



# PROJECT PIPELINE

CAROLINE COUNTY  
U.S. ROUTE 1 (FR-23-07) FROM SOUTHERN  
COUNTY LINE WITH HANOVER COUNTY TO  
NORTHERN COUNTY LINE WITH SPOTSYLVANIA  
COUNTY



# U.S. Route 1 (FR-23-07) From Southern County Line with Hanover County to Northern County Line with Spotsylvania County

Draft Report

August 2024

Prepared for



Prepared by



9201 Arboretum Parkway, Suite 310

Richmond, Virginia 23236

## TABLE OF CONTENTS

Appendices .....	3	Public Involvement Survey .....	23
.....	4	Potential Corridor Improvements .....	24
Chapter 1: NEEDS EVALUATION AND DIAGNOSIS .....	4	Pedestrian and Bicycle Improvements .....	24
Introduction .....	5	General Corridor Improvements .....	25
Background .....	5	Intersection Improvements .....	25
Methodology .....	6	U.S. Route 1 at Mayre/Paige Road (Route 605) .....	25
Study Area .....	8	U.S. Route 1 At Quarters Road/Cedon Road (Route 632/Route 661) .....	26
Traffic Operations and Accessibility: .....	9	U.S. Route 1 at Lake Caroline Drive .....	26
Traffic Data .....	9	U.S. Route 1 at Jericho Road/Rogers Clark Blvd (Route 658/207) .....	27
Measures of Effectiveness (MOEs) .....	9	Existing Condition Report Technical Meeting .....	28
Traffic Operations Analysis Results .....	9	No-Build Conditions Traffic Operations Analysis .....	28
Pedestrian, Bicycle, and Transit Access .....	11	Design Year (2052) No-Build Volume Development .....	28
Access Management .....	12	Synchro and SimTraffic Analysis .....	31
STEAP Analysis .....	12	Chapter 2: CONCEPT DEVELOPMENT AND REFINEMENT .....	33
Field Review .....	15	Introduction .....	34
Cedar Fork Road/Golansville Road .....	15	Alternative Analysis .....	34
Edmund Pendleton Drive/Green Road .....	15	Jericho Road (658)/Rogers Clark Boulevard (207) .....	34
Ladysmith Road .....	15	Lake Caroline Drive .....	36
Durette Road (Route 622)/Starr Drive .....	15	Access Management north of Ladysmith Road (Food Lion) .....	38
Deerfield Road/Glen Meadow Drive .....	15	Ladysmith Road (639) to Pine Tree Drive .....	39
Quarters Road/Cedon Road .....	15	Quarters Road (632)/ Cedon Road (632/661) .....	40
Marye Road/Paige Road .....	15	Route 605 (Marye Road/Paige Road) .....	41
Safety and Reliability .....	16	Anticipated Crash Reduction for Improvements .....	42
Safety Analysis Results .....	16	Chapter 3: PUBLIC AND STAKEHOLDER OUTREACH AND FEEDBACK .....	43
Public Involvement Survey .....	21	Public Involvement: .....	44
Anticipated Corridor Issues .....	23	Survey Design .....	44
Safety .....	23	Survey Questions and Results .....	45
Pedestrian/Bike/Transit .....	23	Improvement 1: U.S. Route 1 and Rogers Clark Boulevard/Jericho Road Intersection .....	45
		Improvement 2: U.S. Route 1 and Lake Caroline Drive Intersection .....	45
		Improvement 3: U.S. Route 1 North of Ladysmith Road .....	46

Improvement 4: Ladysmith Road to Pine Tree Drive Improvements .....	46
Improvement 5: U.S. Route 1 and Cedon Road and Quarters Road.....	47
Improvement 6: U.S. Route 1 and Paige Road (Route 605).....	48
Improvement 7: U.S. Route 1 and Durette Road/Starr Drive Improvements.....	48
Improvement 8: U.S. Route 1 and Deerfield Road/Glen Meadows Drive Improvements .....	49
Improvement 9: U.S. Route 1 and Pine Tree Drive Intersection Improvements .....	49
Preferred Alternatives.....	50
Chapter 4: PREFERRED ALTERNATIVE DESIGN REFINEMENT & INVESTMENT STRATEGY.....	51
Intent of Phase 3.....	52
Preferred Alternative #1: U.S. Route 1 and Paige Road/Marye Road.....	52
Design Assumptions.....	52
Project Risk and Contingency .....	54
Cost Estimate .....	54
Methodology.....	54
Cost Estimate Breakdown .....	54
Preferred Alternative #2: U.S. Route 1 and Cedon Road/Quarters Road .....	54
Preferred Alternative #3: U.S. Route 1 and Lake Caroline Drive.....	55
Design Assumptions.....	55
Project Risk and Contingency .....	58
Cost Estimate .....	58
Methodology.....	58
Cost Estimate Breakdown .....	58
Preferred Alternative #4: U.S. Route 1 and Roger Clark Boulevard/Jericho Road .....	58
Design Assumptions.....	58
Project Risk and Contingency .....	61
Cost Estimate .....	61
Methodology.....	61
Cost Estimate Breakdown .....	61
Preferred Alternative #5: U.S. Route 1 at Pine Tree Drive, Deerfield Road, and Durette Road.....	61
Design Assumptions.....	61

Project Risk and Contingency.....	67
Cost Estimate .....	67
Methodology .....	67
Cost Estimate Breakdown .....	67

## Appendices

Appendix A – Traffic Data
Appendix B – Existing Condition Synchro-SimTraffic
Appendix C – No-Build Design Year Synchro-SimTraffic
Appendix D – Meeting Minutes
Appendix E – VJuST-iCAP
Appendix F – Public Comment
Appendix G – Basis of Design Memorandums

# Chapter 1:

# NEEDS EVALUATION AND DIAGNOSIS

## Introduction

Project Pipeline is a performance-based planning program to identify cost-effective solutions to multimodal transportation needs in Virginia. Through this planning process, projects and solutions may be considered for funding through programs, including SMART SCALE, revenue sharing, interstate funding, and others. Visit the Project Pipeline webpage for additional information: [vapipeline.org](http://vapipeline.org).

This study focuses on concepts targeting identified needs including congestion mitigation, safety improvement, pedestrian and bicycle infrastructure along the corridor, and transit access. The objectives of Project Pipeline are shown below in **Figure 1**.



Figure 1: Project Pipeline Objective

## Background

The Office of Intermodal Planning and Investment (OIPI) prepared the VTrans Virginia's statewide transportation plan for the Commonwealth Transportation Board (CTB), in which mid-term needs (0 - 10 years) were identified for different categories listed in **Table 1**. This study focuses on addressing needs identified in VTrans, and those previously identified by the localities.

Table 1: List of VTrans Needs

VTrans Needs	
	Safety Improvement
	Transportation Demand Management
	Congestion Mitigation
	Pedestrian Safety Improvement
	Transit Access
	Capacity Preservation
	Bicycle Access

## Methodology

The study is broken down into three phases. Phase I is the problem diagnosis and brainstorming alternatives, Phase II is the alternative evaluation and sketch level analysis, and Phase III is the investment strategy and cost estimates. Details on methods and solutions for each study phase are outlined below in **Figure 2**.

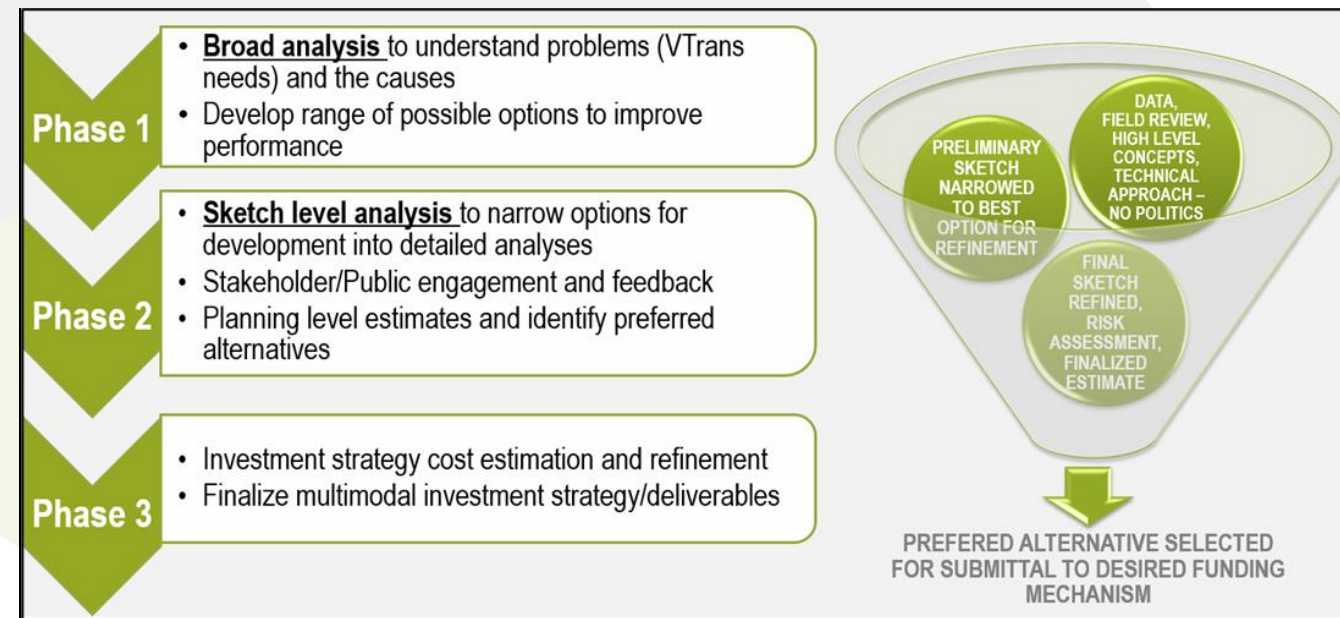


Figure 2: Study Phase Methods and Solutions

The study team is broken down into Technical Teams to improve the efficiency and effectiveness of the study process through extensive collaboration and synchronicity. To achieve the intended efficiency and consistency, it is generally expected that the same Technical Team will be responsible for all studies within a district for the duration of the cycle.

