehicle speeds range from 3 MPH to 14 MPH. Vehicles on segments north of the diverge to the C-D lanes travel at average speeds between 67 MPH and 70 MPH.

Along the northbound I-95 C-D lanes, segments south of and within the Route 17 weave operate with severe congestion due to downstream congestion within the westbound Route 17 weave between the interchange ramps and the approach to the Sanford Drive/Gateway Drive signalized intersection as well as friction in the northbound I-95 C-D lanes weave between the Route 17 loop ramps. Similar to the northbound I-95 mainline lanes, traffic along the northbound I-95 C-D lanes is metered north of the Route 17 weave and results in light traffic conditions through the north end of the study corridor. Average travel speeds are 3 MPH within the weave and 3 MPH to 18 MPH upstream of the weave while vehicles downstream of the weave experience travel speeds of 49 MPH to 63 MPH.

**Table 7-13a: PM Peak Hour Northbound I-95 Mainline Speed and Density (2042 No Build)**

2042 No Build PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput	Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)	
1	18694	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	4507	2643	-41%	5	7	140	131	
2	18694						6		132		
3	18694						10		120		
1	639	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	4507	2648	-41%	38	14	9	114	
2	639						511		158		
3	639						691		146		
4	639						1115		143		
1	1162	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	3917	2287	-42%	3	6	150	139	
2	1162						669		136		
3	1162						1106		130		
1	784	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	3917	2284	-42%	39	13	5	117	
2	784						310		169		
3	784						661		149		
4	784						1112		145		
1	1169	I-95 NB Mainline between diverge to WB Route 3 and merge from Route 3	Mainline	3557	2081	-41%	2	5	159	142	
2	1169						667		137		
3	1169						1125		129		
1	876	I-95 NB Mainline merge at on-ramp from Route 3	Merge	4555	2382	-48%	1	3	49	140	
2	876						244		194		
3	876						235		169		
4	876						702		148		
5	876						1164		142		
1	1325	I-95 NB Mainline merge between on-ramp from Route 3 and diverge to I-95 NB CD Lanes (4 lanes)	Merge	4555	2378	-48%	1	4	170	145	
2	1325						237		152		
3	1325						728		133		
4	1325						1192		124		
1	9571	I-95 NB Mainline between merge from Route 3 and diverge to I-95 NB CD Lanes (3 lanes)	Mainline	4555	2350	-48%	3	7	151	128	
2	9571						648		127		
3	9571						1281		105		
1	935	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	4555	2351	-48%	2	9	163	121	
2	935						191		169		
3	935						304		102		
4	935						1579		51		
1	6200	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	3302	1806	-45%	66	67	6	9	
2	6200						585		9		
3	6200						842		12		
1	1574	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	4023	2444	-39%	69	70	2	9	
2	1574						106		12		
3	1574						853		10		
4	1574						737		11		
1	7322	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	4023	2440	-39%	69	70	13	12	
2	7322						841		12		
3	7322						732		11		
1	808	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	4023	2430	-40%	70	70	3	9	
2	808						207		10		
3	808						709		11		
4	808						810		10		
1	2137	I-95 NB Mainline off-ramp to EB Route 3	Ramp	590	356	356	-40%	36	36	10	10
1	1150	I-95 NB Mainline off-ramp to WB Route 3	Ramp	360	210	210	-42%	29	29	7	7
1	499	I-95 NB Mainline on-ramp from Route 3	Ramp	998	309	-69%	1	1	202	207	
2	499						143		212		
1	705	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1253	517	517	-59%	3	3	155	155
1	1340	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	721	644	644	-11%	63	63	10	10
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	443	259	259	-41%	24	24	11	11

**Table 7-13b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 No Build)**

2042 No Build PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpf)	Average Density (vpmpf)
1	705	I-95 NB CD Lanes between I-95 NB Mainline Lanes and diverge to EB Route 17	Mainline	1253	517	517	-59%	3	3	155	155
1	488	I-95 NB CD Lanes diverge at off-ramp to EB Route 17	Diverge	1253	73	517	-59%	34	18	2	87
2	488				443			3		173	
1	1102	I-95 NB CD Lanes between diverge to EB Route 17 and on-ramp from EB Route 17	Mainline	1052	437	437	-58%	3	3	160	160
1	549	I-95 NB CD Lanes weave between on-ramp from EB Route 17 and off-ramp to WB Route 17	Weave	1411	347	780	-45%	2	3	171	158
2	549				432			3		145	
1	1148	I-95 NB CD Lanes between off-ramp to WB Route 17 and merge from WB Route 17	Mainline	359	347	347	-3%	49	49	7	7
1	739	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	721	53	643	-11%	44	51	1	6
2	739				590			59		10	
1	1340	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	721	644	644	-11%	63	63	10	10
1	1696	I-95 NB CD Lanes off-ramp to EB Route 17	Ramp	201	80	80	-60%	33	33	2	2
1	1246	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	359	351	351	-2%	7	7	60	60
1	1254	I-95 NB CD Lanes off-ramp to WB Route 17	Ramp	1052	427	427	-59%	3	3	157	157
1	1565	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	362	294	294	-19%	34	34	9	9

**2042 Build Conditions**

Based on the segment densities, under 2042 Build conditions in the PM peak hour, all mainline and C-D lanes segments operate with light traffic conditions. Similar to the AM peak hour, severe congestion within the northbound I-95 C-D lanes under No Build conditions will be substantially improved due to the removal of the weave along the northbound I-95 C-D lanes between the Route 17 loop ramps.

Average travel speeds are 68 MPH to 70 MPH along the northbound I-95 mainline and range from 56 MPH to 69 MPH in the C-D lanes.

**Table 7-14a: PM Peak Hour Northbound I-95 Mainline Speed and Density (2042 Build)**

2042 Build PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	18684	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	4507	1511	4504		68	68	22	22
2	18684				1530			68		22	
3	18684				1463			69		21	
1	642	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	4507	446	4499		67	68	7	16
2	642				1329			67		20	
3	642				1381			69		20	
4	642				1343			70		19	
1	1162	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	3917	1233	3900		68	68	18	19
2	1162				1348			69		20	
3	1162				1319			68		19	
1	790	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	3917	312	3902		69	69	5	14
2	790				961			69		14	
3	790				1335			70		19	
4	790				1294			70		19	
1	6184	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	3557	1126	3555		69	69	16	17
2	6184				1299			69		19	
3	6184				1131			69		16	
1	1322	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	3557	276	3554		70	69	4	13
2	1322				1321			68		19	
3	1322				1000			68		15	
4	1322				958			69		14	
1	13139	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	2577	756	2582		70	70	11	12
2	13139				941			70		13	
3	13139				886			69		13	
1	986	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (5 lanes)	Merge	4023	53	4000	-1%	68	69	1	11
2	986				1197			69		17	
3	986				923			70		13	
4	986				963			70		14	
5	986				863			70		12	
1	3155	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes (4 lanes)	Merge	4023	867	3998	-1%	69	69	13	14
2	3155				1137			69		17	
3	3155				1111			69		16	
4	3155				884			69		13	
1	4265	I-95 NB Mainline between merge from I-95 NB CD Lanes and diverge to Centreport Pkwy	Mainline	4023	1529	4002	-1%	67	68	23	20
2	4265				1365			68		20	
3	4265				1108			69		16	
1	803	I-95 NB Mainline diverge at off-ramp to Centreport Pkwy	Diverge	4023	340	4002	-1%	69	68	5	15
2	803				1190			67		18	
3	803				1290			68		19	
4	803				1182			69		17	
1	2141	I-95 NB Mainline off-ramp to EB Route 3	Ramp	590	596	596		38	38	16	16
1	1143	I-95 NB Mainline off-ramp to WB Route 3	Ramp	360	346	346	-4%	33	33	10	10
1	625	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	980	810	972	-1%	69	68	12	7
2	625				161			67		2	
1	719	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1446	486	1410	-2%	69	69	7	10
2	719				924			69		13	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	443	428	428	-3%	25	25	17	17

**Table 7-14b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 Build)**

2042 Build PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vpmpl)	Average Density (vpmpl)
1	7802	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	998	495	1000		66	66	7	8
2	7802				505			66		8	
1	1301	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	1978	490	1951	-1%	69	69	7	7
2	1301				586			70		8	
3	1301				856			69		12	
4	1301				19			69		0	
1	5576	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	1978	528	1954	-1%	68	69	8	9
2	5576				733			69		11	
3	5576				693			69		10	
1	1180	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	725	345	711	-2%	68	68	5	5
2	1180				366			69		5	
1	950	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	1084	47	1068	-2%	39	56	1	6
2	950				506			61		8	
3	950				515			67		8	
1	759	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	1084	516	1068	-2%	69	69	8	8
2	759				551			70		8	
1	1878	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	1446	151	1414	-2%	58	65	3	7
2	1878				639			68		9	
3	1878				625			70		9	
1	719	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	1446	486	1410	-2%	69	69	7	10
2	719				924			69		13	
1	625	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	980	810	972	-1%	69	68	12	7
2	625				161			67		2	
1	433	I-95 NB CD Lanes off-ramp to Route 17	Ramp	1253	550	1248		47	48	12	13
2	433				699			49		14	
1	1247	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	359	354	354	-1%	29	29	12	12
1	1577	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	362	352	352	-3%	34	34	10	10

### 7.3.3 Traffic Volume Throughput Comparison

Volume throughputs were analyzed at four locations along the I-95 corridor from south of Route 3 to Centreport Parkway. **Figures 7-17 and 7-18** show existing, 2042 No Build, and 2042 Build AM and PM peak hour traffic volume demand, throughput, and percent volume unserved at each location along northbound I-95 including all mainline lanes, C-D lanes, and Express Lanes.

#### 2042 No Build Conditions

**AM Peak Hour:** In the AM peak direction, northbound I-95 has 27 percent unserved demand over the Rappahannock River due to congestion from the C-D lanes extending upstream into the mainline lanes beyond Route 3. There is 11 percent unserved demand south of Route 3 due to northbound I-95 mainline congestion extending upstream beyond the Route 3 interchange. This congestion in the mainline lanes also meters traffic traveling northbound, causing 17 percent unserved demand north of Route 17 and 15 percent unserved demand at Centreport Parkway.

**PM Peak Hour:** In the PM peak hour, the northbound I-95 mainline and C-D lanes experience severe congestion similar to the AM peak hour due to severe congestion in the C-D lane weave at the Route 17 interchange and downstream congestion along westbound Route 17. The severe congestion between the south end of the study area and Route 17 results in 42 percent unserved demand south of Route 3 and 49 percent unserved demand over the Rappahannock River. The severe congestion meters northbound traffic and results in 39 percent unserved demand north of Route 17 and at Centreport Parkway.

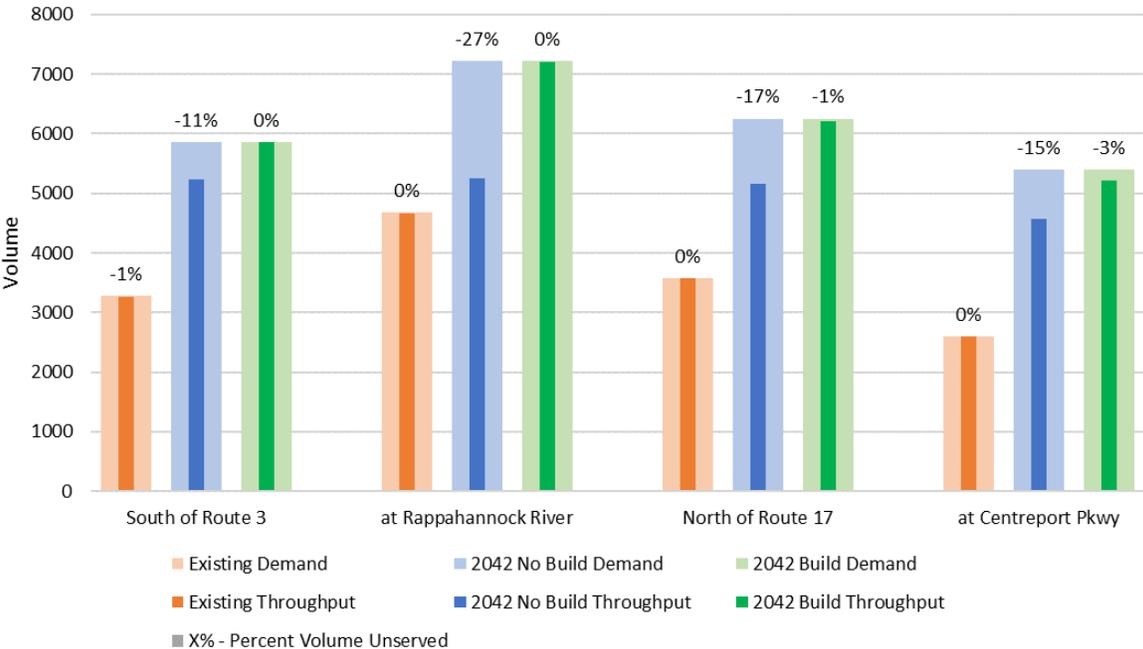
**2042 Build Conditions**

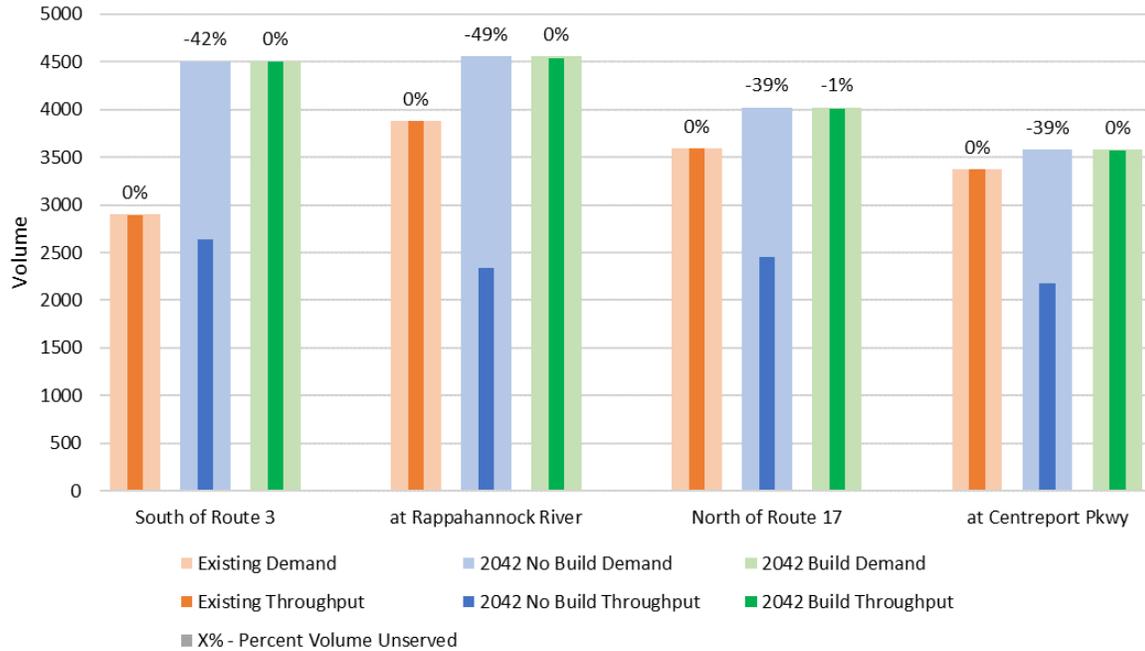
During both the AM and PM peak hours, both the total traffic volume served as well as the percent of demand served increases for all segments throughout the corridor under Build conditions compared to No Build conditions. The improvement in throughput under Build conditions can be attributed to the increased capacity between Route 3 and Route 17 along the northbound I-95 mainline and C-D lanes. The greatest increase in demand served occurs over the Rappahannock River with 1,970 more vehicles served during the AM peak hour and 2,200 more vehicles served during the PM peak hour.

**AM Peak Hour:** During the AM peak hour, all traffic demand is served with the exception of 1 percent unserved demand north of Route 17 and 3 percent unserved demand at Centreport Parkway due to congestion to the north which extends upstream through the Centreport Parkway interchange. Throughput volumes range from 12 to 38 percent higher than under No Build conditions (610 to 1,970 more vehicles).

**PM Peak Hour:** During the PM peak hour, all traffic demand is served with the exception of 1 percent unserved demand north of Route 17, a substantial increase compared to No Build conditions. Throughput volumes range from 63 to 94 percent higher than under No Build conditions (1,390 to 2,200 more vehicles).

**Figure 7-17: Northbound I-95 2042 AM Peak Hour Volume Throughputs**



**Figure 7-18: Northbound I-95 2042 PM Peak Hour Volume Throughputs**

### 7.3.4 Arterial Intersection Operations

**Table 7-15** depicts overall intersection delay for both signalized and unsignalized intersections within the study area for the AM and PM peak hours for 2042 No Build and Build conditions. **Appendix E** contains detailed VISSIM results for intersection volume throughputs, delays, and queues by movement, approach, and for the overall intersections.

#### *2042 No Build Conditions*

**AM Peak Hour:** During the AM peak hour under 2042 No Build conditions, four of the intersections along Route 3 operate with severe congestion with the remaining intersections operating with light or moderate traffic conditions. All of the intersections along Route 3 operate with severe congestion with the exception of Route 3 at I-95 Southbound Off-Ramp due to the severe congestion in the northbound I-95 C-D lanes weave at Route 17 extending upstream into the northbound I-95 mainline lanes beyond Route 3. With severe congestion in the northbound I-95 mainline lanes, traffic along the on-ramp from Route 3 attempting to merge into the northbound I-95 mainline lanes experiences severe delays which extends upstream along eastbound and westbound Route 3. West of the I-95 interchange, eastbound Route 3 experiences severe delays approaching the signalized intersections at Central Park Boulevard/Mall Drive, Carl D. Silver Parkway, and the northbound I-95 On-Ramp. East of the I-95 interchange, westbound Route 3 experiences severe delays at the signalized intersections at Gateway Boulevard and the I-95 Northbound On-Ramp.