Each Technical Team will include certain leadership and technical roles that will be needed for each study, including the following:

- VDOT District Planning Project Manager – Provides leadership and direction; has overall responsibility for the study progress and outcomes.
- Consultant Team Manager – Provides direct support to the VDOT District Planning Project Manager; coordinates the work and technical efforts of consultant staff.
- District Planning Staff – Provides technical input regarding capacity, forecasting, land use, multimodal, and planning.
- District Traffic Engineering Staff – Provide technical input regarding safety and operations.

- Consultant Team Technical Staff – Provides multidisciplinary input, analysis, technical support, and expertise for the identified VTrans need categories.

A sample organizational chart, including the roles, responsibilities, and structure of a Technical Team is shown below in **Figure 3**.



Figure 3: Structure of a Technical Team

Additional team members and roles should be considered where appropriate. Certain roles may not be necessary for all studies. However, the following roles may contribute to study success during different stages and/or for different types of study areas, as shown in **Table 2**.

Table 2: Roles and Responsibilities for the Technical Team and SWGs

Phase	Responsibility	Role					
		OIPI/Program Support	District	Consultant	DRPT	Locality	VDOT Central Office
Study Selection & Initiation	Identify Study Needs and Priorities		X		X	X	
	Coordinate with CTB Members	X	X				
	Approve final study locations	X					
	Data Collection Planning		X				
	Data Dashboards	X					
	Assign Consultants & Issue Consultant Task Orders	X					X
Phase 1	Initiate Study & Hold Kickoff Meeting		X	X	X		
	Prepare Framework Document		X	X			
	Approve Framework Document		X		X	X	
	Provide Existing Data		X		X	X	
	Collect New Data			X			
	Coordinate with local leaders					X	
	Conduct & Support Initial Public Outreach (if desired)	X	X	X		X	X
	Diagnose Existing Needs			X			
	Brainstorm & Develop Preliminary Alternatives		X	X	X		X
	Present Diagnosis & Alternatives to SWG			X			
	Provide Feedback and Input on Analysis & Alternatives					X	
	Develop Phase 2 Scope of Work			X			
Approve Scope & Issue Consultant Task Orders	X					X	
Phase 2	Conduct Detailed Analysis of Alternatives			X			
	Develop Refinements to Alternatives		X	X	X		X
	Present Alternative Analysis Findings to SWG		X	X			
	Provide Feedback on Alternatives				X	X	X
	Prepare Planning Level Cost Estimates			X			
	Conduct & Support Public Outreach on Alternatives	X	X	X		X	
	Concurrence on Preferred Alternative(s)		X		X	X	X
	Develop Phase 3 Scope of Work			X			
Approve Scope & Issue Consultant Task Orders	X					X	
Phase 3	Conduct Alternative Risk Assessment		X	X			X
	Develop Practical Concept Design & Address Risk of Preferred Alternative		X	X			
	Prepare Cost Estimate with Workbook			X			
	Document Assumptions & Basis of Cost			X			
	Review & Concur with Concept & Estimate		X		X		X
Investment, Application, & Closeout	Prepare Final Study Deliverables, Design Packages, and Estimates			X			
	Apply for Funding of Preferred Alternative(s)				X	X	
	Application Support	X	X	X			
	Submit and Documentation and All Related Work			X			
	Review and approve final deliverables for public visibility		X		X		
Program Closeout and Summary	X						



## Study Area

The study corridor is U.S. Route 1 (Jefferson Davis Drive) from the Southern County Line with Hanover County to the Northern County Line with Spotsylvania County. The study limit is 14.87 miles, and it runs in the north-south direction. According to the VDOT's functional classification map, U.S. Route 1 is an *Other Principal Arterial*. The speed limit along the corridor ranges from 45 miles per hour (MPH) to 55 MPH. During the stakeholder meetings, 12 intersections were identified to be analyzed along the corridor. A map detailing the locations of the study intersections along U.S. Route 1 is shown in **Figure 4**.

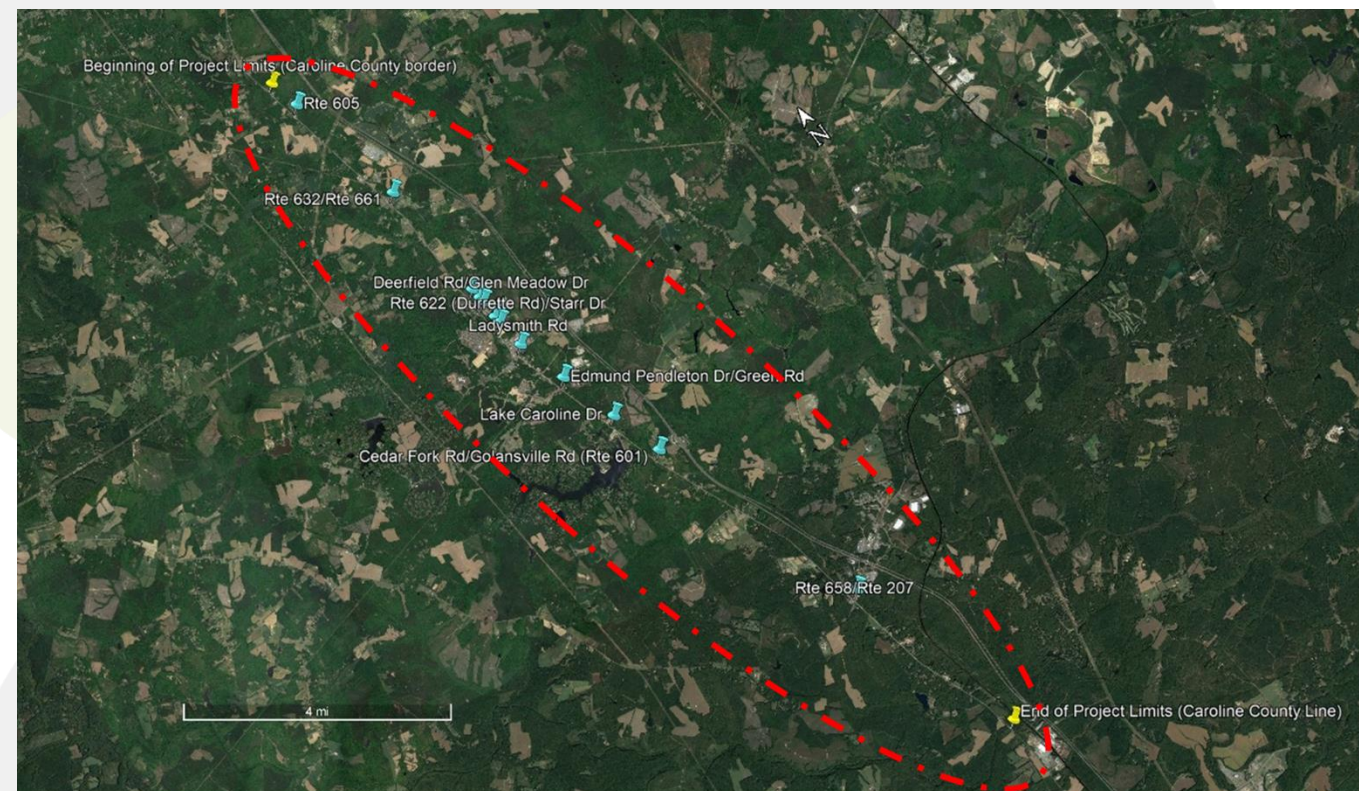


Figure 4: U.S. Route 1 Study Area Map

The study intersections along U.S. Route 1 are as follows:

1. Jericho Road (Route 658)/Roger Clark Boulevard (Route 207) (**signalized**)
2. Cedar Fork Road/Golansville Road (Route 601) (unsignalized)
3. Lake Caroline Drive (unsignalized)
4. Edmund Pendleton Drive/Green Road (Route 712) (unsignalized)
5. Ladysmith Road (Route 639) (**signalized**)
6. Durette Road (Route 622)/Starr Drive (unsignalized)
7. Clara Smith Street (unsignalized)
8. Deerfield Road/Glen Meadow Drive (unsignalized)
9. Ladysmith Common Boulevard (unsignalized)
10. Pine Tree Drive (unsignalized)
11. Quarters Road/Cedon Road (Route 632/Route 661) (unsignalized)
12. Marye Road/Paige Road (Route 605) (unsignalized)

The unsignalized intersections operate as two-way stop control (TWSC), with U.S. Route 1 operating as the free-flow road and the side streets are stop controlled.

VTrans is Virginia's statewide transportation plan. It identifies and prioritizes locations with transportation needs using data-informed transparent processes. The policy for identifying VTrans mid-term needs establish multimodal need categories that correspond to the Commonwealth Transportation Board-adopted VTrans visions, goals, and objectives.<sup>1</sup> Each need category has one or more performance measures and thresholds to identify one or more needs. Visit the VTrans policy guide for additional information: [https://vtrans.org/resources/VTrans\\_Policy\\_Guide\\_v6.pdf](https://vtrans.org/resources/VTrans_Policy_Guide_v6.pdf).

These mid-term needs, identified in VTrans, are prioritized as Low, Medium, High, and Very High. These mid-term needs are updated every two years. The 2021 mid-term needs identified in VTrans for the U.S. Route 1 study corridor were "Very High" for Pedestrian Safety Improvement, "High" for Bicycle Access and Pedestrian Access, and "Medium" for Capacity Preservation, Safety Improvement, and Transit Access, as presented in **Table 3**.

<sup>1</sup> Commonwealth Transportation Board, Actions to Approve the 2019 VTrans Vision, Goals, Objectives, Guiding Principles and the 2019 Mid-term Needs Identification Methodology and Accept the 2019 Mid-term Needs, January 15, 2020

Table 3: VTrans Needs within the Study Area

VTRANS IDENTIFIED NEEDS	PRIORITIES
Bicycle Access	High
Capacity Preservation	Medium
Congestion Mitigation	Select
IEDA (UDA) Access	Select
Pedestrian Access	High
Safety Improvement	Medium
Pedestrian Safety Improvement	Very High
Reliability	Select
Rail On-time Performance	Select
Transit Access	Medium
Transit Access for Equity Emphasis Areas	Select
Transportation Demand Management	Select

- Control Delay (measured in seconds per vehicle – sec/veh)
- Level of service (LOS)
- 95<sup>th</sup> Percentile Queue Length (measured in feet – ft.)

LOS is a quantitative measure to characterize operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. LOS is directly related to the control delay.

## Traffic Operations and Accessibility:

Traffic operational analysis was performed using Synchro, version 11, for all study intersections along the U.S. Route 1 corridor. Inputs and analysis methodologies are consistent with the VDOT Traffic Operations and Safety Analysis Manual (TOSAM) 2.0 guidelines.

Due to the ongoing construction at the intersection of U.S. Route 1 at Ladysmith Road, JMT was directed by VDOT to model the final roadway geometry after construction (applied improvements) as the existing condition. The final construction plan for the roadway and signal plan were provided to JMT by the VDOT inspector on site during the field review.

Signal timing plans were provided by VDOT. Since the intersection of U.S. Route 1 at Ladysmith Road is under construction as of summer 2023, JMT used the field observed cycle lengths, and optimized the splits for the existing condition analysis.

## Traffic Data

Turning movement counts, from 7:00 AM – 7:00 PM, was conducted by National Data and Surveying Services (NDS) on Tuesday, May 17, 2023, at the 12 study intersections. These counts were obtained while Caroline County schools were still in session. Pedestrian traffic was also included in the traffic counts. The universal AM and PM peak hours for the intersections were determined from the turning movement counts. The universal peak hours are 7:30 AM – 8:30 AM, and 4:30 PM – 5:30 PM, for the AM and PM peak hours, respectively. The raw traffic data is provided in **Appendix A**.

## Measures of Effectiveness (MOEs)

For the purposes of this study, guidance for reporting MOEs for signalized and unsignalized intersections was obtained from the VDOT’s TOSAM, Version 2.0. A summary of the MOEs evaluated for the study intersections are as follows:

## Traffic Operations Analysis Results

JMT utilized Synchro and SimTraffic to model the existing conditions for the intersections in the study area. The universal peak hour volumes for both the AM and PM peak hours were used for the analysis. The peak hour factor (PHF), peak hour volumes, and heavy vehicle percentages (HV%) were coded for each movement for both the AM and PM peak hour models. The models were calibrated based on the maximum queue length at each movement from field observations. The maximum queue from SimTraffic was compared to maximum field observed queues. VDOT’s TOSAM 2.0 was used to determine if the models were calibrated. While TOSAM does not give specific thresholds to determine calibrated models, it does state visually acceptable maximum queue lengths are represented at critical locations. The control delays (s/veh) and LOS were reported from Synchro using Highway Capacity Manual (HCM) Methodology and the 95<sup>th</sup> percentile queue lengths (ft.) were reported from SimTraffic.

The result of the operational analysis shows that all 12 study intersections are operating at an acceptable overall intersection LOS of D or better during both the AM and PM peak hours. The queue lengths at the signalized intersections do not exceed the available storage lane lengths on all approaches. The analysis results of Delay, LOS, and queues are presented in **Table 4**. Any LOS that was reported as “D”, “E”, or “F” have been shown in the table as **yellow**, **orange**, and **red**, respectively. During the AM peak hour, for the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard, the northbound traffic operates at LOS E for all the movements, and the southbound through movement and right-turn movement operate at LOS E. During the PM peak hour, the eastbound shared through and right-turn movement, and the approach operate at LOS E. The westbound shared through and right-turn movement operates at LOS E. **The SimTraffic simulation showed the traffic always clears the intersection during each cycle at the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard.** The Synchro and SimTraffic reports for the existing condition are included in **Appendix B**.

Table 4: Existing Condition Synchro Analysis Results Summary

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	EXISTING CONDITION						
					AM PEAK			PM PEAK			
					Delay (S/Veh)	LOS	95th Percentile Queue (ft)	Delay (S/Veh)	LOS	95th Percentile Queue (ft)	
1 (Signalized)	Jericho Road	Eastbound	L		16.5	B	38	50.6	D	27	
			TR		22.5	C	126	57.3	E	153	
			Approach Delay		21.6	C	-	56.7	E	-	
	Rogers Clark Boulevard	Westbound	LU		13.7	B	86	39.9	D	129	
			TR		20.3	C	64	57	E	254	
			Approach Delay		18.2	B	-	53.2	D	-	
	U. S. Route 1	Northbound	LU	225	57.1	E	39	19.2	B	28	
			TH		63.8	E	28	23.7	C	59	
			R	150	62.6	E	22	23.3	C	23	
		Approach Delay		61.4	E	-	23.1	C	-		
		Southbound	L	400	48.4	D	78	16.6	B	57	
			TH		58	E	36	21	C	21	
	R		200	56.1	E	14	20.5	C	1		
Approach Delay		53.2	D	-	18.8	B	-				
Overall Delay					34.6	C	-	36	D	-	
2 (Unsignalized)	Cedar Fork Road	Eastbound	LTR		11.4	B	-	13.3	B	-	
			Approach Delay		11.4	B	-	13.3	B	-	
	Golansville Road	Westbound	LTR		10.1	B	-	11.4	B	-	
			Approach Delay		10.1	B	-	11.4	B	-	
	U.S. Route 1	Northbound	LT		0	A	-	0	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
		Southbound	LT		1	A	-	2.1	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0.7	A	-	1.1	A	-	
Overall Delay					1.4	A	-	1.7	A	-	
3 (Unsignalized)	Lake Caroline Drive	Eastbound	LR		12.2	B	-	20.9	C	-	
			Approach Delay		12.2	B	-	20.9	C	-	
	U.S. Route 1	Northbound	LT		2.2	A	-	4.5	A	-	
			T		0	A	-	0	A	-	
			Approach Delay		0.9	A	-	2.2	A	-	
		Southbound	T		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
Overall Delay					5.4	A	-	4.7	A	-	
4 (Unsignalized)	Edmund Pendleton Drive	Eastbound	LT		12.4	B	-	18.4	C	-	
			TR		13.3	B	-	14.7	B	-	
			Approach Delay		13	B	-	16.7	C	-	
	Green Road	Westbound	LTR		13.3	B	-	20.4	C	-	
			Approach Delay		13.3	B	-	20.4	C	-	
	U.S. Route 1	Northbound	LT		1.1	A	-	1.4	A	-	
			T		0	A	-	0	A	-	
			Approach Delay		0.3	A	-	0.4	A	-	
		Southbound	LT		0.9	A	-	0.7	A	-	
			T		0	A	-	0	A	-	
			Approach Delay		0.3	A	-	0.2	A	-	
	Overall Delay					3	A	-	4.2	A	-

Table 4: Existing Condition Synchro Analysis Results Summary (cont.)