**PM Peak Hour:** During the PM peak hour, three of the signalized intersections operate with light traffic conditions, one signalized intersection operates with heavy congestion and the remaining six intersections operate with severe congestion. Similar to the AM peak hour, all intersections along Route 3 operate with severe congestion with the exception of the signalized intersection of Route 3 at the I-95 Southbound Off-Ramp which operates with light traffic conditions. This is due to severe congestion in the northbound I-95

#### *I-95 Rappahannock River Crossing Northbound*

C-D lanes weave at Route 17 extending upstream into the northbound I-95 mainline lanes beyond the Route 3 interchange. With severe congestion in the northbound I-95 mainline, traffic along the on-ramp from Route 3 attempting to merge into the northbound I-95 mainline lanes experiences severe delays which extend upstream along eastbound and westbound Route 3. All of the signalized intersections along Route 3 which operate with severe congestion experience severe delays on all approaches with the exception of westbound Route 3 west of the interchange.

Along Route 17, the signalized intersection of Route 17 at Sanford Drive/Gateway Drive operates with severe congestion as well as the unsignalized intersection of Route 17 at Short Street. Severe delays occur on the westbound approach to the Route 17 at Sanford Drive/Gateway Drive intersection due to the high left-turn volume to Sanford Drive in the single left-turn lane on Route 17 as well as friction in the weave on westbound Route 17 between the ramps from northbound and southbound I-95 to westbound Route 17 and the intersection of Route 17 at Sanford Drive/Gateway Drive. The high delays on the westbound approach to the intersection of Route 17 at Sanford Drive/Gateway Drive in combination with the weave on westbound Route 17 causes severe congestion on Route 17 to extend upstream through the northeast quadrant loop ramp as well as through the intersection of Route 17 at Short Street and the intersection of Route 17 at Olde Forge Drive. This severe congestion on westbound Route 17 causes severe delays on not only the westbound Route 17 Business approaches to the intersections east of the I-95 interchange, but also severe delays on the side street approaches for vehicles attempting to turn onto westbound Route 17 Business.

### ***2042 Build Conditions***

Under Build conditions during both the AM and PM peak hours, all intersections operate with light or moderate traffic conditions. The two new signalized intersections on Route 17 at the northbound and southbound I-95 ramps operate with light traffic conditions as shown in **Tables 7-15a and 7-15b**, respectively. Improvements in intersection delays along the corridor can be attributed to the removal of the northbound I-95 C-D lanes weave at Route 17 and improvements to the intersection of Route 17 at Sanford Drive/Gateway Drive as well as additional capacity due to the southward extension of northbound C-D lanes to north of Route 3.

**AM Peak Hour:** Under Build conditions during the AM peak hour, all intersections operate with light or moderate traffic conditions, an improvement compared to the four intersections on Route 3 that operated with severe congestion under No Build conditions. In addition, all eastbound and westbound approaches to intersections on Route 3 and Route 17 operate with light or moderate traffic conditions. As shown in **Tables 7-15c and 7-15d**, the average intersection delays at the new signalized intersection along Route 17 at the I-95 Southbound Off-Ramp is 10 seconds and the average intersection delay at the I-95 Northbound Off-Ramp is 30 seconds. Additionally, queues from the new signalized intersections along Route 17 do not extend beyond the turn lanes and into the northbound and southbound C-D lanes. The maximum northbound left-turn queue for the triple left turn from northbound I-95 to westbound Route 17 is approximately 625 feet which does not extend onto the northbound I-95 C-D lanes.

**PM Peak Hour:** Under Build conditions during the PM peak hour, all intersections operate with light or moderate traffic conditions, an improvement compared to the six intersections which operated with severe congestion under No Build conditions. In addition, all eastbound and westbound approaches to intersections on Route 3 and Route 17 operate with light or moderate traffic conditions with the exception of the

eastbound left-turn approach to the signalized intersection at Route 3 and the northbound I-95 on-ramp which operates with heavy congestion due to the high turn volume (590 vehicles). As shown in **Tables 7-15a, 7-15b, 7-15c, and 7-15d**, the average intersection delay at the new signalized intersection along Route 17 at the I-95 Southbound Off-Ramp is 15 seconds and the average intersection delay at the I-95 Northbound Off-Ramp is 19 seconds. Additionally, queues from the new signalized intersections along Route 17 do not extend beyond the turn lanes and into the northbound and southbound C-D lanes. The maximum northbound left-turn queue for the triple left turn from northbound I-95 to westbound Route 17 is approximately 375 feet which does not extend onto the northbound I-95 C-D lanes.

**Table 7-15: Intersection Delay Summary (2042 Conditions)**

Intersection	Intersection Control	Average Delay (seconds)			
		2042 No Build		2042 Build	
		AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Route 3 at Central Park Boulevard/ Mall Drive	Signalized	149	173	14	33
Route 3 at Carl D. Silver Parkway	Signalized	134	409	18	40
Route 3 at I-95 Southbound Off-Ramp	Signalized	8	30	12	29
Route 3 at I-95 Northbound On-Ramp	Signalized	546	1117	45	22
Route 3 at Gateway Boulevard	Signalized	288	471	21	24
Route 17 at Falls Run Drive	Signalized	8	16	10	16
Route 17 at McLane Drive	Signalized	5	4	6	4
Route 17 at Sanford Drive/ Gateway Drive	Signalized	51	186	22	29
Route 17 at I-95 Southbound Off-Ramp	Signalized	N/A	N/A	10	15
Route 17 at I-95 Northbound Off-Ramp	Signalized	N/A	N/A	30	19
Route 17 at Short Street	Stop	3	109	3	7
Route 17 at Olde Forge Drive	Signalized	17	62	18	18

**Table 7-15a: AM Peak Hour Route 17 at I-95 Northbound Off-Ramp Intersection Delay Summary (2042 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
NB	41.1	NB Left	2109	2097	-12	-1%	43.3	188	626	1590	29.9
		NB Right	398	393	-5	-1%	29.5	202	643	1590	
EB	22.8	EB Through	1495	1493	-2		22.8	71	401		
WB	17.7	WB Through	1444	1442	-2		17.7	61	364		

**Table 7-15b: AM Peak Hour Route 17 at I-95 Southbound Off-Ramp Intersection Delay Summary (2042 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
SB	29.0	SB Right	325	322	-3	-1%	29.0	29	136	1490	9.7
WB	7.9	WB Through	3453	3465			7.9	23	364		

**Table 7-15c: PM Peak Hour Route 17 at I-95 Northbound Off-Ramp Intersection Delay Summary (2042 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
NB	36.8	NB Left	1052	1055			40.2	111	373	1590	19.5
		NB Right	201	201			19.0	122	387	1590	
EB	16.9	EB Through	2571	2307	-264	-10%	16.9	68	529		
WB	8.0	WB Through	1366	1360	-6		8.0	24	263		

**Table 7-15d: PM Peak Hour Route 17 at I-95 Southbound Off-Ramp Intersection Delay Summary (2042 Build Conditions)**

Approach	Approach Delay (sec/veh)	Movement	Volume Input	Volume Throughput	Vehicles Not Served	Percent Unserved	Delay (sec/veh)	Avg Queue Length (feet)	Max Queue Length (feet)	Storage (feet)	Intersection Delay (sec/veh)
SB	26.2	SB Right	1087	790	-297	-27%	26.2	49	227	1490	14.7
WB	10.5	WB Through	2187	2187			10.5	29	255		

### 7.3.5 Bid Option A – Auxiliary Lane between Route 17 and Centreport Parkway Traffic Analysis

Bid Option A includes construction of an auxiliary lane that would extend along northbound I-95 from the C-D lane entrance north of Route 17 to the northbound I-95 off-ramp to Centreport Parkway to provide additional capacity at the merge between the northbound I-95 mainline lanes and C-D lanes. Traffic operations analysis was performed for 2042 Build conditions to document the benefits of the auxiliary lane should funding be available to implement this bid option as part of the Build improvements.

#### 7.3.5.1 AM Peak Hour

Under 2042 AM peak hour No Build conditions, the C-D lanes weave at the Route 17 interchange meters downstream traffic and results in 20 percent unserved demand and light traffic conditions at the north end of the study area. Under Build conditions when the northbound I-95 bottleneck at the Route 17 interchange is eliminated, the high throughput north of the study area causes severe congestion from points north of the study area to extend upstream beyond the Centreport Parkway interchange. In order to lessen the impact of the downstream congestion on operations along the northbound I-95 mainline lanes between Route 17 and Centreport Parkway, Bid Option A includes extending the I-95 northbound auxiliary lane to Centreport Parkway to create additional capacity and eliminate a merge and diverge segment. Density and speed results in the northbound I-95 mainline and C-D lanes are shown in **Tables 7-16a and 7-16b**.

With the auxiliary lane to Centreport Parkway, the northbound I-95 mainline lanes travel speeds increase and density is reduced between Route 17 and Centreport Parkway compared to Build conditions without Bid Option A. At the northbound I-95 mainline lanes merge with the northbound C-D lanes from five to four lanes, the travel speeds increase by 8 MPH and the density improves from severe congestion to heavy congestion. Upstream northbound I-95 mainline segments have a negligible difference with Bid Option A, while downstream segments continue to experience severe congestion and low travel speeds.

With the addition of the northbound I-95 auxiliary lane, congestion in the northbound I-95 mainline lanes does not extend upstream into the C-D lanes whereas without the auxiliary lane, severe congestion in the northbound I-95 mainline lanes extends upstream into the C-D lanes and causes severe and heavy congestion upstream to the diverge to the northbound I-95 Express Lanes. Increases in travel speeds and reduction in density along the northbound C-D lanes occur between the merge into the northbound I-95 mainline lanes and upstream through the diverge to the northbound Express Lanes. At the north end of the C-D lanes, average travel speeds increase by 14 MPH and the density improves from severe congestion to light traffic conditions.

**Table 7-16a: AM Peak Hour Northbound I-95 Mainline Speed and Density (2042 Build - Bid Option A)**

2042 Build-BID Option A AM I-95 Northbound Mainline				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)
1	18704	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	5858	1986	5851		67	68	30	29
2	18704				1967			68		29	
3	18704				1897			68		28	
1	642	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	5858	357	5829	-1%	67	66	5	22
2	642				1858			65		29	
3	642				1813			66		27	
4	642				1801			67		27	
1	1148	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	5374	1806	5377		67	67	27	27
2	1148				1791			68		26	
3	1148				1780			68		26	
1	793	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	5374	671	5368		68	68	10	20
2	793				1236			68		18	
3	793				1708			69		25	
4	793				1753			69		26	
1	6196	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	4584	1472	4596		68	68	22	22
2	6196				1655			68		24	
3	6196				1469			69		21	
1	1322	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	4584	520	4594		70	69	7	17
2	1322				1713			68		25	
3	1322				1177			68		17	
4	1322				1184			69		17	
1	11814	I-95 NB Mainline between diverge to I-95 NB CD Lanes and diverge to I-95 NB Express Lanes	Mainline	3005	707	3008		70	69	10	15
2	11814				1022			70		15	
3	11814				1279			66		19	
1	165	I-95 NB Mainline diverge at off-ramp to I-95 NB Express Lanes	Diverge	3005	661	2928	-3%	69	48	10	18
2	165				852			65		13	
3	165				534			27		20	
4	165				881			32		27	
1	1094	I-95 NB Mainline between diverge to I-95 NB Express Lanes and merge from I-95 NB CD Lanes	Mainline	1605	646	1609		68	66	10	8
2	1094				786			68		12	
3	1094				177			64		3	
1	998	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	3352	240	3301	-2%	33	38	36	39
2	998				1010			38		52	
3	998				787			38		44	
4	998				799			40		37	
5	998				464			41		25	
1	8249	I-95 NB Mainline weave between on-ramp from I-95 NB CD Lanes and off-ramp to Centreport Pkwy	Weave	3352	676	3154	-6%	6	7	127	124
2	8249				604			5		139	
3	8249				796			7		119	
4	8249				1078			10		110	
1	2132	I-95 NB Mainline off-ramp to EB Route 3	Ramp	484	470	470	-3%	39	39	12	12
1	1108	I-95 NB Mainline off-ramp to WB Route 3	Ramp	790	781	781	-1%	32	32	25	25
1	626	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	1579	1290	1580		69	45	19	12
2	626				290			68		4	
1	4372	I-95 NB Mainline off-ramp to I-95 NB Express Lanes	Ramp	1400	1390	1390	-1%	66	66	21	21
1	719	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1747	715	1724	-1%	53	38	22	23
2	719				1010			56		24	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	855	759	759	-11%	20	20	39	39

**Table 7-16b: AM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 Build - Bid Option A)**

2042 Build-BID Option A AM I-95 Northbound CD Lanes				7-8 AM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserviced	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)
1	7815	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	2633	1307	2627		65	65	20	20
2	7815				1319			65		20	
1	1299	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	4212	1308	4200		69	68	19	15
2	1299				1409			69		20	
3	1299				1443			68		21	
4	1299				40			68		1	
1	5575	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	4212	1328	4197		65	65	21	22
2	5575				1588			65		24	
3	5575				1281			66		19	
1	1167	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	1705	748	1707		63	65	12	13
2	1167				959			66		15	
1	951	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	2583	177	2580		40	54	5	15
2	951				1250			57		22	
3	951				1153			64		18	
1	750	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	2583	1488	2581		61	63	25	21
2	750				1093			64		17	
1	403	I-95 NB CD Lanes between on-ramp from WB Route 17 and diverge to I-95 NB Express Lanes	Mainline	3247	1066	3233		50	59	22	20
2	403				1099			60		19	
3	403				1068			66		17	
1	1065	I-95 NB CD Lanes diverge to I-95 NB Express Lanes	Diverge	3247	1120	3228	-1%	52	57	24	17
2	1065				487			52		13	
3	1065				615			61		13	
4	1065				1006			64		18	
1	364	I-95 NB CD Lanes merge between off-ramp to I-95 NB Express Lanes and I-95 NB Mainline Lanes (3 lanes)	Merge	1747	19	1734	-1%	33	51	8	16
2	364				705			59		20	
3	364				1011			62		22	
1	719	I-95 NB CD Lanes between diverge to I-95 NB Express Lanes and I-95 NB Mainline Lanes (2 lanes)	Mainline	1747	715	1724	-1%	53	55	22	23
2	719				1010			56		24	
1	626	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	1579	1290	1580		69	68	19	12
2	626				290			68		4	
1	413	I-95 NB CD Lanes off-ramp to Route 17	Ramp	2507	1302	2491	-1%	39	39	33	32
2	413				1189			39		31	
1	1246	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	878	874	874	-1%	29	29	30	30
1	1583	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	664	659	659	-1%	33	33	20	20
1	3809	I-95 NB CD Lanes off-ramp to I-95 NB Express Lanes	Ramp	1500	1488	1488	-1%	67	67	22	22

**7.3.5.2 PM Peak Hour**

During the PM peak hour under Build conditions without Bid Option A, the northbound I-95 mainline lanes and C-D lanes operate with light traffic conditions. As shown in **Tables 7-17a and 7-17b**, there is no substantial change in the average speed or density in the northbound I-95 mainline lanes or C-D lanes with the addition of the northbound I-95 auxiliary lane with Bid Option A.

**Table 7-17a: PM Peak Hour Northbound I-95 Mainline Speed and Density (2042 Build - Bid Option A)**

2042 Build-BID Option A PM I-95 Northbound Mainline				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserved	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)
1	18684	I-95 NB Mainline between merge from Route 1 and diverge to EB Route 3	Mainline	4507	1511	4504		68	68	22	22
2	18684				1530			68		22	
3	18684				1463			69		21	
1	642	I-95 NB Mainline diverge at off-ramp to EB Route 3	Diverge	4507	446	4499		67	68	7	16
2	642				1329			67		20	
3	642				1381			69		20	
4	642				1343			70		19	
1	1162	I-95 NB Mainline between diverge to EB Route 3 and diverge to WB Route 3	Mainline	3917	1233	3900		68	68	18	19
2	1162				1348			69		20	
3	1162				1319			68		19	
1	790	I-95 NB Mainline diverge at off-ramp to WB Route 3	Diverge	3917	312	3902		69	69	5	14
2	790				961			69		14	
3	790				1335			70		19	
4	790				1294			70		19	
1	6184	I-95 NB Mainline between diverge to WB Route 3 and diverge to I-95 NB CD Lanes	Mainline	3557	1126	3555		69	69	16	17
2	6184				1299			69		19	
3	6184				1131			69		16	
1	1322	I-95 NB Mainline diverge at off-ramp to I-95 NB CD Lanes	Diverge	3557	276	3554		70	69	4	13
2	1322				1321			68		19	
3	1322				1000			68		15	
4	1322				958			69		14	
1	13139	I-95 NB Mainline between diverge to I-95 NB CD Lanes and merge from I-95 NB CD Lanes	Mainline	2577	756	2582		70	70	11	12
2	13139				941			70		13	
3	13139				886			69		13	
1	986	I-95 NB Mainline merge at on-ramp from I-95 NB CD Lanes	Merge	4023	51	4002	-1%	68	69	1	11
2	986				1199			69		17	
3	986				925			70		13	
4	986				964			70		14	
5	986				863			70		12	
1	8258	I-95 NB Mainline weave between on-ramp from I-95 NB CD Lanes and off-ramp to Centreport Pkwy	Weave	4023	987	4003		69	69	14	14
2	8258				1111			69		16	
3	8258				1055			70		15	
4	8258				850			69		12	
1	2141	I-95 NB Mainline off-ramp to EB Route 3	Ramp	590	596	596		38	38	16	16
1	1143	I-95 NB Mainline off-ramp to WB Route 3	Ramp	360	346	346	-4%	33	33	10	10
1	625	I-95 NB Mainline off-ramp to I-95 NB CD Lanes	Ramp	980	810	972	-1%	69	68	12	7
2	625				161			67		2	
1	719	I-95 NB Mainline on-ramp from I-95 NB CD Lanes	Ramp	1446	484	1412	-2%	69	69	7	10
2	719				928			69		13	
1	2113	I-95 NB Mainline off-ramp to Centreport Pkwy	Ramp	443	427	427	-4%	24	24	18	18

**Table 7-17b: PM Peak Hour Northbound I-95 C-D Lanes Speed and Density (2042 Build - Bid Option A)**

2042 Build-BID Option A PM I-95 Northbound CD Lanes				5-6 PM							
Lanes	Length (ft)	Location	Type	Volume Input	Volume Throughput		Percent Unserviced	Lane Speed (mph)	Average Speed (mph)	Lane Density (vp/mt)	Average Density (vp/mt)
1	7802	I-95 NB CD Lanes between merge from Route 3 and merge from I-95 NB Mainline Lanes	Mainline	998	497	1001		66	66	8	8
2	7802				504			66		8	
1	1301	I-95 NB CD Lanes merge at on-ramp from I-95 NB Mainline Lanes	Merge	1978	491	1951	-1%	69	69	7	7
2	1301				584			70		8	
3	1301				857			69		12	
4	1301				19			69		0	
1	5576	I-95 NB CD Lanes diverge at off-ramp to Route 17	Diverge	1978	532	1954	-1%	69	69	8	9
2	5576				730			69		11	
3	5576				692			69		10	
1	1180	I-95 NB CD Lanes between diverge to Route 17 and merge from EB Route 17	Mainline	725	341	713	-2%	68	68	5	5
2	1180				373			69		5	
1	950	I-95 NB CD Lanes merge at on-ramp from EB Route 17	Merge	1084	48	1069	-1%	39	56	1	6
2	950				501			61		8	
3	950				520			67		8	
1	759	I-95 NB CD Lanes between merge from EB Route 17 and merge from WB Route 17	Mainline	1084	512	1069	-1%	69	69	7	8
2	759				557			70		8	
1	1878	I-95 NB CD Lanes merge at on-ramp from WB Route 17	Merge	1446	150	1417	-2%	58	65	3	7
2	1878				636			68		9	
3	1878				630			70		9	
1	719	I-95 NB CD Lanes between merge from WB Route 17 and I-95 NB Mainline Lanes	Mainline	1446	484	1412	-2%	69	69	7	10
2	719				928			69		13	
1	625	I-95 NB CD Lanes on-ramp from I-95 NB Mainline Lanes	Ramp	980	810	972	-1%	69	68	12	7
2	625				161			67		2	
1	433	I-95 NB CD Lanes off-ramp to Route 17	Ramp	1253	548	1247		48	49	11	13
2	433				699			50		14	
1	1247	I-95 NB CD Lanes on-ramp from EB Route 17	Ramp	359	354	354	-1%	29	29	12	12
1	1577	I-95 NB CD Lanes on-ramp from WB Route 17	Ramp	362	352	352	-3%	34	34	10	10

### 7.4 TRAFFIC ANALYSIS FINDINGS

The traffic analysis for the I-95 Rappahannock River Crossing Northbound project demonstrates that the Build Alternative will improve operations along the I-95 corridor within the project area compared to No Build conditions under both 2022 and 2042 Build conditions based on a review of corridor travel times, speeds, densities, vehicle throughputs, and arterial intersection operation results of the microsimulation analysis.

#### 2022 Conditions

Under 2022 Build conditions, AM peak hour travel times are 1.6 minutes less (18% reduction) in the northbound I-95 mainline and 1.8 minutes less (61% reduction) in the northbound I-95 C-D lanes between the start of existing C-D lanes and the end of the C-D lanes corridor compared to No Build conditions. During the PM peak hour, travel time savings under Build conditions are similar to No Build conditions (differences are less than one minute).

Under 2022 No Build conditions, AM peak hour severe congestion is projected in the northbound I-95 C-D lanes which extends upstream into the northbound I-95 mainline lanes to the merge with the on-ramp from Route 3. Under 2022 Build conditions during the AM and PM peak hours, the northbound I-95 mainline lanes, C-D lanes and Express Lanes are projected to operate with light traffic conditions including all merge and diverge junctions serving the C-D lanes and Express Lanes. Under 2022 Build conditions,

travel speeds along the northbound I-95 mainline lanes, C-D lanes, and Express Lanes segments range from 56 MPH to 72 MPH within the study limits during the AM and PM peak hours.

Along northbound I-95 during the AM peak hour, volume throughput increases compared to No Build conditions by as much as 290 vehicles (6 percent) over the Rappahannock River. Along northbound I-95 during the PM peak hour, there is a negligible change in volume throughput because all traffic demand is served under No Build and Build conditions.

The 2022 Build improvements along the corridor will reduce congestion and delays at the northbound I-95 C-D lanes weave at Route 17, eliminating the severe queues that extend along both the northbound I-95 mainline and C-D lanes. Improvements at the Route 17 interchange and the signalized intersection of Route 17 at Sanford Drive/Gateway Drive will reduce congestion and delays along westbound Route 17. During the AM and PM peak hours, all signalized and unsignalized intersections operate with light or moderate traffic conditions under Build conditions.

### ***2042 Conditions***

Under 2042 Build conditions, AM peak hour travel times are 11.1 minutes less in the northbound I-95 mainline between Route 620/Harrison Road and Truslow Road and approximately 1.7 minutes less in the northbound I-95 C-D lanes between the start of existing C-D lanes and the end of the C-D lanes compared to No Build conditions. During the PM peak hour, 2042 Build conditions travel times are 40.1 minutes less in the northbound I-95 mainline lanes between Route 620/Harrison Road and Truslow Road and 11.3 minutes less in the northbound I-95 C-D lanes between the start of existing C-D lanes and end of the C-D lane corridor compared to No Build conditions.

Under 2042 No Build conditions, severe congestion is projected in the northbound I-95 C-D lanes at the Route 17 interchange which extends upstream onto the northbound I-95 mainline lanes beyond Route 3 and onto eastbound and westbound Route 3. Severe congestion within the northbound C-D lanes and along westbound Route 17 is caused by the signalized intersection at Sanford Drive/Gateway Drive as well as the multiple weaves along westbound Route 17 in the vicinity of the I-95 interchange.

The Build Alternative improves the northbound I-95 mainline lanes, C-D lanes, and Express Lanes to operate with light or moderate traffic conditions during the AM peak hour with the exception of the northbound I-95 mainline and C-D lanes at the north end of the study area. The northbound I-95 mainline between the C-D lanes merge and the diverge to Centreport Parkway operates under severe congestion due to congestion north of the study area that extends upstream beyond Centreport Parkway. Severe congestion in the mainline lanes extends upstream into the C-D lanes and results in severe and heavy congestion between the diverge to the Express Lanes and the merge into the northbound I-95 mainline lanes. During the PM peak hour under Build conditions, all northbound I-95 mainline and C-D lanes operate with light traffic conditions. It should be noted that although congestion is anticipated in the northbound I-95 mainline and C-D lanes at the northern end of the study area between Route 17 and Centreport Parkway, this congestion is a result of capacity constraints outside of the I-95 Rappahannock River Crossing Northbound project area. Improvements north of Centreport Parkway are outside the scope of the project; however, the I-95 Corridor Improvement Plan which is currently underway will identify potential solutions to address weekday and weekend congestion along I-95 north of the study area.

Along northbound I-95, volume throughput increases compared to No Build conditions by as much as 1,970 vehicles (38 percent) during the AM peak hour and 2,200 vehicles (94 percent) during the PM peak hour over the Rappahannock River.

The 2042 Build improvements along the corridor will reduce congestion and delays along the northbound I-95 C-D lanes weave at Route 17, eliminating the severe queues that extend along both the northbound I-95 mainline lanes and C-D lanes and cause severe delays on eastbound and westbound Route 3. Improvements at the Route 17 interchange and the signalized intersection of Route 17 at Sanford Drive/Gateway Drive will reduce congestion and delays along westbound Route 17. During the AM and PM peak hours, all signalized and unsignalized intersections operate with light or moderate traffic conditions under Build conditions.

## 8. SAFETY AND CRASH ANALYSIS

### 8.1 CRASH DATA

Crash data within the study area was reviewed for a five-year period from January 1, 2013 through December 31, 2017. Crash data was obtained from the VDOT Tableau-Crash Analysis Tool (T-CAT). Using the latitude and longitude information from each crash, the crash data was converted to a shapefile to geospatially depict the location of each crash. **Figure 8-1** depicts the crash locations by type and severity.

#### 8.1.1 Crash Data Summary

A total of 2,511 crashes were reported along I-95, Route 3, Route 17, and the associated interchange ramps and minor street approaches within the study area between January 2013 and December 2017. **Table 8-1** summarizes the crashes by collision type, severity, surface condition, weather condition, crash year, and time of the day. As shown, 550 crashes (22 percent) resulted in an injury and eight (0.3%) crashes resulted in a fatality. Of the eight fatal crashes, five occurred along I-95, two occurred on Route 17, and one occurred on Route 3. 1,431 (57 percent) of the crashes were rear end collisions, 252 (10 percent) were angle crashes, 359 (14 percent) were sideswipe crashes, and 333 (13 percent) were fixed-object crashes. 1,888 (75 percent) crashes occurred on dry surface conditions and 616 (25 percent) occurred on wet or snowy/icy surface conditions.

There were 781 crashes that occurred on northbound I-95 and 669 that occurred on southbound I-95 excluding crashes reported along ramps and the C-D road serving northbound I-95 in the vicinity of Route 17. There were 85 reported crashes along the ramp from eastbound Route 3 to northbound I-95. In addition to the crashes reported along this ramp, there were 45 crashes reported in the weave segment between the ramp from eastbound Route 3 to northbound and the ramp from northbound I-95 to westbound Route 3. These crashes occurred prior to the removal of the ramp from northbound I-95 to westbound Route 3 in September 2018 as part of the I-95 Safety Improvements at Route 3 (Exit 130).

During the study period, there was an average of 103 crashes per mile reported along northbound I-95 and 88 crashes per mile reported along southbound I-95. As shown in **Figure 8-2**, the total number of crashes per year within the study area has increased by 23 percent from 441 in 2013 to 542 in 2017.

**Figure 8-3** summarizes weekday (Monday - Friday) crashes by time of day within the study area. Seventy-one percent of all reported crashes occurred on weekdays. As shown, the greatest portion of crashes occurred during the PM peak period from 5:00 PM to 7:00 PM with 17 percent of all weekday crashes occurring during this two-hour period. The highest period of crashes in the AM was from 7:00 AM to 8:00 AM with 8 percent of crashes occurring during this one-hour period.

Figure 8-1: Crashes by Type and Severity (Sheet 1 of 7)

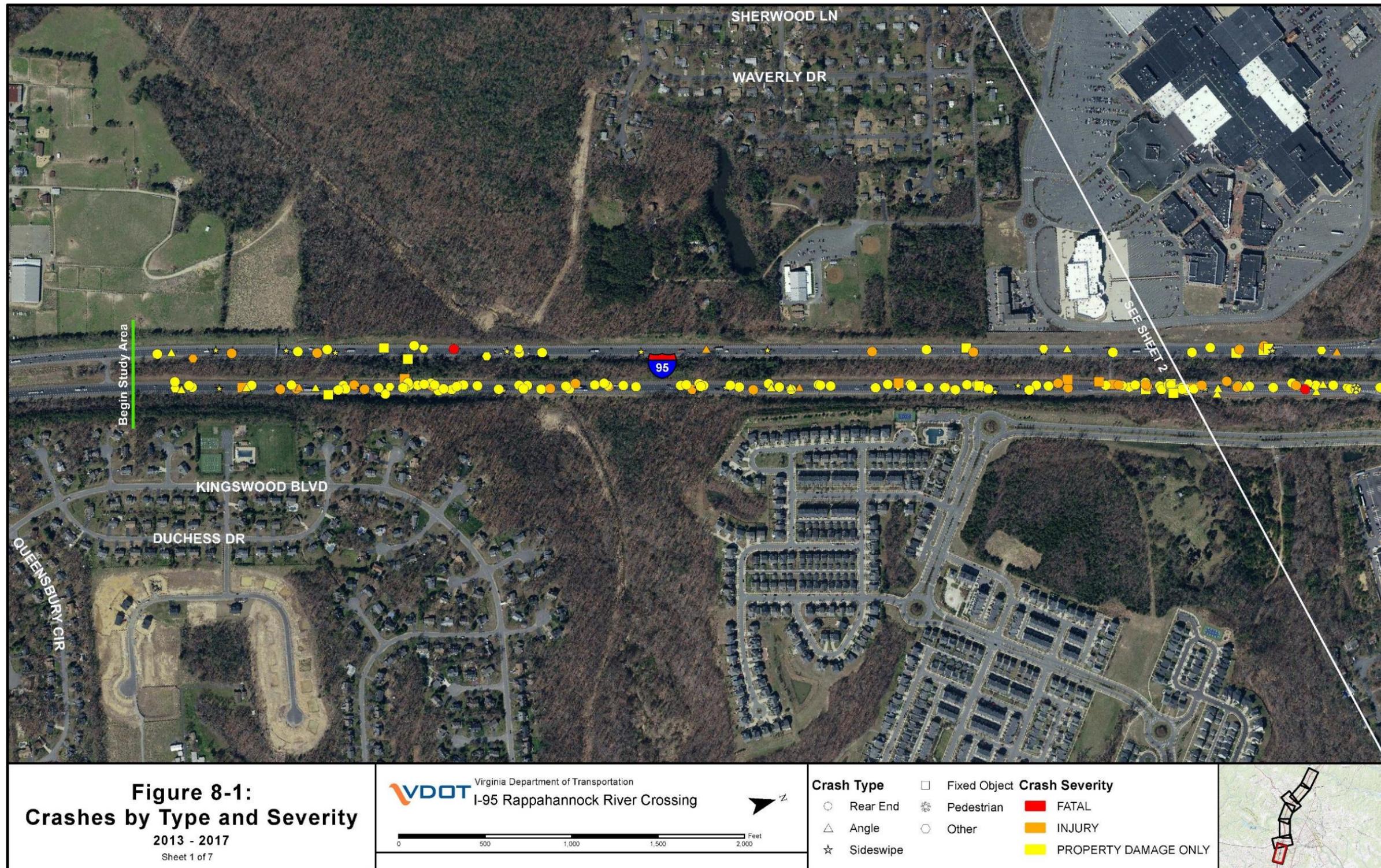


Figure 8-1: Crashes by Type and Severity (Sheet 2 of 7)

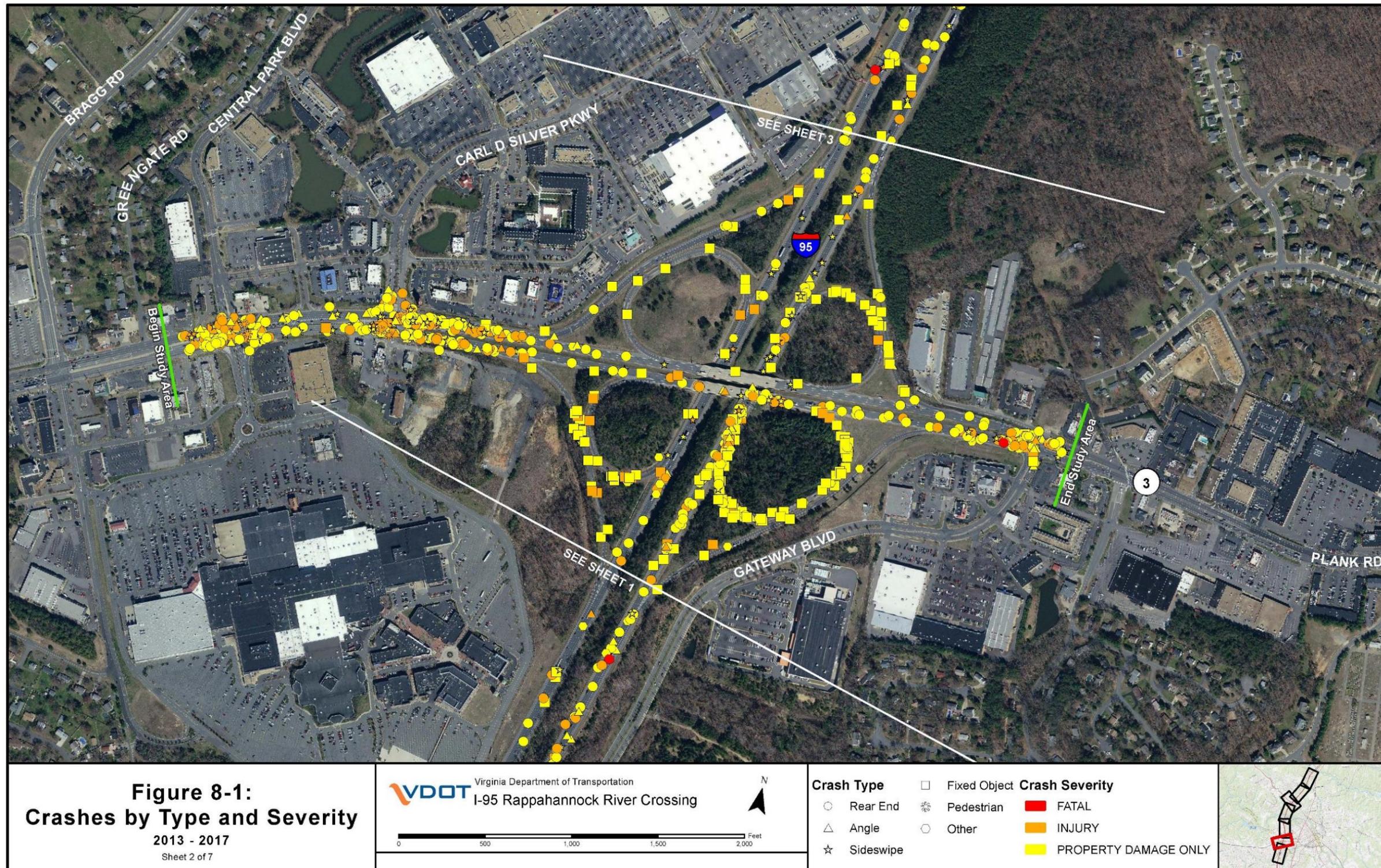


Figure 8-1: Crashes by Type and Severity (Sheet 3 of 7)