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	EXISTING CONDITION					
					AM PEAK			PM PEAK		
					Delay (S/Veh)	LOS	95th Percentile Queue (ft)	Delay (S/Veh)	LOS	95th Percentile Queue (ft)
5 (Signalized)	Ladysmith Road	Eastbound	L	225	30.9	C	106	35.4	D	110
			TH		27.4	C	155	27.5	C	101
			R	200	17.5	B	22	18	B	27
		Approach Delay		27.1	C	-	28.3	C	-	
		Westbound	L	625	37.1	D	24	26.9	C	78
			TH		32	C	102	31.1	C	171
	R		600	20.1	C	42	18.7	B	52	
	Approach Delay		28.5	C	-	28.4	C	-		
	U.S. Route 1	Northbound	L	325	24.6	C	91	23.4	C	92
			TH		32.2	C	84	33.1	C	105
			R	500	25.9	C	34	23.5	C	39
		Approach Delay		28.9	C	-	28.9	C	-	
		Southbound	L	650	20.5	C	148	22.8	C	107
T				27.9	C	79	31.7	C	101	
R			712	17.7	B	39	22.5	C	51	
Approach Delay			21.9	C	-	26.2	C	-		
Overall Delay					26.4	C	-	27.9	C	-
6 (Unsignalized)	Durette Road	Eastbound	LTR		10.2	B	-	11.5	B	-
			Approach Delay		10.2	B	-	11.5	B	-
	Starr Drive	Westbound	LT		15.4	C	-	25.5	D	-
			Approach Delay		9.2	A	-	10.2	B	-
	U.S. Route 1	Northbound	R		13.4	B	-	19.5	C	-
			Approach Delay		1.6	A	-	1.9	A	-
			LT		0	A	-	0	A	-
		Southbound	TR		0.8	A	-	1	A	-
			Approach Delay		0.3	A	-	0.9	A	-
			L		0	A	-	0	A	-
T		0	A	-	0	A	-			
R		0	A	-	0	A	-			
Approach Delay		0.1	A	-	0.3	A	-			
Overall Delay					1.6	A	-	2.1	A	-
7 (Unsignalized)	Clara Smith Street	Eastbound	L		12.7	B	-	18.4	C	-
			R		9.3	A	-	9.8	A	-
			Approach Delay		10.4	B	-	12.3	B	-
	U.S. Route 1	Northbound	L		8	A	-	8.6	A	-
			TH		0	A	-	0	A	-
		Approach Delay		0.8	A	-	1.4	A	-	
		Southbound	TH		0	A	-	0	A	-
Approach Delay			0	A	-	0	A	-		
Overall Delay					1.6	A	-	1.4	A	-
8 (Unsignalized)	Deerfield Road	Eastbound	LTR		9.8	A	-	10.8	B	-
			Approach Delay		9.8	A	-	10.8	B	-
	Glen Meadow Drive	Westbound	LTR		11.3	B	-	15.3	C	-
			Approach Delay		11.3	B	-	15.3	C	-
	U.S. Route 1	Northbound	LT		1	A	-	1	A	-
			T		0	A	-	0	A	-
			Approach Delay		0.4	A	-	0.4	A	-
		Southbound	LT		0.1	A	-	0.3	A	-
			TR		0	A	-	0	A	-
			Approach Delay		0	A	-	0.1	A	-
Overall Delay					0.9	A	-	0.7	A	-

Table 4: Existing Condition Synchro Analysis Results Summary (cont.)

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	EXISTING CONDITION						
					AM PEAK			PM PEAK			
					Delay (S/Veh)	LOS	95th Percentile Queue (ft)	Delay (S/Veh)	LOS	95th Percentile Queue (ft)	
9 (Unsignalized)	Ladysmith Common Boulevard	Westbound	L		11.9	B	-	14.7	B	-	
			R		9.9	A	-	9.6	A	-	
			Approach Delay		11.6	B	-	13.6	B	-	
	U.S. Route 1	Northbound	TH		0	A	-	0	A	-	
			R		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
		Southbound	L		7.9	A	-	8.3	A	-	
			TH		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
	Overall Delay					0.3	A	-	0.5	A	-
10 (Unsignalized)	Pine Tree Drive	Eastbound	TL		10.3	B	-	12.6	B	-	
			Approach Delay		10.3	B	-	12.6	B	-	
	U.S. Route 1	Northbound	LT		0.6	A	-	1.8	A	-	
			TH		0	A	-	0	A	-	
			Approach Delay		0.2	A	-	0.7	A	-	
		Southbound	TH		0	A	-	0	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
	Overall Delay					0.5	A	-	0.8	A	-
	11 (Unsignalized)	Cedon Road	Eastbound	LTR		10.4	B	-	12.4	B	-
Approach Delay					10.4	B	-	12.4	B	-	
Westbound		LTR		12.5	B	-	14.8	B	-		
		Approach Delay		12.5	B	-	14.8	B	-		
U.S. Route 1		Northbound	LT		0.2	A	-	0.9	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0.1	A	-	0.5	A	-	
		Southbound	T		0	A	-	0	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0	A	-	0	A	-	
Overall Delay					0.8	A	-	0.8	A	-	
Cedon Road		Westbound	LTR		9.8	A	-	13	B	-	
Quarters Road		Eastbound	LTR		10	A	-	11.4	B	-	
			Approach Delay		10	A	-	11.4	B	-	
U.S. Route 1	Northbound	LT		0.4	A	-	1.4	A	-		
		T		0	A	-	0	A	-		
		Approach Delay		0.2	A	-	0.5	A	-		
	Southbound	LT		0.3	A	-	0.4	A	-		
		TR		0	A	-	0	A	-		
		Approach Delay		0.1	A	-	0.2	A	-		
Overall Delay					0.7	A	-	0.7	A	-	
12 (Unsignalized)	Marye Road	Eastbound	LTR		11.3	B	-	15	B	-	
			Approach Delay		11.3	B	-	15	B	-	
	Paige Road	Westbound	LTR		10.9	B	-	12.7	B	-	
			Approach Delay		10.9	B	-	12.7	B	-	
	U.S. Route 1	Northbound	LT		0.1	A	-	1	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		0.1	A	-	0.5	A	-	
		Southbound	LT		1.7	A	-	2.3	A	-	
			TR		0	A	-	0	A	-	
			Approach Delay		1	A	-	1.3	A	-	
Overall Delay					2	A	-	2.3	A	-	

## Pedestrian, Bicycle, and Transit Access

To identify the needs with respect to accessibility, the study team reviewed existing conditions of pedestrian and bicycle accommodations. JMT did not observe any pedestrian activity along the study corridor during the field review. U.S. Route 1 has no pedestrian accommodations along the corridor, except the NE quadrant of Ladysmith Road intersection. However, according to the Caroline County Transportation Plan, a sidewalk is planned along U.S. Route 1 between Caroline County/Hanover County line and Telegraph Road, and between CCC Road (Route 683) and Gatewood Road. As part of the improvements at U.S. Route 1 at Ladysmith Road intersection, crosswalks across all legs of the intersection will be installed. Additionally, a 10-foot shared-use path will be installed on the south side along Ladysmith Road from 0.15 mile west of U.S. Route 1 to 0.84 mile east of U.S. Route 1, which will connect to the south leg crosswalk. A 5-foot sidewalk will be installed on the north side along Ladysmith Road from 0.15 mile west of U.S. Route 1 to 0.84 mile east of U.S. Route 1, which will connect to the north leg crosswalk. This will improve the pedestrian access and safety at the retail stores along Ladysmith Road.

No bike activities were observed along the study corridor. U.S. Route 1 has no bike accommodations along the corridor. According to the East Coast Greenway mapping tool, U.S. Route 1, between Caroline County/Hanover County line and Jericho Road/Roger Clark Boulevard, and between Telegraph Road and Cedar Fork Road/Golansville Road, is a shared on-road bike route. However, no bike route signs were observed along U.S. Route 1 during the field review. There is a bike route sign along Cedon Road. The sign is shown in **Figure 5**. The bike route on Cedon Road is not indicated in the East Coast Greenway mapping tool, as shown in **Figure 6**. The U.S. Route 1 corridor is not a bus route; therefore, transit stops were not observed along U.S. Route 1. In addition, the Carmel Church Park-n-Ride lot was observed during the field visit. Only one vehicle was parked for the entirety of the field visit.



Figure 5: Cedon Road Bike Route Sign (Photo captured July 2023)

During the existing condition technical meeting, Caroline County mentioned there is a plan to move the Carmel Church Park and Ride location south of Jericho Road/Roger Clark Boulevard, along U.S.

Route 1. Also, according to the Caroline County Transportation Plan, a Carmel Church Rail Station is being proposed along the existing CSX rail line. A Transit Oriented Development Study report, dated October 2008, was prepared by Michael Baker Jr., Inc. for Caroline County. The report placed the access to the proposed station and parking at approximately 1.2 miles south of Jericho Road/Roger Clark Boulevard, along U.S. Route 1. VDOT indicated this access might be too far from the I-95 interchange.

## Access Management

There is a total of 251 access points in the northbound and southbound directions located within the 14.87-mile segment of U.S. Route 1, averaging 16.88 access points per mile. Most of these access points are driveways, turn lanes to parking lots, and minor roadways that are not part of the 12 identified intersections, as shown in **Figure 7**. There are a few access points located near the study intersections, however the vast majority are located on the main corridor, away from the 12 study intersections.