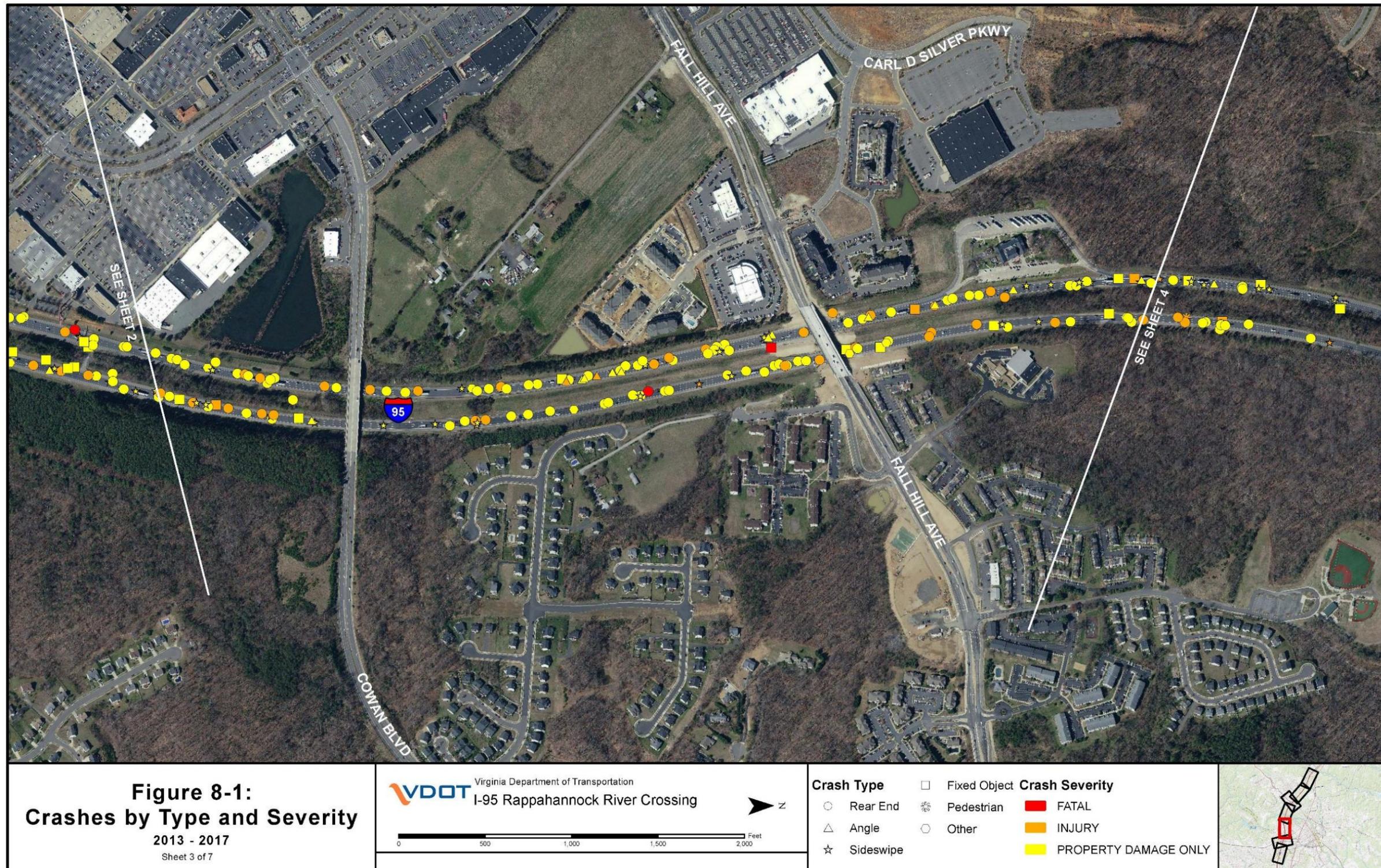


Figure 8-1: Crashes by Type and Severity (Sheet 4 of 7)

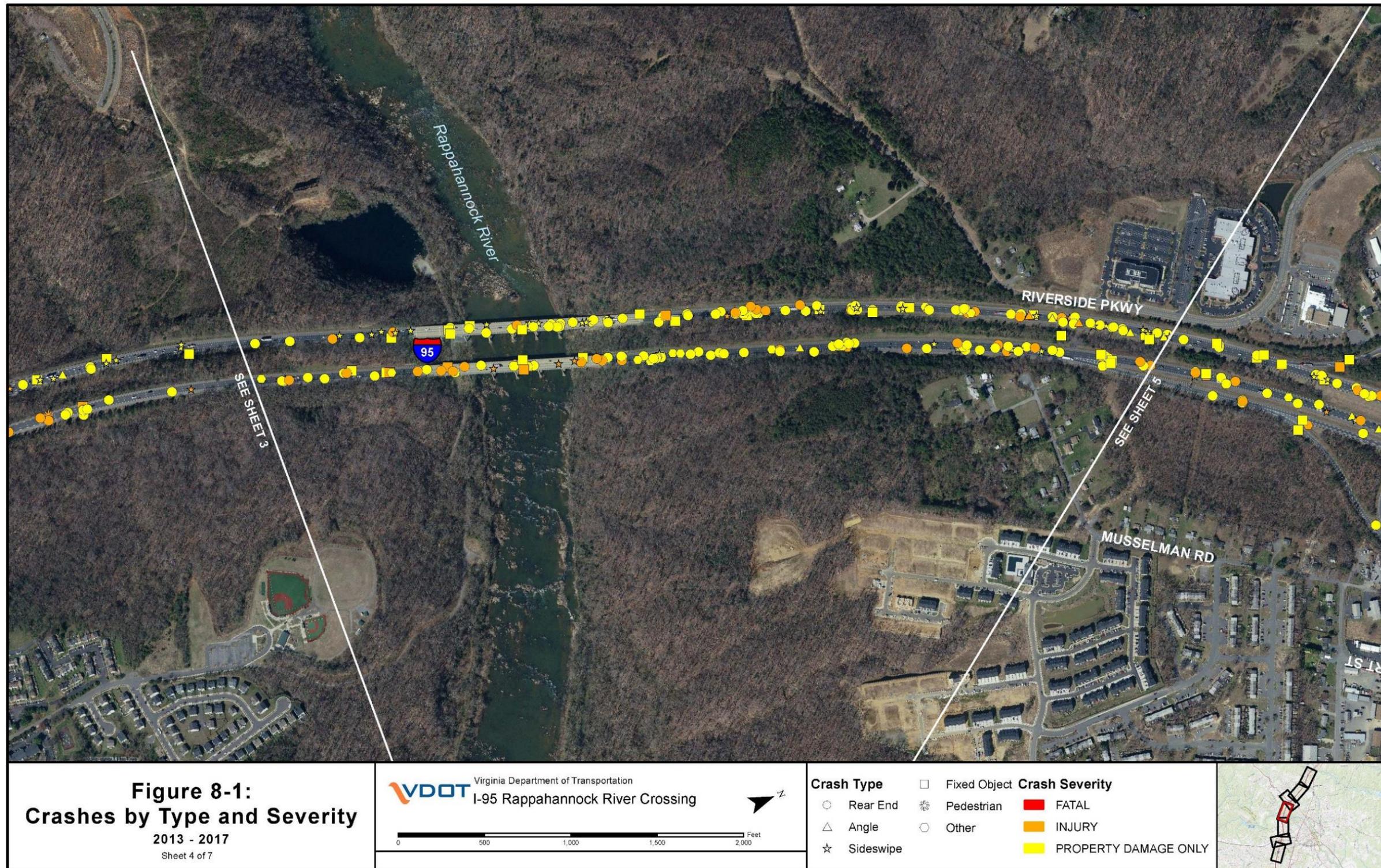


Figure 8-1: Crashes by Type and Severity (Sheet 5 of 7)

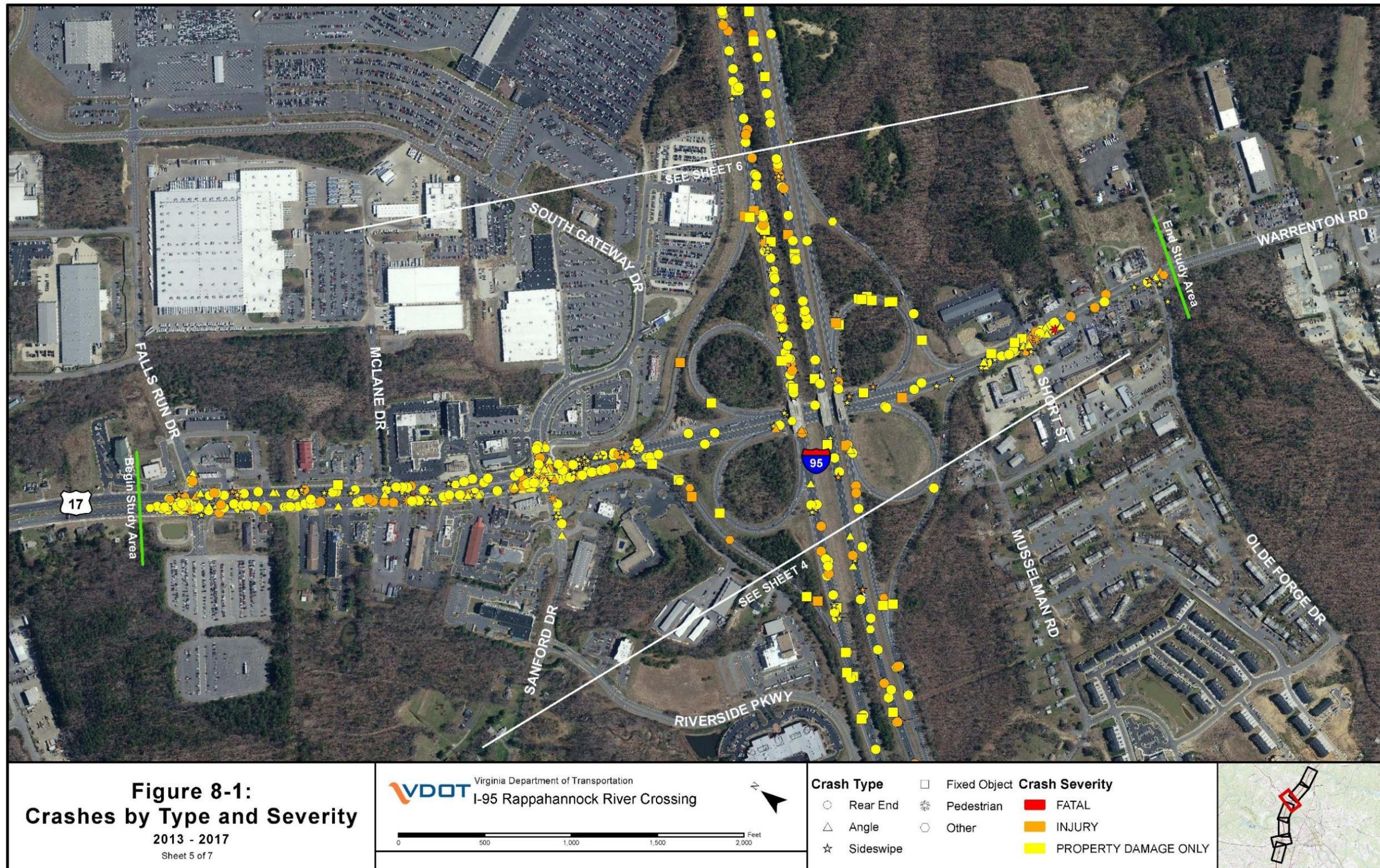


Figure 8-1: Crashes by Type and Severity (Sheet 6 of 7)

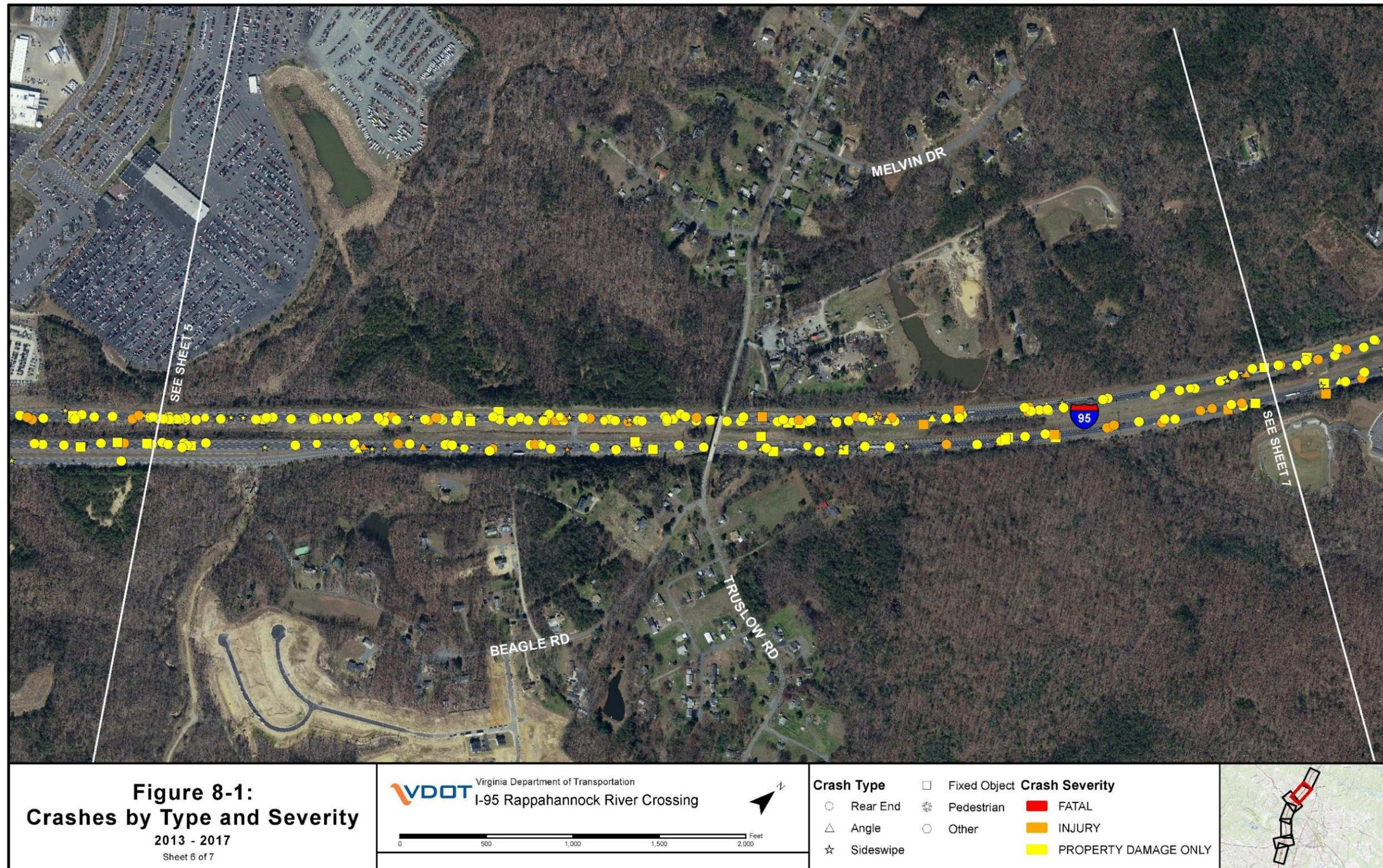


Figure 8-1: Crashes by Type and Severity (Sheet 7 of 7)

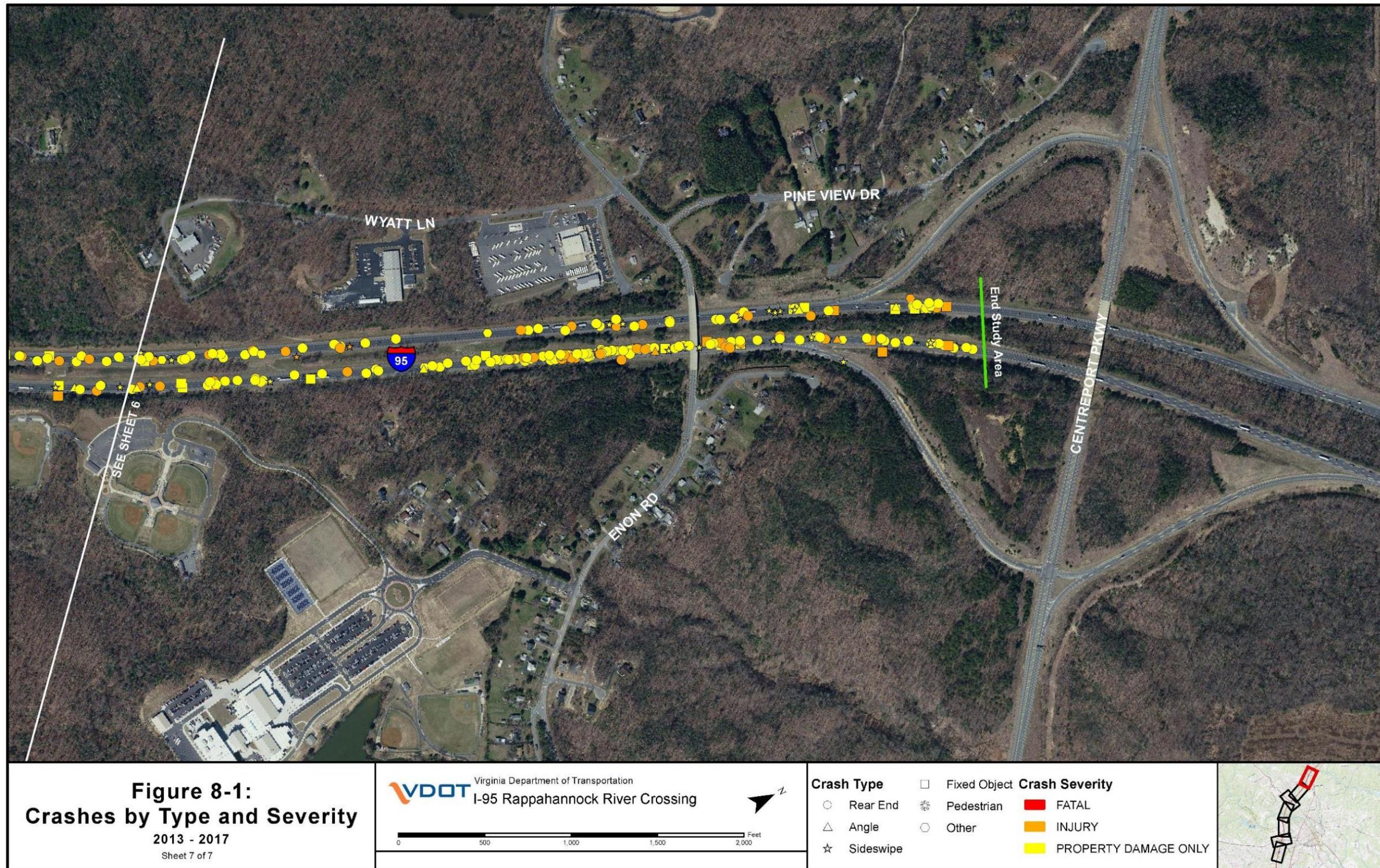


Table 8-1: Crash Summary

Crash Type		Number of Crashes						Ramps and Minor Street Approaches	Total Crashes	% of Total Crashes
		I-95		Route 3		Route 17/ Route 17 Business				
		NB	SB	EB	WB	EB	WB			
Collision Type	Rear End	497	418	148	111	116	59	82	1,431	57.0%
	Sideswipe	103	113	26	32	28	40	17	359	14.3%
	Angle	50	40	26	53	29	30	24	252	10.0%
	Fixed Object	92	66	5	8	2	3	157	333	13.3%
	Other	39	32	9	12	9	6	29	136	5.4%
Crash Severity	Fatal Injury	2	3	1	0	2	0	0	8	0.3%
	Ambulatory Injury	32	20	11	9	7	2	14	95	3.8%
	Visible Injury	125	94	57	47	25	23	36	407	16.2%
	Non-Visible Injury	20	13	0	0	6	6	3	48	1.9%
	Property Damage Only	602	539	145	160	144	107	256	1,953	77.8%
Surface Condition	Dry	572	563	171	165	159	116	142	1,888	75.2%
	Wet	183	95	40	46	25	21	159	569	22.7%
	Snowy/Icy/Slush	24	10	3	4	0	1	5	47	1.9%
	Other	2	1	0	1	0	0	3	7	0.3%
Weather Condition	No Adverse Conditions (Clear/Cloudy)	594	576	178	181	161	119	168	1,977	78.7%
	Rain/Mist	161	81	33	31	23	17	135	481	19.2%
	Snow/Sleet/Hail	24	10	3	3	0	2	5	47	1.9%
	Fog	1	2	0	0	0	0	0	3	0.1%
	Other	1	0	0	1	0	0	1	3	0.1%
Crash Year	2013	129	120	33	39	39	17	64	441	17.6%
	2014	157	134	54	51	26	31	67	520	20.7%
	2015	172	124	47	41	32	35	84	535	21.3%
	2016	148	153	29	47	38	25	33	473	18.8%
	2017	175	138	51	38	49	30	61	542	21.6%
Time	12AM – 3 AM	32	38	2	6	5	6	21	110	4.4%
	3 AM – 6 AM	32	34	5	2	4	1	17	95	3.8%
	6 AM – 9 AM	148	43	59	14	17	25	45	351	14.0%
	9 AM – 12 PM	78	82	15	25	37	15	47	299	11.9%
	12 PM – 3 PM	170	113	34	49	42	33	42	483	19.2%
	3 PM - 6 PM	158	202	51	61	44	26	58	600	23.9%
	6 PM – 9 PM	115	109	31	42	24	22	53	396	15.8%
	9 PM – 12 AM	48	48	17	17	11	10	26	177	7.0%
<b>Total Crashes by Facility</b>		<b>781</b>	<b>669</b>	<b>214</b>	<b>216</b>	<b>184</b>	<b>138</b>	<b>309</b>	<b>2,511</b>	<b>-</b>
<b>Length (mile)</b>		<b>7.6</b>	<b>7.6</b>	<b>1.0</b>	<b>1.0</b>	<b>1.2</b>	<b>1.2</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Crashes per Mile</b>		<b>102.7</b>	<b>88.0</b>	<b>214.0</b>	<b>216.0</b>	<b>153.3</b>	<b>115</b>	<b>-</b>	<b>-</b>	<b>-</b>

Figure 8-2: Crashes by Year by Facility

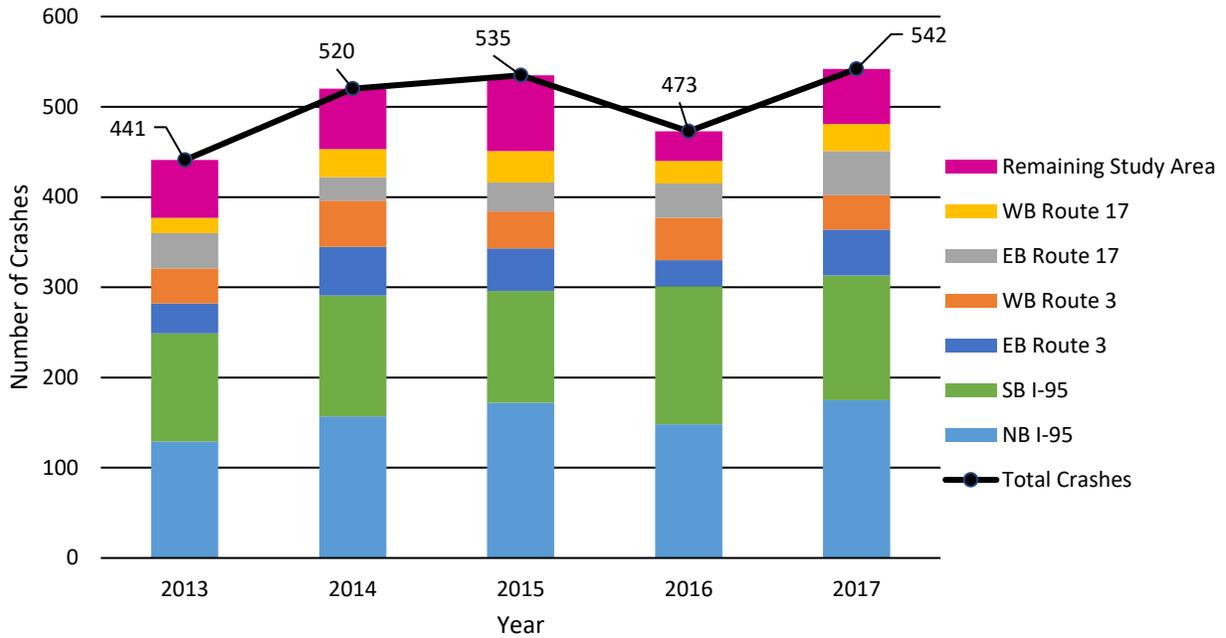
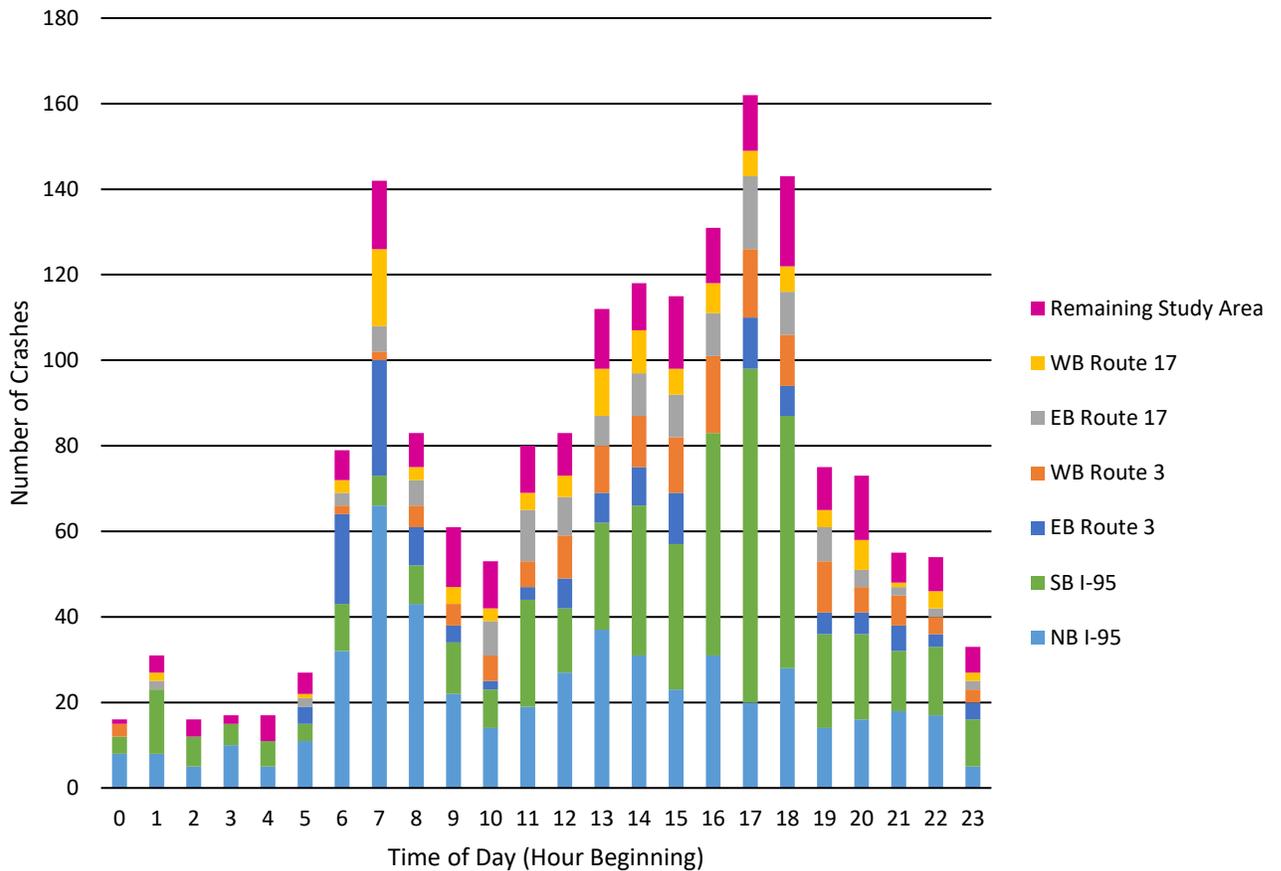


Figure 8-3: Weekday (Monday – Friday) Crashes by Time of Day



To further analyze the crash data and identify crash trends, the I-95 study corridor was separated into 76 segments along northbound and southbound I-95, each covering a 0.10-mile roadway segment. Tenth-mile segments were established at consistent locations along northbound and southbound I-95. All crashes reported along I-95 were associated with a specific 0.10-mile segment based on geospatial data. For example, crashes associated with mile point 130.0 represent the roadway segment from milepoint 129.95 to 130.05. Crashes along I-95 are summarized using crash frequency histograms depicting crash types in 0.10-mile segments in **Figure 8-4**. Crash rates per 100 million vehicle miles traveled (VMT) were calculated along I-95 and are summarized by 0.10-mile segments in **Figure 8-5**. Crash frequency and crash rates per 100 million vehicle miles traveled (VMT) for each 0.10-mile segment along I-95 are also summarized in **Table 8-2**.

Calculated crash rates along I-95 were compared to VDOT's annually-published 2017 average crash rates for Statewide Urban Interstates and Fredericksburg Interstates. The northbound crash rate of 115.9 is 66 percent higher than the than the average crash rate for Statewide Urban Interstates and the southbound crash rate of 95.1 is 36 percent higher than the average crash rate for Statewide Urban Interstates. Of the 152 total 0.10-mile segments analyzed (76 per direction along I-95), 99 segments (65 percent) have a total crash rate greater than the Statewide Urban Interstates average crash rate (69.9 crashes per 100 million VMT). Twelve segments (8 percent) have a total crash rate more than three times the Statewide Urban Interstates crash rate.

Along northbound I-95, crash rates are greatest approaching the off-ramp to Centreport Parkway with crash rates more than eight times greater than the average crash rate for Statewide Urban Interstates. The next highest crash rates along northbound I-95 are located within the Route 3 interchange with crash rates more than six times greater than the average crash rate for Statewide Urban Interstates. Along southbound I-95, the highest crash rates are in the vicinity of the Route 17 interchange with crash rates exceeding the average crash rate for Statewide Urban Interstates by more than four times. In summary, the highest crash rates along northbound I-95 are located in the vicinity of conflict points along the mainline lanes.

**Table 8-2: Crash Frequency and Rate (per 100 million VMT) Comparison by Tenth-Mile Segment**

MP	Interstate Reference Area	I-95 Total Crash Frequency		I-95 Total Crash Rate [per 100 Million Vehicle Miles Traveled (VMT)] <sup>1</sup>	
		NB	SB	NB	SB
128.8		8	4	105.4	51.6
128.9		9	5	118.5	64.5
129.0		18	5	<b>237.1</b>	64.5
129.1		16	4	<b>210.7</b>	51.6
129.2		9	4	118.5	51.6
129.3		9	1	118.5	12.9
129.4		9	2	118.5	25.8
129.5		6	0	79.0	0.0
129.6		13	2	171.2	25.8
129.7		10	5	131.7	64.5
129.8		13	2	171.2	25.8
129.9		22	2	<b>289.8</b>	25.8
130.0	Off-ramp to Route 3	12	7	158.1	90.3
130.1		12	4	158.1	51.6
130.2		20	8	<b>263.4</b>	103.2
130.3	Route 3	34	4	<b>447.8</b>	51.6
130.4		16	5	<b>210.7</b>	64.5
130.5		12	5	119.1	51.1
130.6		7	3	69.5	30.7
130.7	On-ramp from Route 3	9	8	89.3	81.8
130.8		12	7	119.1	71.6
130.9		11	10	109.2	102.2
131.0	Cowan Blvd	3	5	29.8	51.1
131.1		3	4	29.8	40.9
131.2		8	9	79.4	92.0
131.3		6	12	59.6	122.7
131.4		6	12	59.6	122.7
131.5		10	8	99.3	81.8
131.6	Fall Hill Ave	8	6	79.4	61.3
131.7		5	8	49.6	81.8
131.8		5	8	49.6	81.8
131.9		7	8	69.5	81.8
132.0		9	9	89.3	92.0
132.1		2	5	19.9	51.1
132.2		6	1	59.6	10.2
132.3		8	5	79.4	51.1
132.4		10	9	99.3	92.0
132.5	Rappahannock River	12	15	119.1	153.3
132.6		19	10	188.6	102.2
132.7		8	15	79.4	153.3
132.8		13	14	129.0	143.1
132.9		3	13	29.8	132.9
133.0	Off-ramp to NB C-D lane	18	11	178.7	112.5
133.1		8	17	79.4	173.8

MP	Interstate Reference Area	I-95 Total Crash Frequency		I-95 Total Crash Rate [per 100 Million Vehicle Miles Traveled (VMT)] <sup>1</sup>	
		NB	SB	NB	SB
133.2		11	15	109.2	153.3
133.3		4	5	39.7	51.1
133.4		6	12	59.6	122.7
133.5		5	9	49.6	92.0
133.6	Route 17	3	6	29.8	61.3
133.7		9	23	89.3	<b>235.1</b>
133.8	On-ramp from Route 17	10	22	99.3	<b>224.9</b>
133.9		6	9	66.1	99.1
134.0		9	8	99.1	88.1
134.1		5	28	55.1	<b>308.3</b>
134.2		5	11	55.1	121.1
134.3		8	11	88.1	121.1
134.4		10	15	110.1	165.2
134.5		7	17	77.1	187.2
134.6	Truslow Road	5	14	55.1	154.2
134.7		7	12	77.1	132.1
134.8		7	17	77.1	187.2
134.9		5	10	55.1	110.1
135.0		6	11	66.1	121.1
135.1		7	5	77.1	55.1
135.2		9	10	99.1	110.1
135.3		6	10	66.1	110.1
135.4		11	14	121.1	154.2
135.5		12	12	132.1	132.1
135.6		5	9	55.1	99.1
135.7		7	4	77.1	44.0
135.8		21	3	<b>231.2</b>	33.0
135.9		53	9	<b>583.6</b>	99.1
136.0	Enon Road	21	5	<b>231.2</b>	55.1
136.1	Off-ramp to Centreport Pkwy	14	13	154.2	143.2
136.2		12	5	132.1	55.1
136.3		11	14	121.1	154.2
<b>Overall Corridor</b>		<b>781</b>	<b>669</b>	<b>115.9</b>	<b>95.1</b>
<b>2017 Average Crash Rate per 100 Vehicle Miles Traveled</b>					
<b>Statewide Urban Interstates</b>				<b>69.9</b>	
<b>Fredericksburg Interstates</b>				<b>78.6</b>	

<sup>1</sup> Segments with crash rates greater than the average crash rate for Statewide Urban Interstates are indicated with shading. Segments with rates more than 3 times the average crash rate are indicated in **bold**.

Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 1 of 11)



Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 2 of 11)



Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 3 of 11)

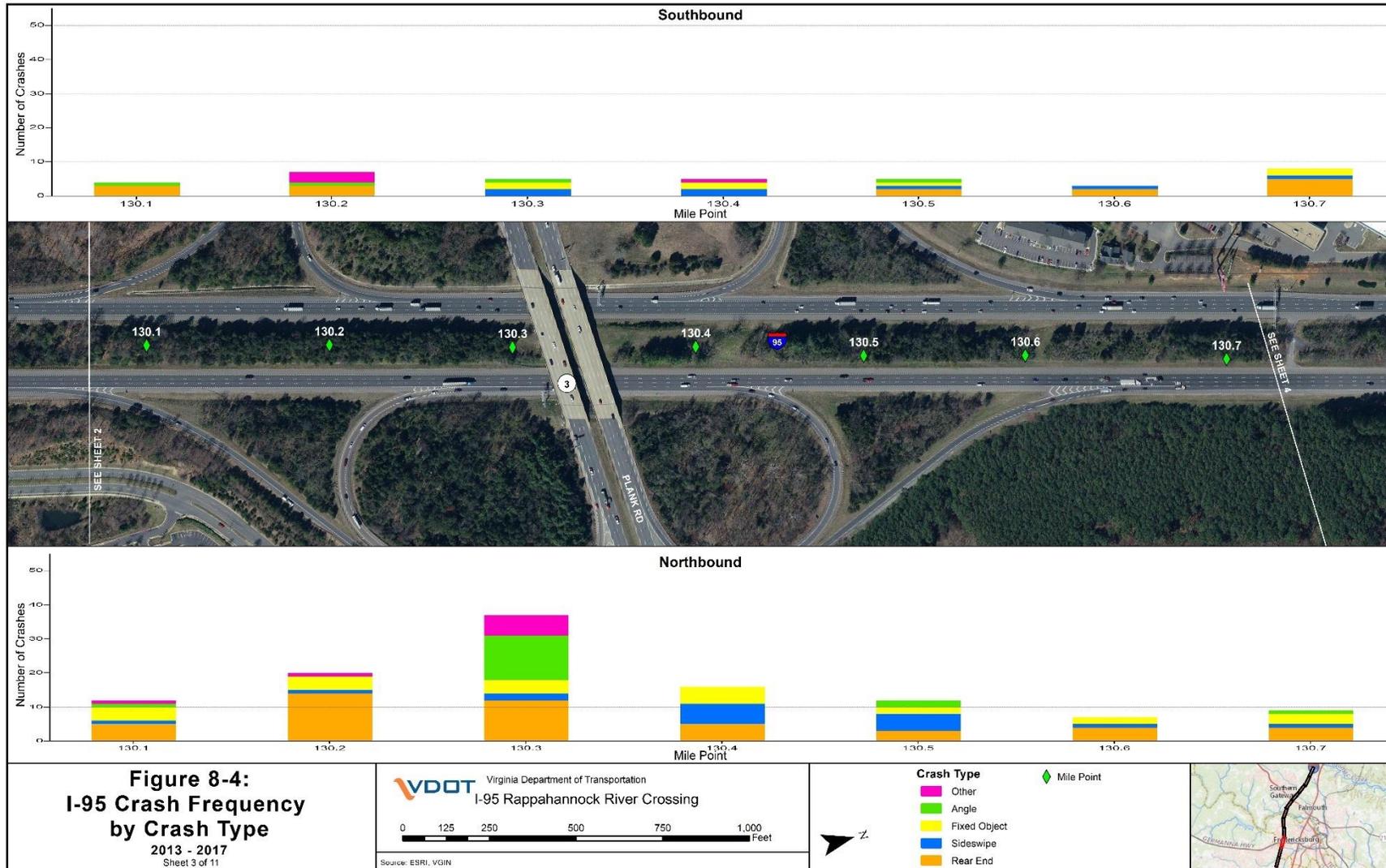


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 4 of 11)

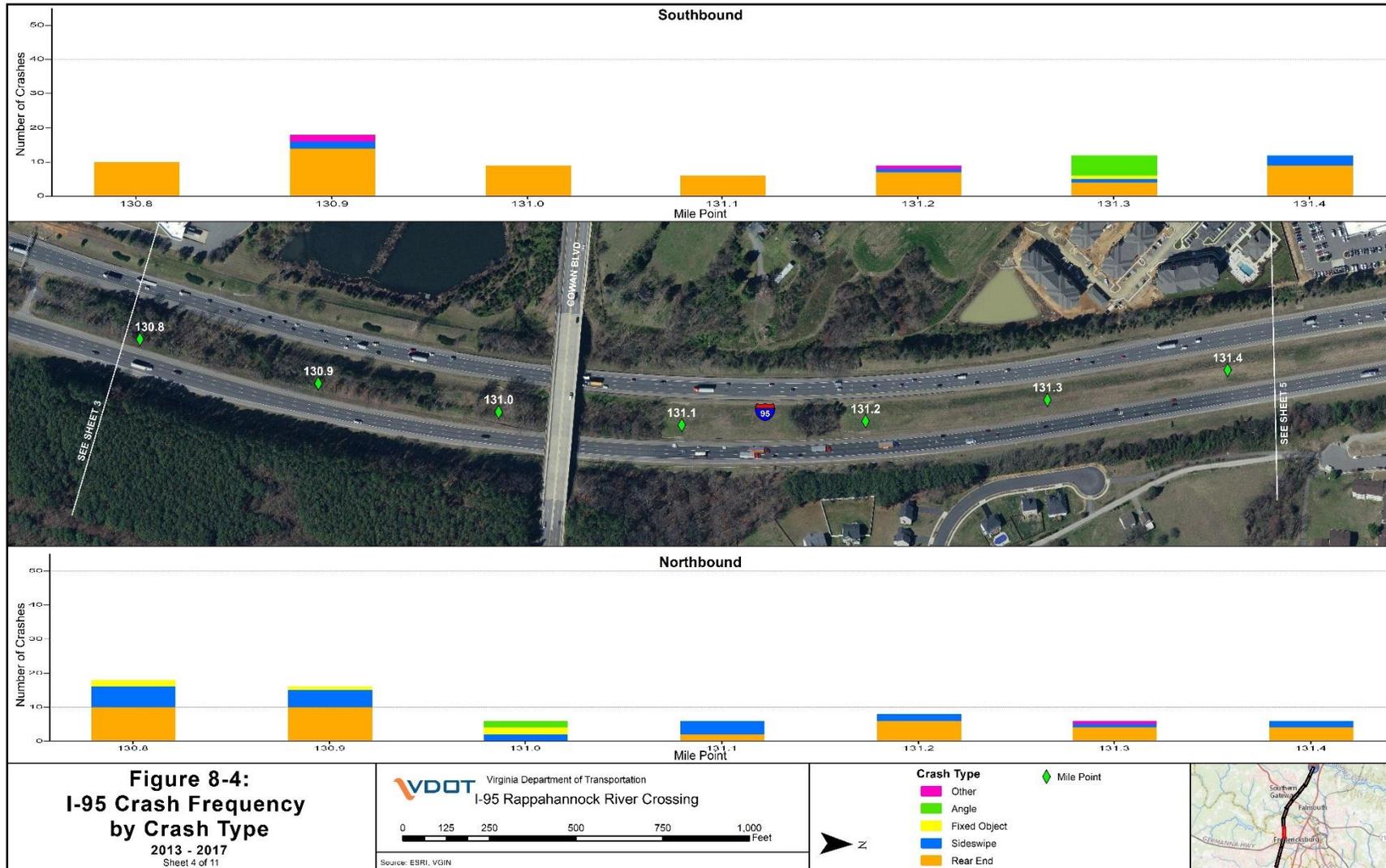


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 5 of 11)

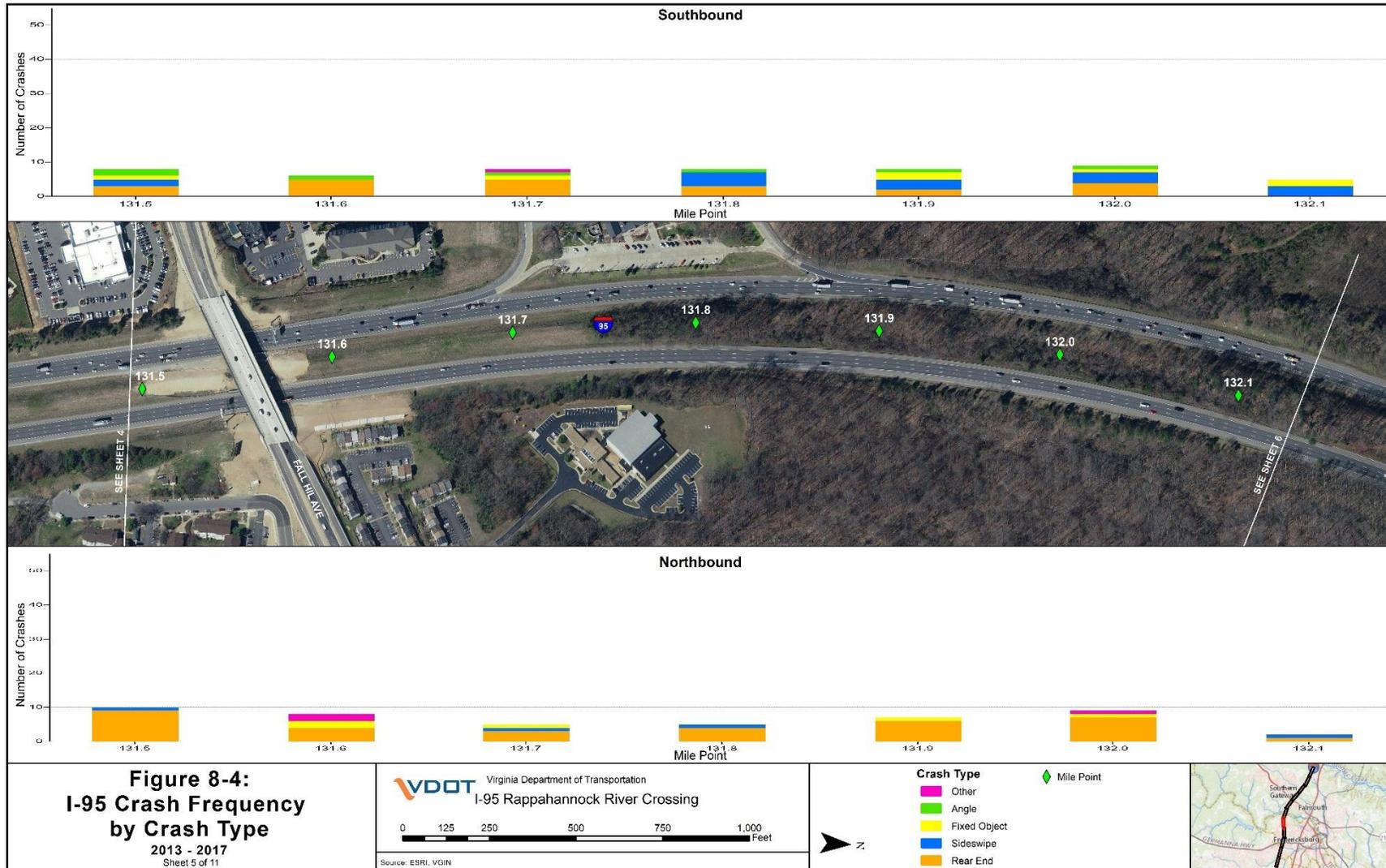


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 6 of 11)

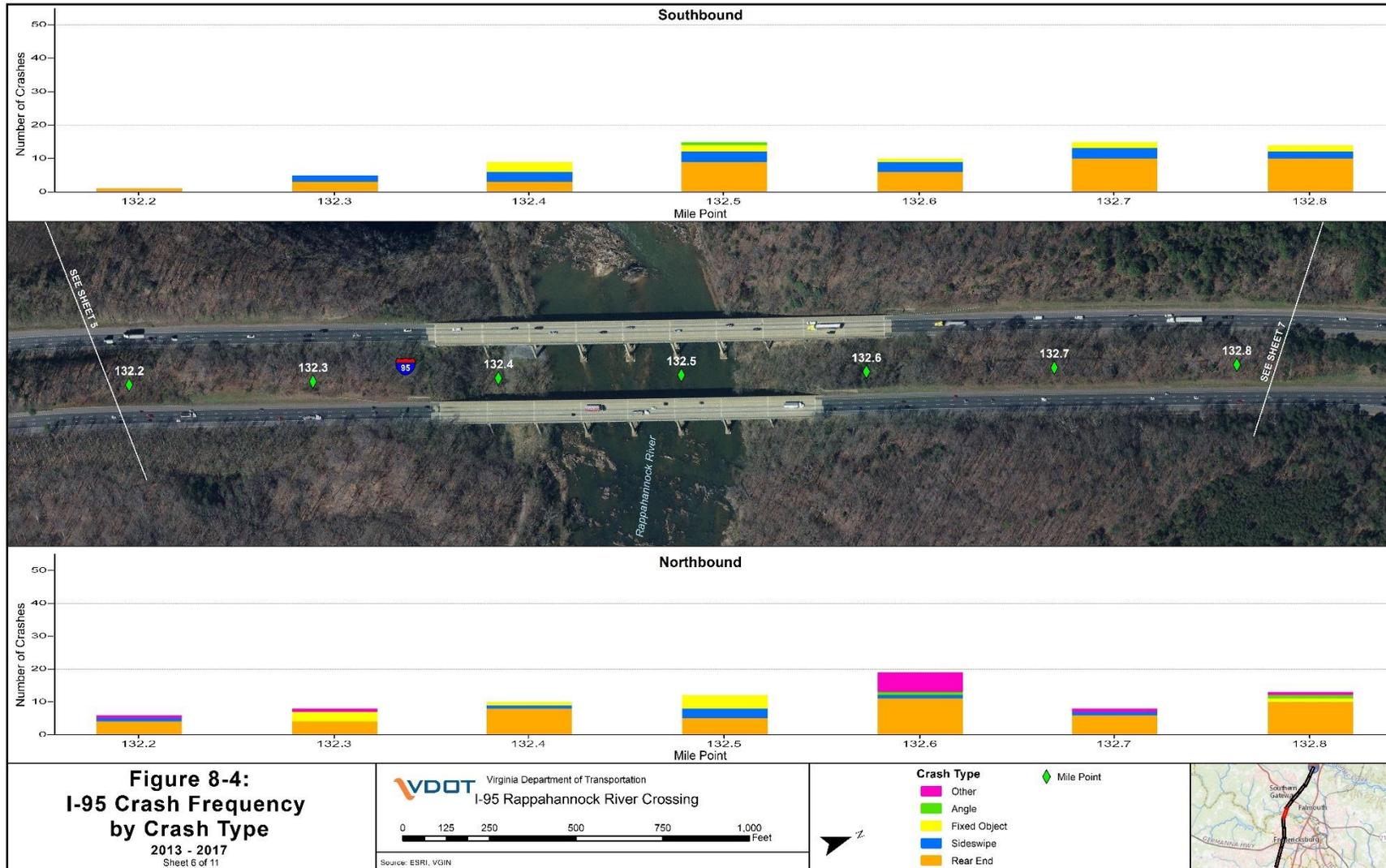


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 7 of 11)

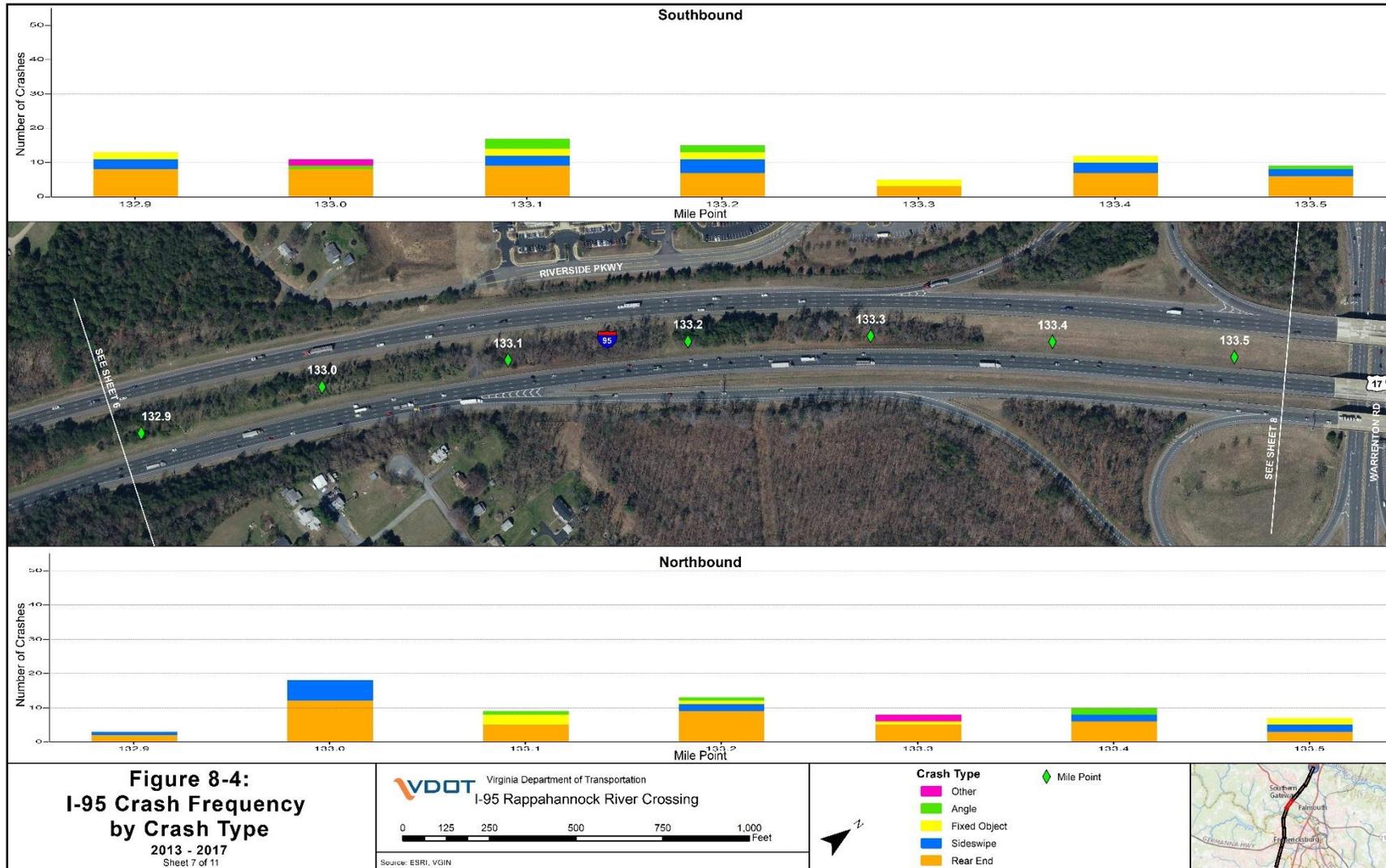


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 8 of 11)