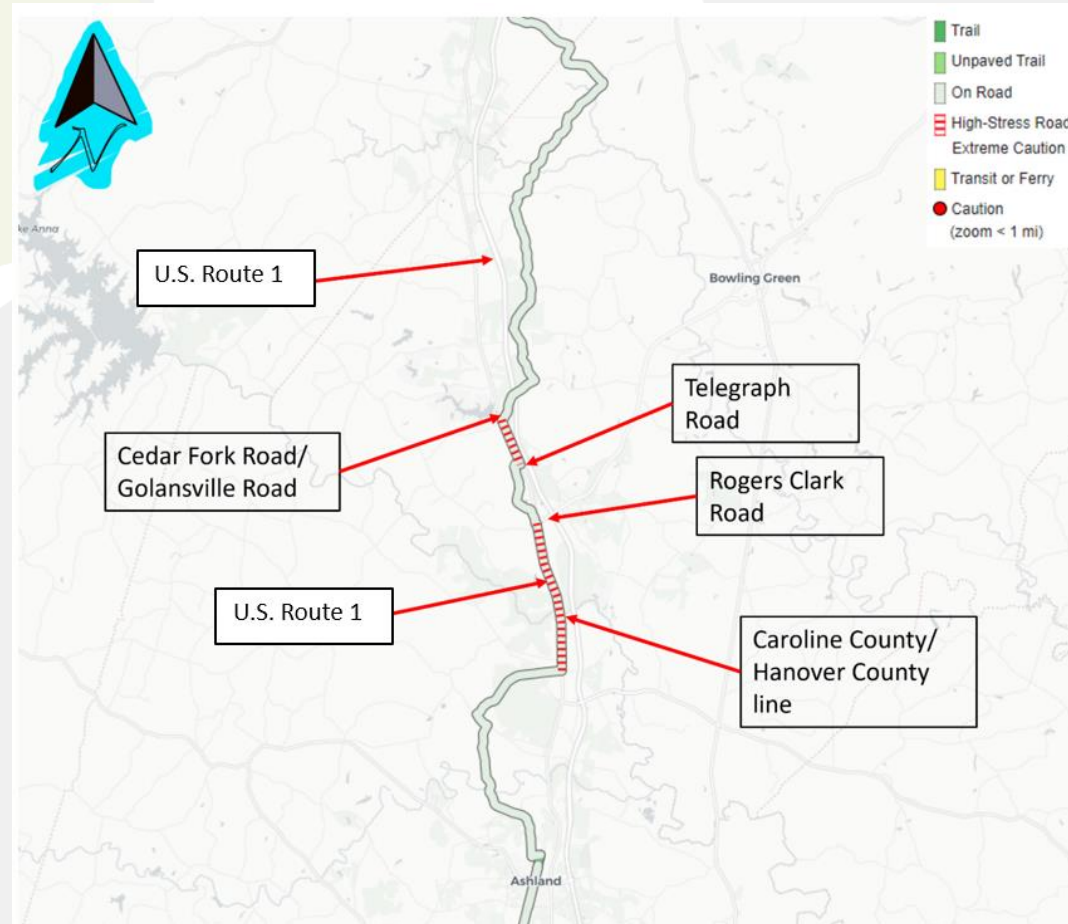


Figure 6: East Coast Greenway Bicycle Route

Most of the crashes that occurred near an access point were either angle or rear end crashes. Of the 134 angle crashes and 63 rear end crashes that occurred along the study corridor, 17 angle crashes and 22 rear end crashes were located at access points that are not part of an intersection. While most of these crashes were scattered throughout the access points along the corridor, there was one location that had a significantly higher rate of crashes. Seven angle crashes occurred in Hotspot 3 from the crash analysis, the entrance of a shopping center north of the intersection of U.S. Route 1 at Ladysmith Road. This appears to be the only access point that has a strong correlation between the number of crashes and access management issues. While it is not fully known if access spacing is a result of these crashes, it should be noted that at most of the access points where a crash occurred, there was no designated turn lane, or two-way left-turn lane median.



Figure 7: Access Point along U.S. Route 1

## STEAP Analysis

A screening tool for equity analysis of projects (STEAP) report from FHWA was developed for the U.S. Route 1 corridor within the study limits. This tool provides estimates of the socioeconomic characteristics of the population surrounding a project location. The statistical categories reported relate to race, ethnicity, age, sex, household size and income, and household vehicle ownership. This analysis helps

to identify disadvantaged population size and characteristics, to determine if any accommodation needs to be provided in any of the proposed alternatives. The data source used for the analysis was the

American Community Survey 2016 – 2020 and a 0.5-mile radius was used for the analysis buffer size. The general demographic of the project location with a 0.5-mile buffer size compared to the Caroline County and state of Virginia is presented in **Table 5** and a map showing the depicted buffer size coverage around the study corridor is presented in **Figure 8**.

Table 5: STEAP Analysis Area Statistics

General Buffer Area Statistics	Estimates		
	0.5-mile	Caroline County	Virginia
Land Area (in square miles)	15	527	39,482
Population	2,430	30,581	8,509,358
Housing Units	1,025	12,322	3,537,788
Households	938	10,978	3,184,121
Families	632	7,911	2,103,100

The results of the STEAP tool analysis are as follows:

- Most of the population (55%) within the study area is between ages 18 and 64, as shown in **Figure 9**.
- Nearly 46% of households own three or more vehicles, which is higher than Caroline County and the state of Virginia. As shown in **Figure 10**, all the households in the 0.5-mile buffer size of the project location own at least one personal vehicles.
- Of the non-English speakers (age 5+) at home, only one percent of the population within the 0.5-mile buffer size do not speak English at all, as shown in **Figure 11**.
- The result shows 39% have household income greater than \$75,000, followed by household income between \$50,000 and \$75,000, as shown in **Figure 12**. This trend is similar in Caroline County and the state of Virginia.
- When compared to Caroline County, the study area has a lower average number of veterans, people with disabilities, households with no computers, and households without internet connection, as shown in **Figure 13**.

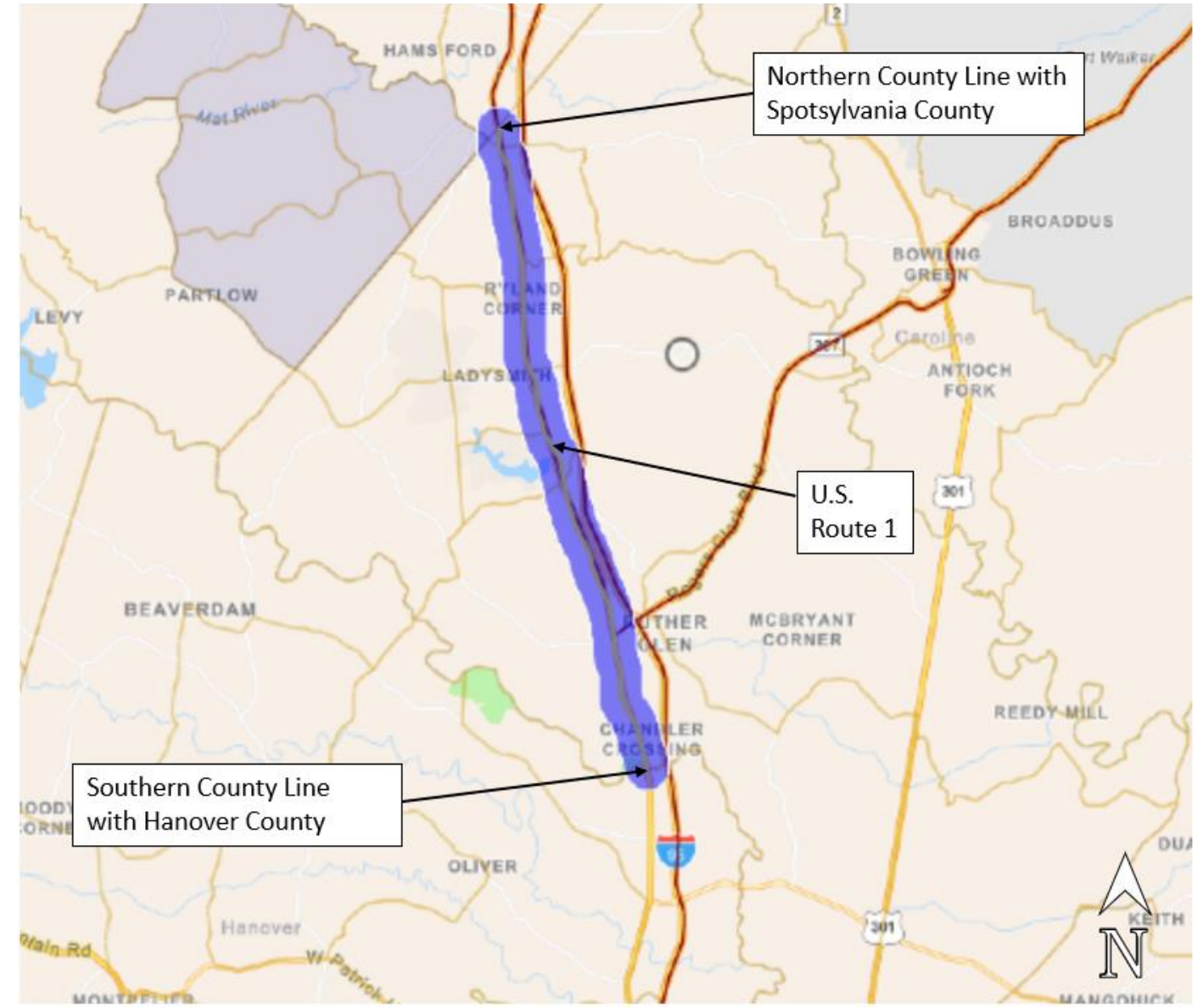


Figure 8: STEAP Analysis 0.5-Mile Buffer Size

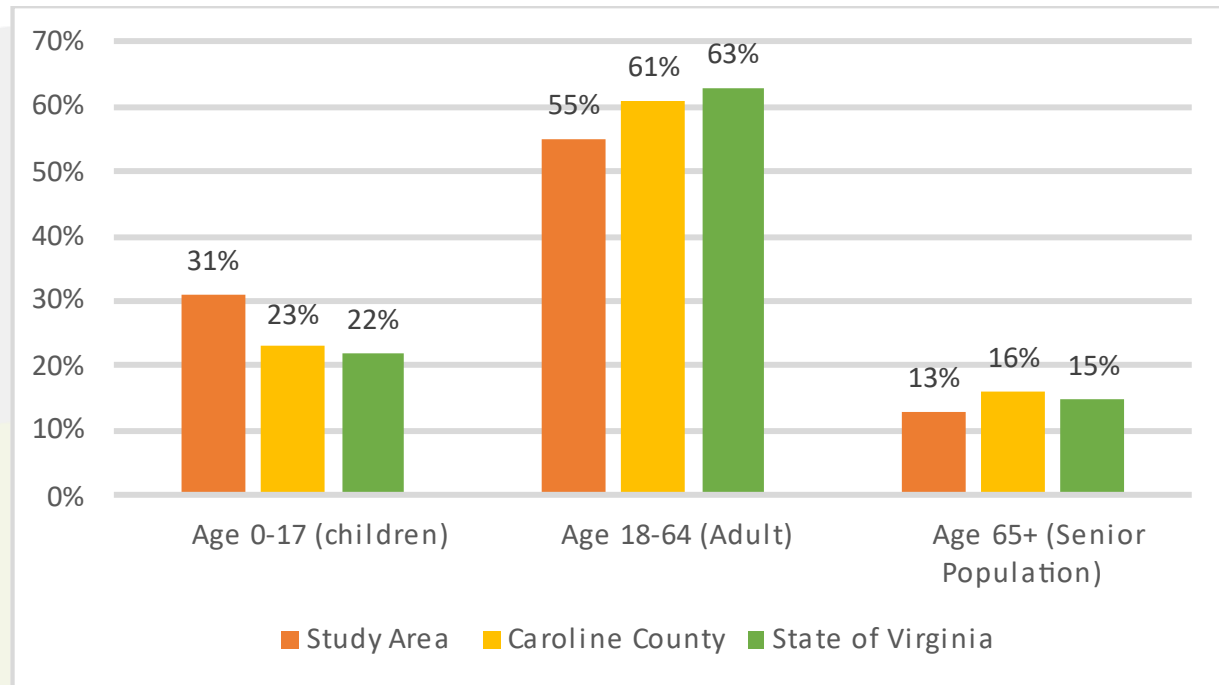


Figure 9: STEAP Analysis Result of Population by Age

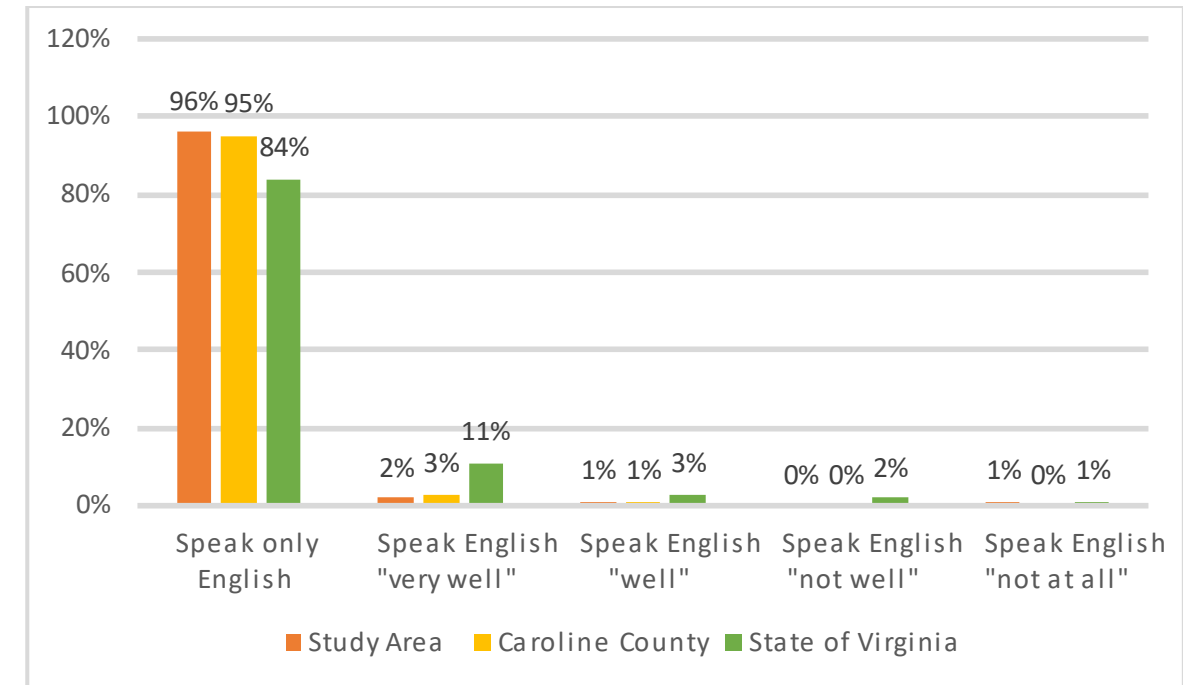


Figure 11: STEAP Analysis Results of Population Age 5+ Years by Ability to Speak English