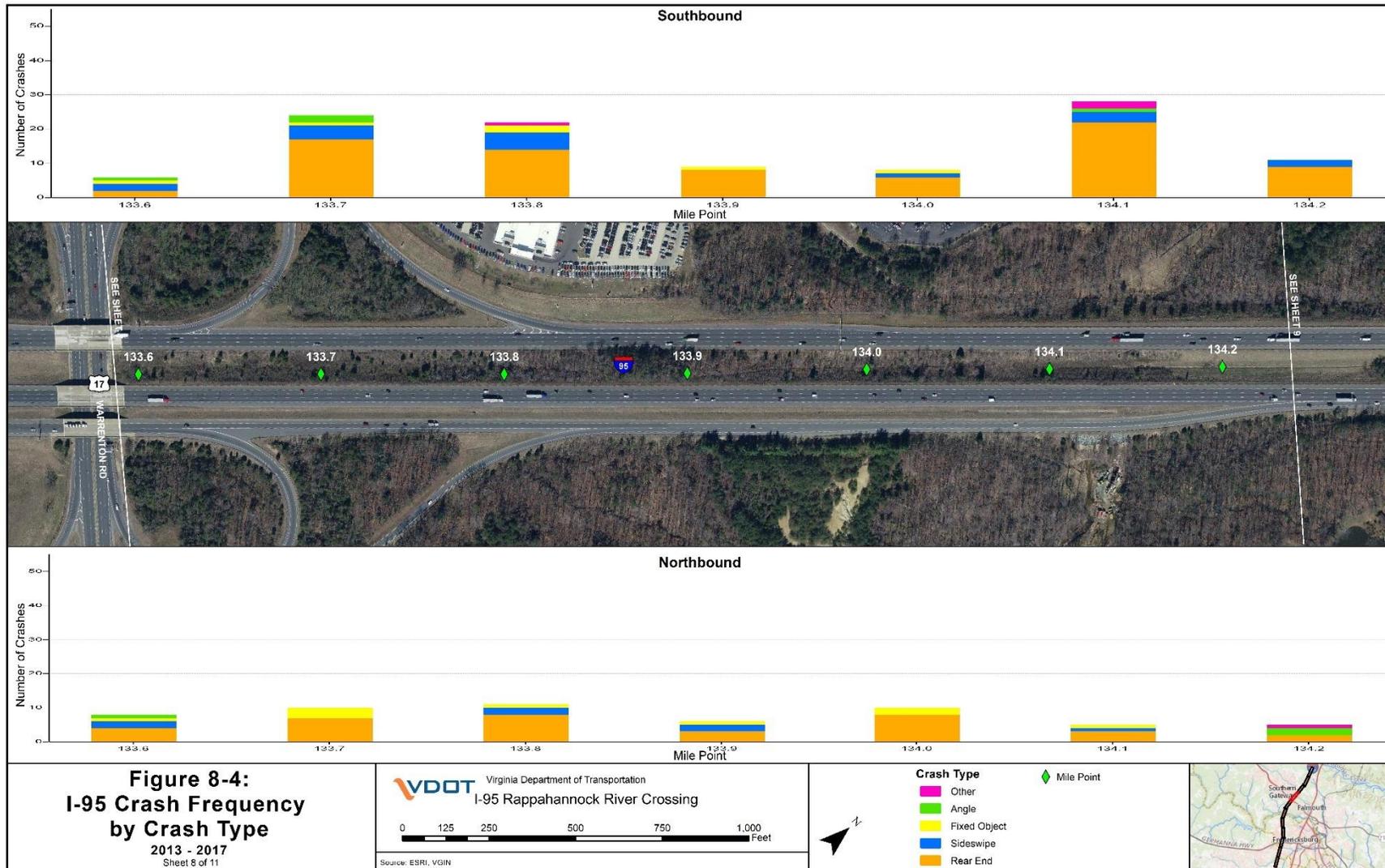


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 9 of 11)

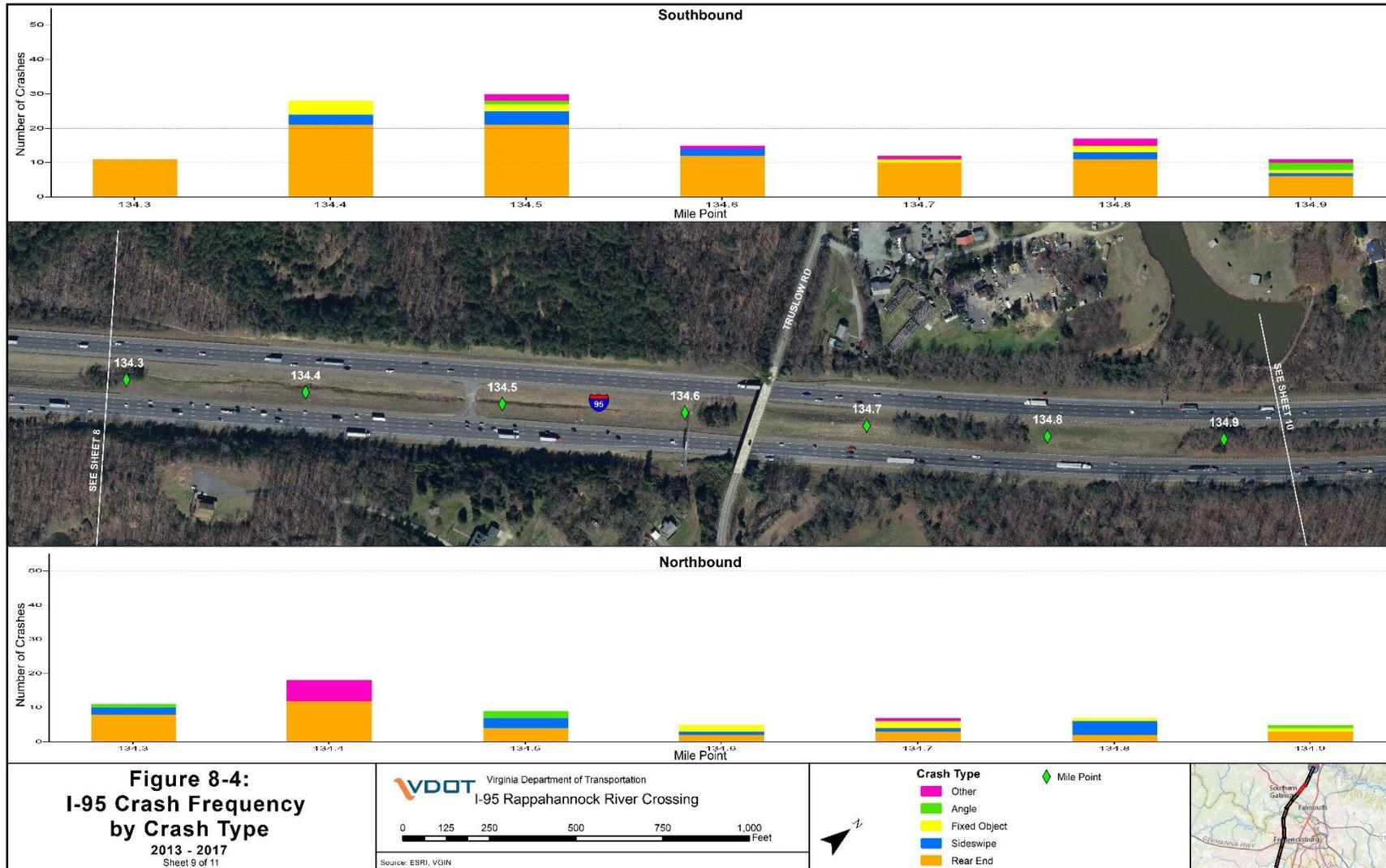


Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 10 of 11)



Figure 8-4: I-95 Crash Frequency by Crash Type (Sheet 11 of 11)

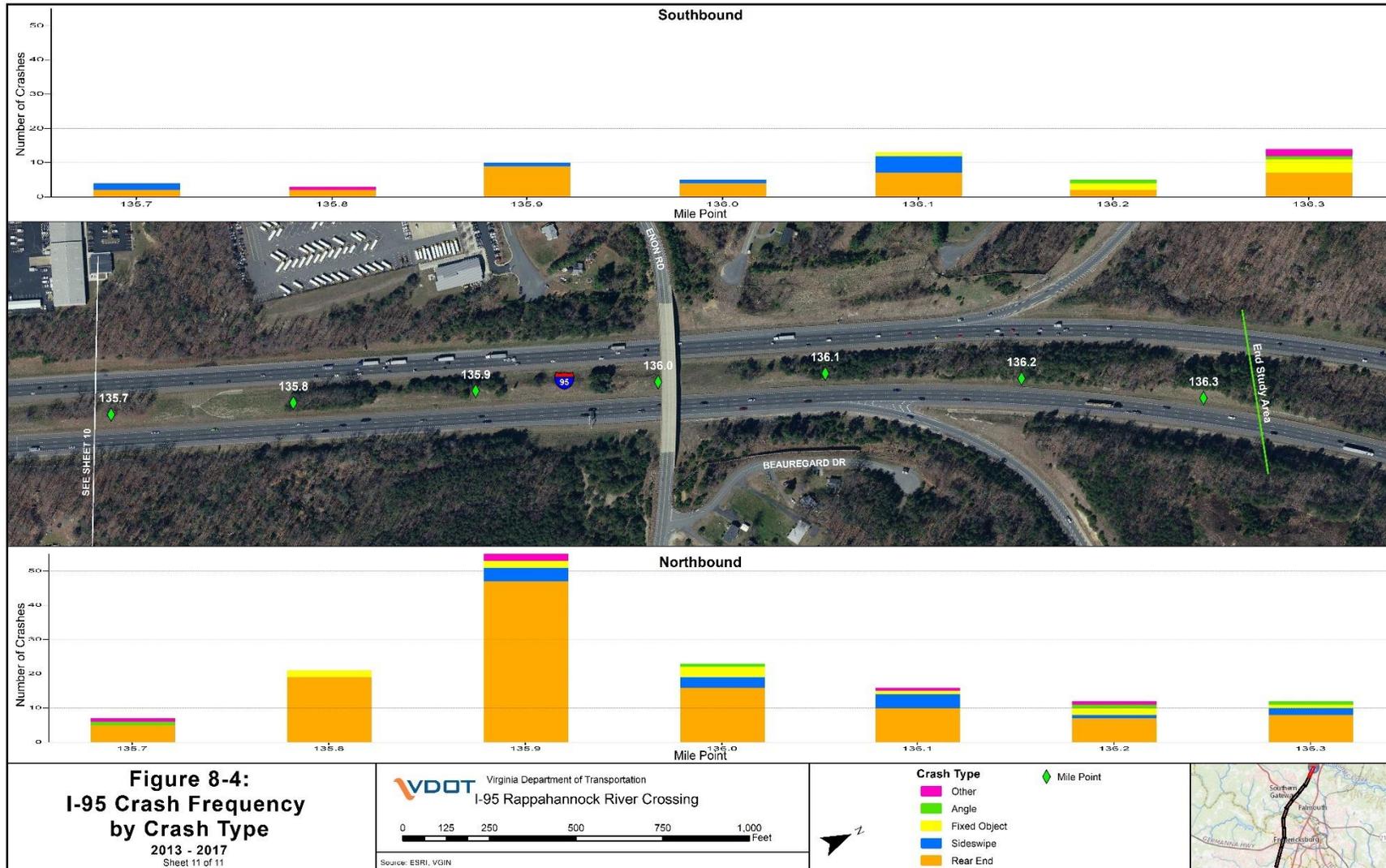
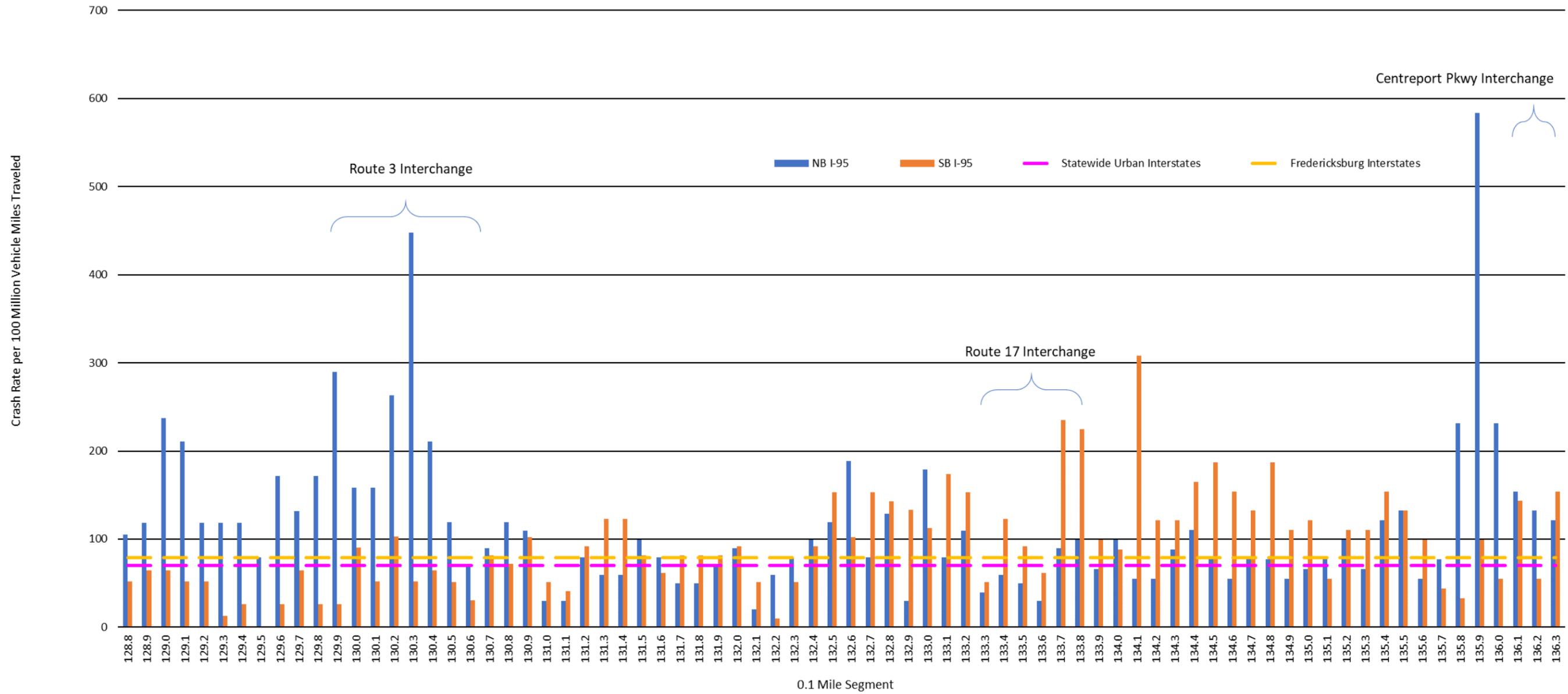


Figure 8-5: I-95 Crash Rates by Mile Point



### 8.1.2 Intersection Crashes

Crashes reported at the study area intersections were identified geospatially using the latitude and longitude information for each crash. A total of 537 intersection crashes were identified at the eight study intersections located along Route 3 and Route 17 during the five-year study period including 156 (29 percent) injury and fatal crashes. As shown in **Table 8-3**, the intersection of Route 3 at Carl D Silver Parkway experienced the highest number of both injury crashes and property damage only crashes, resulting in the highest total number of intersection crashes at 156 crashes including 43 injury crashes during the five-year study period. The intersection of Route 3 and Central Park Boulevard experienced the next highest number of crashes at 99 total crashes. The Route 17 at South Gateway Drive/Sanford Drive intersection experienced the next highest number of crashes at 95 total crashes.

**Table 8-3: Intersection Crashes by Severity (January 2013 – December 2017)**

Intersection	Fatal Crashes	Injury Crashes	Property Damage Only	Total
Route 3 at Central Park Boulevard	0	36	63	99
Route 3 at Carl D Silver Parkway	0	43	113	156
Route 3 at Gateway Boulevard	1	19	41	61
Route 17 at Falls Run Drive	0	13	41	54
Route 17 at McLane Drive	1	8	26	35
Route 17 at South Gateway Drive/Sanford Drive	0	20	75	95
Route 17 Business at Short Street	0	12	18	30
Route 17 Business at Olde Forge Drive	0	3	4	7
<b>Total</b>	<b>2</b>	<b>154</b>	<b>381</b>	<b>537</b>

As shown in **Table 8-4**, rear end crashes are the most predominant crash type at the study intersections with 302 (56 percent) rear end crashes. Of these, 93 (31 percent) occurred at the Route 3 and Carl D Silver Parkway intersection and 62 (21 percent) occurred at the Route 3 and Central Park Boulevard intersection. Angle crashes were the next most predominant crash type with 115 (21 percent) angle crashes. Of the 115 angle crashes, 32 (28 percent) occurred at the Route 3 and Carl D Silver Parkway intersection and 28 (24 percent) occurred at the Route 3 and South Gateway Drive/Sanford Drive intersection.