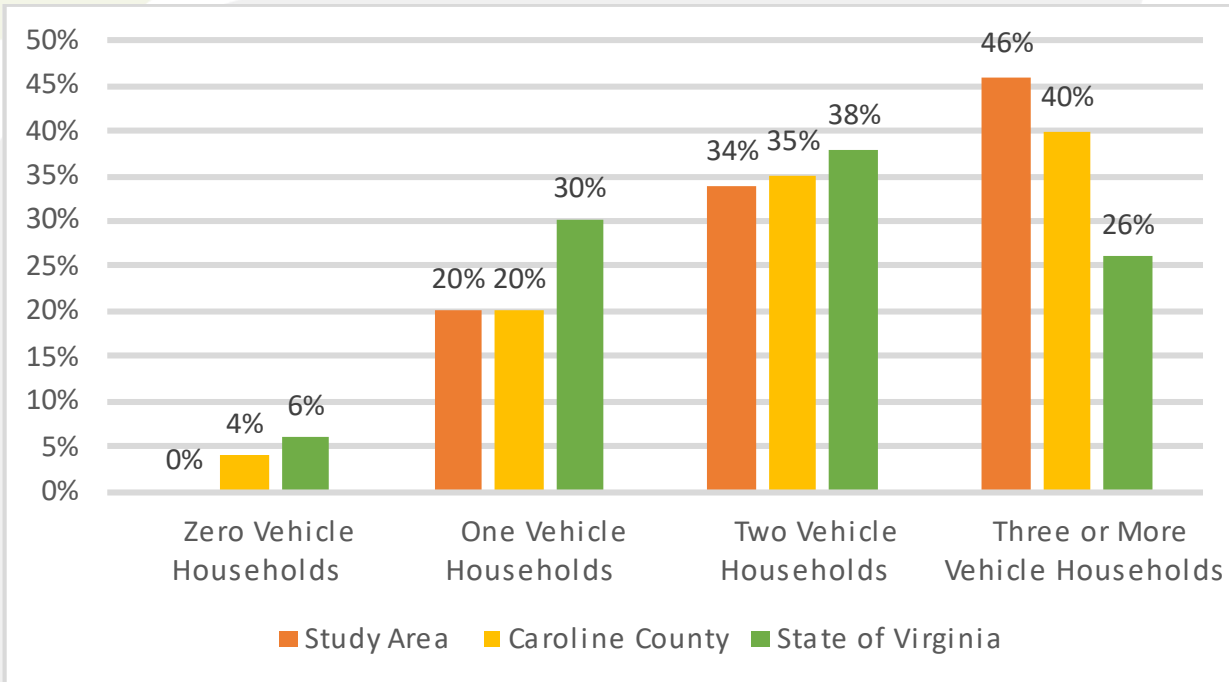


Figure 10: STEAP Analysis Result of Vehicle Ownership

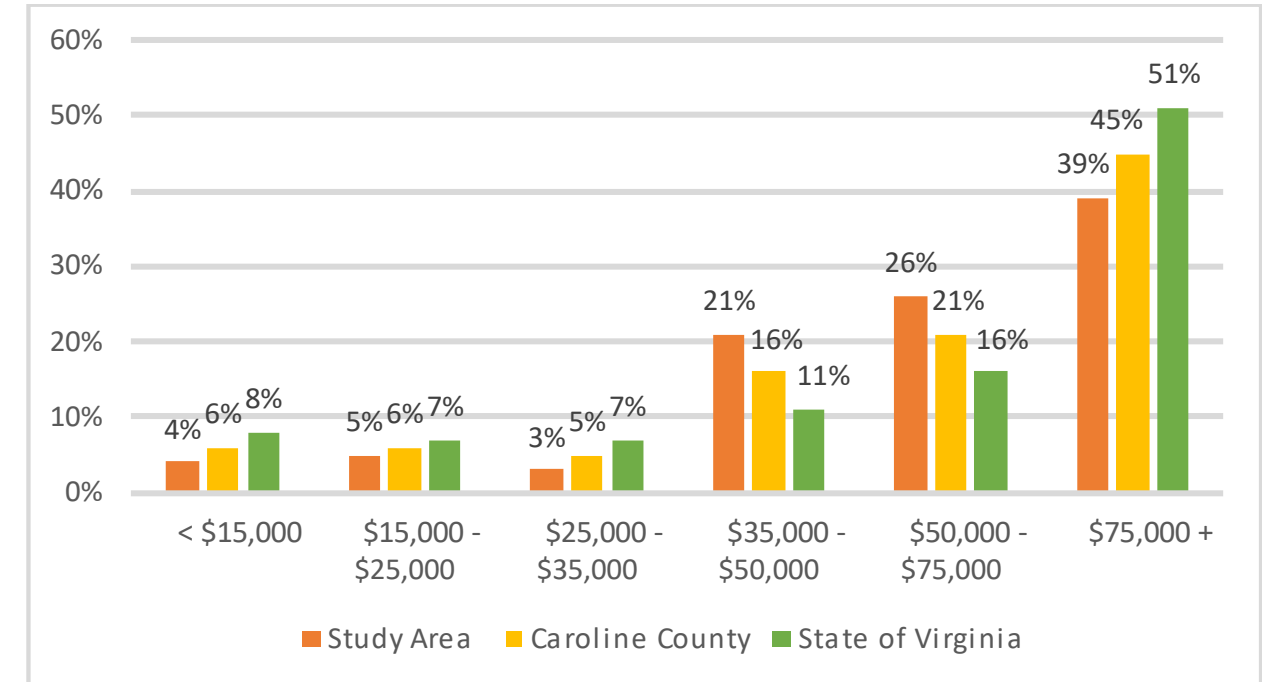


Figure 12: STEAP Analysis Result of Household Income

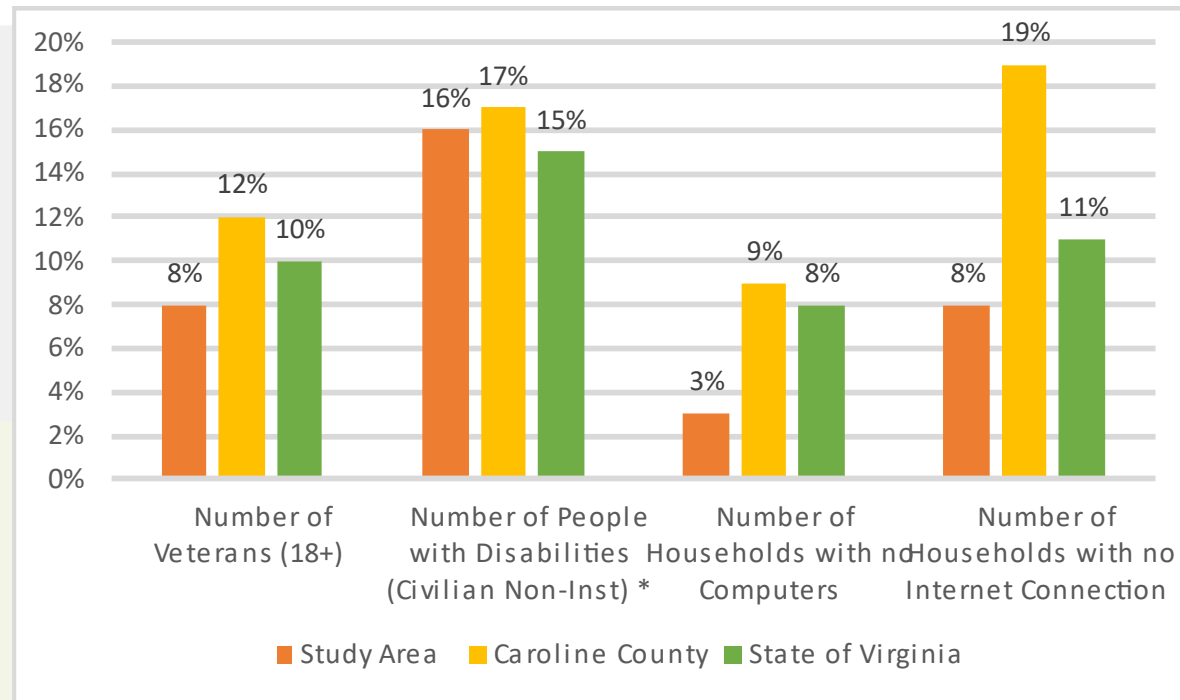


Figure 13: STEAP Analysis Result of Other Vulnerable Populations

## Field Review

JMT conducted a field visit on Thursday, July 13, 2023, to observe existing conditions during the universal AM and PM peak hours. The field review focused on intersection operations, travel pattern, signal timing cycle length and phasing. Queue lengths at all approaches of the signalized intersections along the study corridor were observed and collected. In addition, road geometry, lane configurations, signing and pavement conditions, and sight distances were collected outside the peak hour period along the study corridor. During the field review, center line and shoulder rumble strips were observed along the corridor. In addition, the Carmel Church Park and Ride lot, located close to the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard, was observed.

Major observations during the field review are as follows:

### Cedar Fork Road/Golansville Road

It is difficult for drivers to identify the presence of the intersection because it is located at the crest of a hill in the southbound direction. Additionally, the house located in the northeast quadrant of the intersection blocks the southbound drivers' view until they are approximately 125' from the intersection. In the northbound direction, it is difficult for drivers to identify the intersection due to the absence of a route name sign at the intersection, identifying the side streets.

### Edmund Pendleton Drive/Green Road

There is inadequate intersection sight distance in the eastbound direction (west leg of the intersection).

### Ladysmith Road

Ongoing roadway construction (Ladysmith Improvement project) along Ladysmith Road through the intersection. There is an anticipated completion date of late 2023/early 2024.

### Durrette Road (Route 622)/Starr Drive

A stop bar is not present on the eastbound direction (west leg of the intersection), it is optional to have it for the minor roadway. There is inadequate intersection sight distance in the westbound direction, looking left (east leg of the intersection).

### Deerfield Road/Glen Meadow Drive

There is a missing stop sign in the westbound direction (east leg of the intersection). There is inadequate intersection sight distance in the westbound direction, looking right (east leg of the intersection) – the sight is blocked by an advertisement board.

### Quarters Road/Cedon Road

The placement of the Route 632 sign has potential for driver confusion - it is facing Route 632 in the eastbound direction and Route 661 in the westbound direction. The layout and configuration of the intersection appears to cause drivers confusion. The intersection layout also makes it difficult to properly place the roadway directional signs.

### Marye Road/Paige Road

Intersection warning signs with flashers were observed to have been recently installed on U.S. Route 1 approaching the intersection in the northbound and southbound directions. Per VDOT, the flashers were installed due to safety issues at the intersection. The signs with flashers will help notify drivers on U.S. Route 1 of the presence of Marye Road/Paige Road. There is a stop bar missing in the eastbound direction (west leg of the intersection).



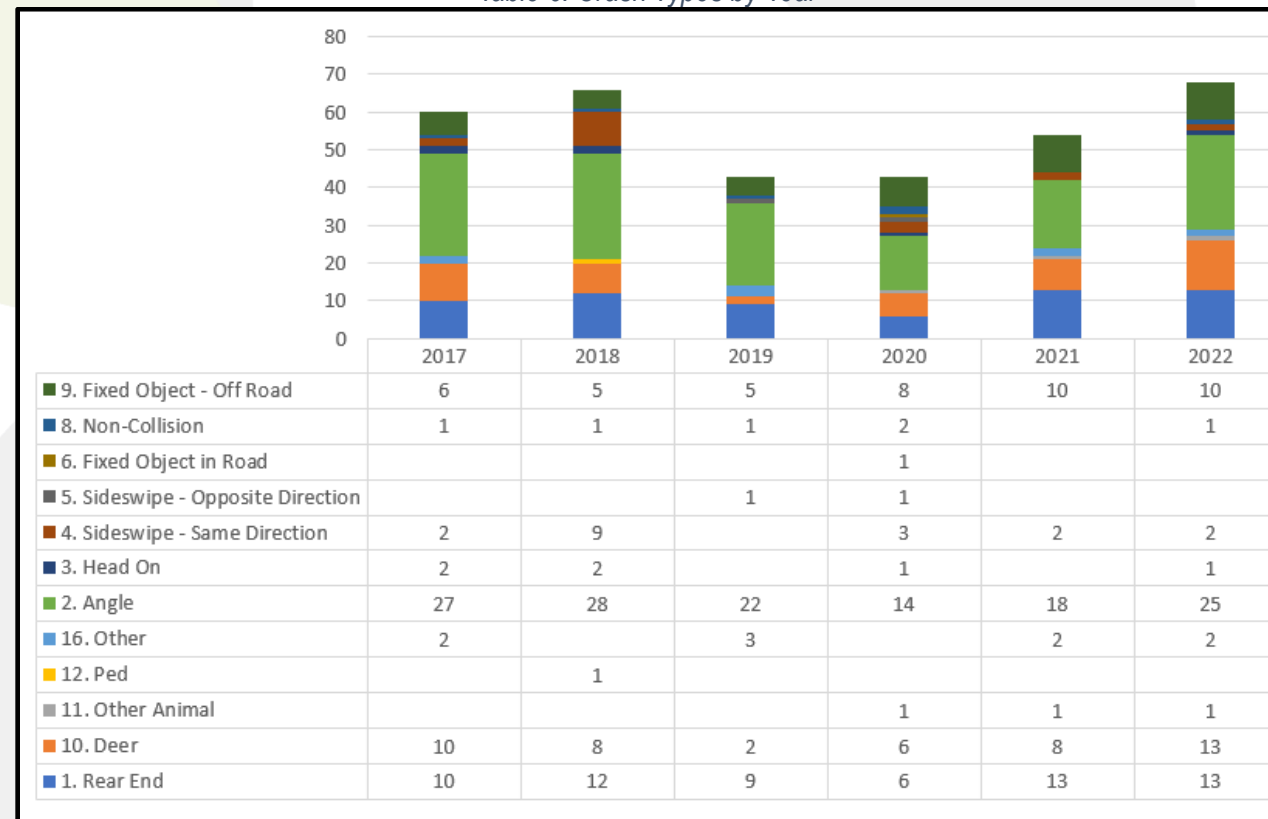
## Safety and Reliability

A crash analysis was conducted for the study corridor along U.S. Route 1, within the study limit. Crash data was collected from VDOT ArcGIS Crash Map, as well as the Project Pipeline Dashboard for a 6-year period, between January 1, 2017, and December 31, 2022. A six-year period was used in place of the standard five-year period to more accurately encompass the years affected by the COVID pandemic (2020, and 2021), and to increase the sample size of years unaffected by the pandemic.