**Table 8-4: Intersection Crashes by Type (January 2013 – December 2017)**

Intersection	Rear End	Angle	Sideswipe	Fixed Object	Pedestrian	Other	Total
Route 3 at Central Park Boulevard	62	20	9	1	2	5	99
Route 3 at Carl D Silver Parkway	93	32	23	1	4	3	156
Route 3 at Gateway Boulevard	36	12	6	3	0	4	61
Route 17 at Falls Run Drive	34	8	8	0	0	4	54
Route 17 at McLane Drive	24	2	7	0	2	0	35
Route 17 at South Gateway Drive/Sanford Drive	43	28	20	1	2	1	95
Route 17 Business at Short Street	9	11	4	3	2	1	30
Route 17 Business at Olde Forge Drive	1	2	3	0	0	1	7
<b>Total</b>	<b>302</b>	<b>115</b>	<b>80</b>	<b>9</b>	<b>12</b>	<b>19</b>	<b>537</b>

#### 8.1.2.1 Route 3 and Carl D Silver Parkway Intersection

The Route 3 at Carl D Silver Parkway intersection experienced the highest number of intersection crashes (156 crashes) and injury crashes (43 crashes) in the study area, in addition to the greatest number of rear end (93 crashes) and angle (32 crashes) collisions. The high frequency of rear end crashes can be attributed to congestion and weaving movements in the vicinity of the I-95 interchange specifically along westbound Route 3 between the ramp from southbound I-95 and the signal at Carl D Silver Parkway. Additionally, 23 sideswipe crashes were reported which can also be partially attributed to the weave condition between the I-95 ramps and the signal. Of the 32 angle crashes reported at the intersection, the second highest crash type, many can be attributed to disregarding traffic signals and red light running. These types of crashes are frequently attributed to driver inattention but also aggressive driving behavior that is exacerbated by long delays and high congestion levels as motorists attempt to “beat the light” to avoid additional travel delays. Of the 156 total crashes, 41 crashes (26 percent) were reported during the three-hour period between 3:00 PM and 6:00 PM. It should be noted that the I-95 Safety Improvements at Route 3 project that was completed in 2018 included improvements along westbound Route 3 between the ramp from southbound I-95 and the Carl D Silver Parkway intersection to reduce the potential for weave conflicts and increase capacity on the approach to the signal.

#### 8.1.2.2 Route 3 and Central Park Boulevard Intersection

The Route 3 at Central Park Drive intersection experiences the second highest number of intersection crashes (99 crashes), the second highest number of injury crashes (36 crashes), and the second highest number of rear end crashes (62 crashes) in the study area. Of the 99 total crashes, 44 crashes (44 percent) were reported during the five-hour period between 2:00 PM and 7:00 PM. Similar to the Route 3 at Carl D Silver Parkway intersection, the crash trends at the Route 3 and Central Park Drive intersection include a high percentage (63 percent) of rear end crashes which are frequently attributed to congestion.

### 8.1.2.3 Route 17 at South Gateway Drive/Sanford Drive

The Route 17 at South Gateway Drive/Sanford Drive had the third highest total intersection crashes (95 crashes), the third highest number of injury crashes (20 crashes), and the third highest number of rear end crashes (43 crashes). The high frequency of rear end crashes can be attributed to congestion and weaving movements in the vicinity of the I-95 interchange specifically along westbound Route 17 between the ramp from southbound I-95 and the signal at South Gateway Drive/Sanford Drive. Of the 95 total crashes, 25 crashes (26 percent) occurred during the three-hour period between 4:00 PM and 7:00 PM.

### 8.1.3 Ramp Crashes

Crashes reported along the ramps within the study area were identified geospatially using the latitude and longitude information for each crash. A total of 240 crashes were identified along the nineteen ramps (including the northbound C-D road at the Route 17 interchange) during the five-year study period including 38 injury crashes. Crashes that occurred on the ramps within the study area are summarized in **Table 8-5** and **Table 8-6**. **Table 8-5** summarizes the crashes by severity and **Table 8-6** summarizes the crashes by the type of collision. The eastbound Route 3 ramp to northbound I-95 experienced the highest number of crashes with a total of 85 crashes including nine injury crashes. The number of reported crashes on this ramp is nearly five times any other ramp within the study area.

**Table 8-5: Ramp Crashes by Severity (January 2013 – December 2017)**

Ramp	Fatal Crashes	Injury Crashes	Property Damage Only	Total
Eastbound Route 3 to northbound I-95	0	9	76	85
Eastbound Route 3 to southbound I-95	0	4	14	18
Westbound Route 3 to northbound I-95	0	0	13	13
Westbound Route 3 to southbound I-95	0	1	6	7
Northbound I-95 to eastbound Route 3	0	1	5	6
Northbound I-95 to westbound Route 3	0	1	13	14
Southbound I-95 to eastbound Route 3	0	5	12	17
Southbound I-95 to westbound Route 3	0	2	12	14
Eastbound Route 17 to I-95 North	0	0	4	4
Eastbound Route 17 to southbound I-95	0	5	13	18
Westbound Route 17 to northbound I-95	0	0	3	3
Westbound Route 17 to southbound I-95	0	0	2	2
Northbound I-95 to eastbound Route 17	0	0	2	2
Northbound I-95 to westbound Route 17	0	2	8	10
Southbound I-95 to eastbound Route 17	0	0	1	1
Southbound I-95 to westbound Route 17	0	2	2	4
Northbound I-95 to Centreport Pkwy	0	0	1	1
Centreport Pkwy to southbound I-95	0	0	0	0
I-95 Northbound C-D Road at Route 17	0	6	15	21
<b>Total</b>	<b>0</b>	<b>38</b>	<b>202</b>	<b>240</b>

Table 8-6: Ramp Crashes by Type (January 2013 – December 2017)

Intersection	Rear End	Angle	Sideswipe	Fixed Object	Pedestrian	Other	Total
Eastbound Route 3 to northbound I-95	11	5	1	61	0	7	85
Eastbound Route 3 to southbound I-95	0	0	1	16	0	1	18
Westbound Route 3 to northbound I-95	2	1	0	9	0	1	13
Westbound Route 3 to southbound I-95	0	0	0	7	0	0	7
Northbound I-95 to eastbound Route 3	0	0	0	4	0	2	6
Northbound I-95 to westbound Route 3	0	0	0	12	0	2	14
Southbound I-95 to eastbound Route 3	0	0	1	13	0	3	17
Southbound I-95 to westbound Route 3	5	2	0	7	0	0	14
Eastbound Route 17 to I-95 North	3	1	0	0	0	0	4
Eastbound Route 17 to southbound I-95	7	1	1	6	0	3	18
Westbound Route 17 to northbound I-95	1	0	0	1	0	1	3
Westbound Route 17 to southbound I-95	0	0	0	2	0	0	2
Northbound I-95 to eastbound Route 17	1	0	0	1	0	0	2
Northbound I-95 to westbound Route 17	0	0	1	9	0	0	10
Southbound I-95 to eastbound Route 17	0	0	0	1	0	0	1
Southbound I-95 to westbound Route 17	0	0	0	3	0	1	4
Northbound I-95 to Centreport Pkwy	0	0	1	0	0	0	1
Centreport Pkwy to southbound I-95	0	0	0	0	0	0	0
I-95 Northbound C-D Road at Route 17	14	1	3	2	0	1	21
<b>Total</b>	<b>44</b>	<b>11</b>	<b>9</b>	<b>154</b>	<b>0</b>	<b>22</b>	<b>240</b>

### 8.1.3.1 Eastbound Route 3 to Northbound I-95 Ramp

The eastbound Route 3 to northbound I-95 ramp experienced the highest number of ramp crashes and highest number of all crash types with 85 total crashes. The ramp serves the heavy eastbound Route 3 to northbound I-95 movement and enters northbound I-95 as a weave condition with the ramp from northbound I-95 to westbound Route 3. In addition to the 85 crashes that occurred along the ramp, 45 crashes occurred in the weave section along northbound I-95 between the ramp from eastbound Route 3 and the ramp to westbound Route 3. Sixty-one (72 percent) of the crashes were fixed-object crashes which can be partially attributed to the geometry and tight radius along the loop ramp. As noted above, the I-95

Safety Improvements at Route 3 project that was completed in 2018 (see **Section 4.2.3**) removed this loop ramp and accommodated this movement with a new signalized intersection along Route 3. Eastbound Route 3 motorists destined for northbound I-95 now make a signalized triple left-turn onto a ramp to northbound I-95 eliminating the potential for fixed-object crashes along the existing loop ramp and reducing the potential for crashes along northbound I-95 within the weave segment.

## 8.2 SAFETY ASSESSMENT OF THE PREFERRED ALTERNATIVE

With the anticipated growth in travel demand along the I-95 corridor and other roadways within the study area, congestion will increase and correspondingly, crash frequency will increase under future No Build conditions. The Build Alternative will improve safety, reduce conflict points, and reduce the potential for crashes.

The Highway Safety Manual (HSM) presents a variety of quantitative methods for estimating crash frequency or severity for various facility types including the application of crash modification factors (CMF). The quantitative safety analysis focuses on the review of available CMFs contained in the Crash Modification Factors Clearinghouse and their application to the proposed Build Alternative. The Crash Modification Factors Clearinghouse is a web-based comprehensive listing of available CMFs including both those included and not included in the HSM. A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific location. Applicable CMFs were identified for each of the proposed design elements and applied to calculate the predicted change in crash frequency per year. In addition to a review of CMFs, a comparison of merging, diverging, and crossing conflict points along northbound I-95 was also performed.

A summary of individual design elements associated with the proposed Build Alternative that may contribute to safety within the study limits is discussed below.

### 8.2.1 Northbound I-95 C-D Lanes

One of the established purposes of the project is to eliminate I-95 weaving movements and conflict points along northbound I-95. A primary safety benefit of the Build Alternative compared to No Build conditions is the reduction in the number of conflict points and weaving movements along the I-95 northbound mainline lanes. **Table 8-7** summarizes the number of conflict points including on-ramps and off-ramps along the northbound I-95 C-D road and mainline lanes under No Build conditions and with the Build Alternative. As shown, there are ten total conflict points under No Build conditions and nine total conflict points with the Build Alternative when summing the conflict points along the northbound I-95 mainline lanes and the C-D lanes; however, the number of conflict points along the mainline lanes is reduced from six to five conflict points with the Build Alternative compared to No Build conditions. The Build Alternative has the potential to improve safety compared to No Build conditions by reducing conflicts points along the higher speed I-95 northbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions. A reduction in the number of conflict points along the mainline facility rather than the C-D lanes is preferred because travel speeds are expected to be lower on the C-D road, minimizing the severity of crashes.

**Table 8-7: Northbound I-95 Comparison of Conflict Points**

Northbound I-95 Location		No Build Conditions			Build Alternative		
		NB Mainline Lanes	NB C-D Road	Total	NB Mainline Lanes	NB C-D Road	Total
Route 3 Interchange Area <sup>1</sup>	On-Ramp	1	-	1	0	1	1
	Off-Ramp	2	-	2	3	0	3
Route 17 Interchange Area <sup>2</sup>	On-Ramp	1	2	3	1	2	3
	Off-Ramp	1	2	3	0	1	1
Centreport Pkwy Interchange	On-Ramp	0	-	0	0	-	0
	Off-Ramp	1	-	1	1	-	1
<b>Total Conflict Points</b>	<b>On-Ramp</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>1</b>	<b>3</b>	<b>4</b>
	<b>Off-Ramp</b>	<b>4</b>	<b>2</b>	<b>6</b>	<b>4</b>	<b>1</b>	<b>5</b>
	<b>Total</b>	<b>6</b>	<b>4</b>	<b>10</b>	<b>5</b>	<b>4</b>	<b>9</b>

<sup>1</sup> Assumes I-95 Safety Improvements at Route 3 are implemented as part of both No Build and Build conditions

<sup>2</sup> Does not include conflicts points associated with the Fred Ex ramps

The Crash Modification Factors Clearinghouse does not provide a CMF specific to the overall construction of a C-D lane facility; however, VDOT's *State Preferred CMF List* provides a CMF of 0.9 for all crash types indicating a 10 percent reduction in crashes along northbound I-95 from south of Route 3 at the entrance to the proposed C-D lanes to the entrance to the existing Route 17 C-D lanes. **Table 8-8** summarizes the application of this CMF to reported crashes along northbound I-95 within the limits of the proposed C-D lanes. By applying this CMF, the predicted crash frequency along northbound I-95 within the limits of the proposed C-D lanes may decrease by 10 percent or approximately 4.1 crashes per year.

### 8.2.2 Route 17 Interchange Improvements

The Build Alternative includes the removal of the loop ramp from the northbound I-95 C-D lanes to westbound Route 17 and the installation of a signalized triple left turn from the northbound I-95 C-D lanes off-ramp to westbound Route 17 which will eliminate crashes along the loop and reduce the potential for crashes within the weave segments along both the northbound I-95 C-D lanes and westbound Route 17. The CMF for the replacement of a loop ramp with a directional ramp (CMF ID 480) is 0.70 for all crash types indicating a 30 percent reduction in crashes. This CMF was applied to crashes along the loop ramp from the northbound I-95 C-D lanes to westbound Route 17 and within the weave segments that would be eliminated with the ramp removal. **Table 8-8** summarizes the application of this CMF to reported crashes associated with the ramp removal. By applying this CMF, the crash frequency is predicted to decrease by approximately 1.4 crashes per year.

### 8.2.3 Northbound I-95 Auxiliary Lane between Route 17 and Centreport Parkway

The bid option for the Build Alternative includes the addition of an auxiliary lane along northbound I-95 between the C-D lanes serving the Route 17 interchange and the northbound I-95 off-ramp to Centreport Parkway. The auxiliary lane will provide a longer distance for motorists entering from the northbound C-

D lanes to merge with mainline I-95 traffic. The CMF for installing an auxiliary lane between entrance and exit ramps (CMF ID 7440) is 0.79 for all crash types indicating a 21 percent reduction in crashes. This CMF was applied to crashes along northbound I-95 between the Route 17 C-D lane entrance and the northbound I-95 off-ramp to Centreport Parkway. **Table 8-8** summarizes the application of this CMF to reported crashes along northbound I-95. By applying this CMF, the crash frequency is predicted to decrease by approximately 9.0 crashes per year.

#### 8.2.4 Summary of Crash Modification Factors

**Table 8-8** summarizes the relevant CMFs discussed above. The CMFs were applied to relevant crashes along northbound I-95 and Route 17 to calculate the predicted crash frequency per year for each location.

**Table 8-8: Crash Modification Factor Summary**

Design Element	Crash Type (Severity)	Crash Modification Factor	CMF ID	CMF Star Rating <sup>1</sup>	Historical Crash Frequency <sup>2</sup>	Predicted Crash Frequency	Change in Crashes per Year
					(crashes per year)		
Northbound I-95 – North of Route 3 to south of Route 17 interchange - <i>Install C-D lanes</i>	All Crashes (All Severities)	0.90	_3	_3	41.4	37.3	-4.1
Route 17 Interchange - <i>Remove loop ramp and install direct ramp</i>	All Crashes (All Severities)	0.70	480	3	4.8	3.4	-1.4
Northbound I-95 – North of Route 17 interchange to Centreport Pkwy off-ramp - <i>Install auxiliary lane (Bid Option)</i>	All Crashes (All Severities)	0.79	7440	3	43.0	34.0	-9.0

<sup>1</sup> The star quality rating indicates the quality or confidence in the results of the study that produced the CMF and is based on a scale of 1 to 5, where 5 indicates the highest rating

<sup>2</sup> Five-year crash study period from January 1, 2013 through December 31, 2017

<sup>3</sup> Source: Virginia State Preferred CMFs

### 8.3 SAFETY AND CRASH ANALYSIS FINDINGS

Overall it can be concluded that the Build Alternative should have a positive safety benefit along the northbound I-95 mainline lanes compared to existing conditions. Recurring daily congestion due to heavy commuter traffic especially during the morning peak period creates the potential for crashes along northbound I-95. The predominant crash type is rear end crashes, which account for 57 percent of all crashes and are frequently attributed to congestion. The proposed Build Alternative will increase capacity along northbound I-95 and reduce conflict points along the mainline lanes thereby reducing the potential for congestion-related crashes and improving safety along the corridor compared to No Build conditions.

A primary safety benefit of the Build Alternative compared to No Build conditions is the reduction in the number of conflict points and weaving movements along the I-95 northbound mainline lanes. With the Build Alternative, the number of conflict points along the mainline lanes is reduced from six to five conflict points compared to No Build conditions. The Build Alternative has the potential to improve safety by reducing conflicts points along the higher speed I-95 northbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions.

A quantitative crash analysis using HSM methodologies was performed to document the safety impacts associated with the proposed Build Alternative. Based on a review of available CMFs, a reduction of 4.1 crashes per year (10 percent reduction) is predicted within the limits of the proposed northbound C-D lanes. A reduction of 1.4 crashes per year (30 percent reduction) is predicted at the Route 17 interchange. A reduction of 9.0 crashes per year (21 percent) is predicted along northbound I-95 between the C-D lanes and Centreport Parkway due to the addition of an auxiliary lane with the potential Bid Option A.

## 9. ENVIRONMENTAL COMPLIANCE

Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA), and in accordance with Federal Highway Administration (FHWA) regulations<sup>1</sup>, an Environmental Assessment (EA) has been prepared and a Finding of No Significant Impact (FONSI) was issued by the FHWA on November 17, 2015. The EA analyzed and documented the potential social, economic, and environmental effects associated with the proposed transportation improvements and the FONSI concluded that the project would not have significant impacts on the environment. Since approval of the EA and issuance of the FONSI, VDOT has proposed design modifications (analyzed in this IMR). Based on these design modifications, VDOT conducted a Re-evaluation of the EA. The Re-evaluation of the EA was approved by FHWA on December 04, 2018. The EA and Re-evaluation include information from various technical reviews including those related to historic properties, natural resources, water quality, threatened and endangered species, air quality, noise, etc. The EA and Re-evaluation, identify and further explain the environmental resources that are within the study area and discuss the potential impact that the project would have on those resources.

Permits that are likely needed, as identified through NEPA analysis may include the following: a Section 404 permit from the United States Army Corps of Engineers (USACE), a Virginia Water Protection Permit from the Virginia Department of Environmental Quality (VDEQ), and a subaqueous bottomland permit from Virginia Marine Resources Commission (VMRC). The permit type would be determined during the design phase of the project.

The project will continue to be coordinated with the appropriate federal, state, and local agencies as part of the environmental review and approval processes required throughout project development and construction. All required environmental clearances and permits will be obtained prior to commencement of construction. Strict compliance with all environmental conditions and commitments resulting from regulatory approvals and implementation of VDOT's specifications and standard best management practices will protect the environment during construction.

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<sup>1</sup> NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.