## Safety Analysis Results

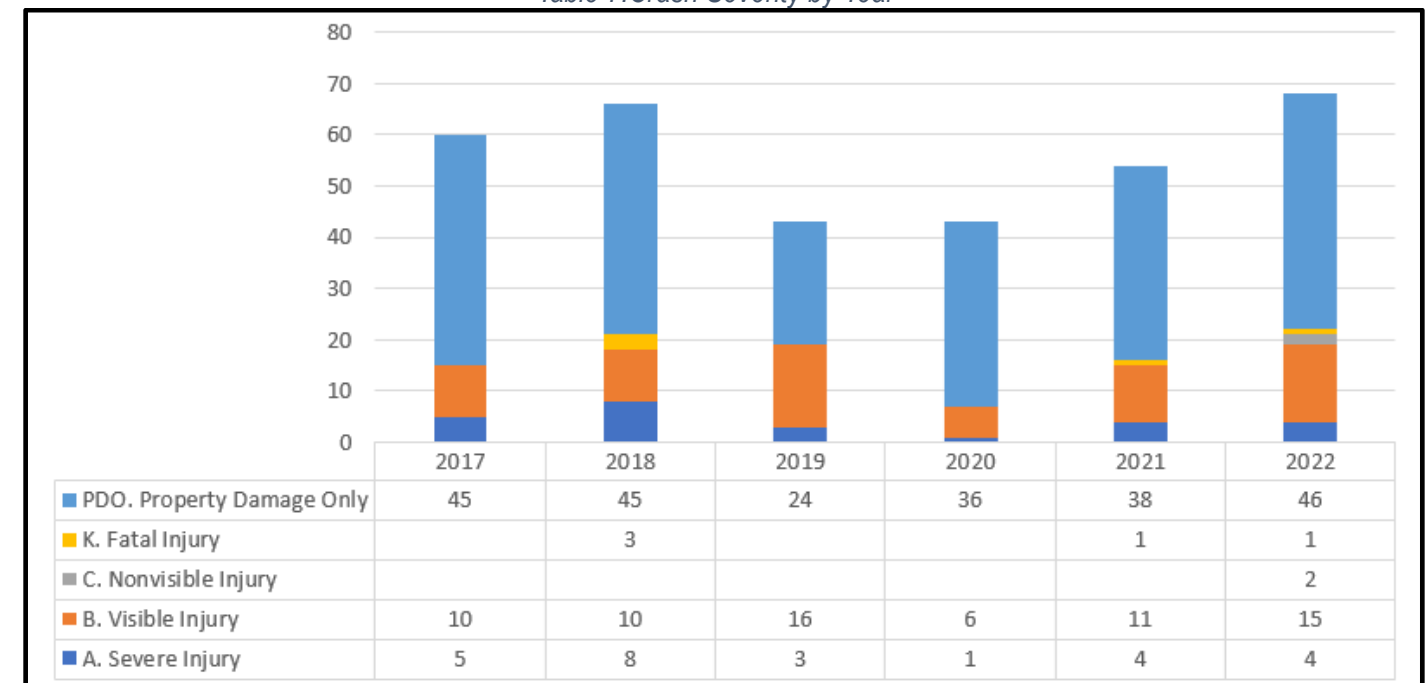
Review of the data showed a total of 334 crashes occurred along the segment over the 6-year period. Crashes per year are shown in **Table 6**.

Table 6: Crash Types by Year



**Table 7** shows crashes by severity for each analysis year. Crash data is categorized as K: Fatal injury, A: Serious Injury, B: Visible Injury, C: Nonvisible Injury, and PDO: Property Damage Only. Of the total crashes, 70% (234) of the crashes caused property damage only (PDO), and 28% of the crashes caused injuries. There were five fatal crashes reported within the six-year period. Three of the five fatal crashes occurred in 2018. Three of the fatal crashes occurred in the northbound direction.

Table 7: Crash Severity by Year



The crash history was also sorted by environmental factors, including lighting conditions, weather, and roadway surface conditions. **Table 8** shows that 86% of crashes occurred under clear weather, and 86% on dry pavement. Therefore, inclement weather, and inadequate pavement friction were not likely contributing factors for these crashes based on the crash data. Under lighting conditions, 60% occurred during daylight, and 30% (100 crashes) occurred when it was dark, and the road was not lighted. Lack of illumination is likely a contributing factor to the crashes along U.S. Route 1. In general, 51% of crashes occurred under normal conditions, and the remaining 49% of the crashes occurred under certain adverse conditions, especially lack of illumination.

Table 8: Crash History by Environment

US, 1Crash History by Environment 2017-2022																			
Crash Type	Lighting						Weather						Surface				Total		
	2. Daylight	1. Dawn	3. Dusk	4. Darkness - Road Lighted	5. Darkness - Road Not Lighted	6. Darkness - Unknown Road Lighting	1. No Adverse Condition (Clear/Cloudy)	3. Fog	4. Mist	5. Rain	6. Snow	9. Other	1. Dry	2. Wet	3. Snowy	4. Icy	9. Water (Standing, Moving)	Number	%
1. Rear End	47	1	1	3	11	0	52	0	0	9	1	1	52	9	1	0	1	63	19%
2. Angle	98	2	2	10	22	0	114	2	4	11	3	0	113	19	1	1	0	134	40%
3. Head On	4	0	0	1	1	0	5	0	0	1	0	0	5	1	0	0	0	6	2%
4. Sideswipe - Same Direction	13	0	0	1	4	0	16	0	1	1	0	0	16	2	0	0	0	18	5%
5. Sideswipe - Opposite Direction	1	0	0	0	1	0	2	0	0	0	0	0	2	0	0	0	0	2	1%
6. Fixed Object in Road	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0%
8. Non-Collision	5	0	0	0	1	0	6	0	0	0	0	0	6	0	0	0	0	6	2%
9. Fixed Object - Off Road	21	3	1	1	18	0	36	1	0	7	0	0	36	7	0	1	0	44	13%
10. Deer	8	2	2	1	34	0	44	1	0	2	0	0	45	2	0	0	0	47	14%
11. Other Animal	1	0	0	1	1	0	3	0	0	0	0	0	3	0	0	0	0	3	1%
12. Ped	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	0%
16. Other	3	1	0	0	5	0	6	0	0	3	0	0	6	3	0	0	0	9	3%
Total Frequency	201	9	6	18	100	0	286	4	5	34	4	1	286	43	2	2	1	334	
Total(%)	60%	3%	2%	5%	30%	0%	86%	1%	1%	10%	1%		86%	13%	1%	1%	0%		
% of Crashes occurred during a combination of daylight, clear weather, and dry surface conditions				40%			86%			14%			86%		14%				
							171												51%

The hotspot locations along U.S. Route 1 are:

- Hotspot 1: Approximately 0.31 miles south of the Northern County Line with Spotsylvania County (5 crashes)
- Hotspot 2: Approximately 0.50 miles south of Marye Road/Paige Road (5 crashes)
- Hotspot 3: Approximately 0.09 miles north of Ladysmith Road (9 crashes)
- Hotspot 4: Approximately 1.78 miles north of Jericho Road/Roger Clark Boulevard (5 crashes)

The crash types at these hotspot locations are summarized in **Table 9**.

Table 9: Hotspot Crash Type

Crashes	Hotspot 1	Hotspot 2	Hotspot 3	Hotspot 4
1. Rear End	2	1		3
2. Angle	1		7	
4. Sideswipe - Same Direction			1	
8. Non-Collision	1			
9. Fixed Object - Off Road		1	1	1
10. Deer	1	2		1
16. Other		1		

Based on the crash types at these hotspot locations, no crash pattern can be determined from the crashes, except at Hotspot 3, which is located at the entrance of a shopping center. A review of the crashes at hotspot 3 showed that six of the seven angle crashes occurred between the westbound driver turning left from the shopping center, and the northbound driver. All six crashes occurred during the daytime. A review of the location showed the shopping center sign blocks the view of the northbound driver from adequately noticing the entrance of the shopping center.

A heat map of the crashes showing the density along the corridor is presented in **Figure 14**.

Using the 2019 annual average daily traffic (AADT) of 6,325 veh/day from VDOT's database, the average crash rate along the study corridor was determined to be 162.16 crashes per 100 million vehicle-miles of travel (VMT). This crash rate is higher than the average state-wide crash rate of 82.13 crashes per 100 million VMT on roadways with the same functional classification (Other Principal Arterial) in 2019. Also, the crash rate on the study corridor is higher than the average crash rate of 129.23 crashes per 100 million VMT of all roadway types in the Fredericksburg District in 2019. This indicates that the study corridor has a higher crash rate than the average crash rate on roadways with the same functional classification (Other Principal Arterial) state-wide, and of all roadway types in the same district.

In addition, the crash rate per mile was determined to be 3.74 crashes per mile. Four hotspot locations along the corridor were observed. The hotspot locations were determined based on occurrence of five or more crashes within a 250-foot radius. The hotspot locations do not include intersection crashes. Intersection crashes are described in the following section.



Figure 14: U.S. Route 1 Corridor Crash Frequency Heatmap



In addition to the crashes along U.S. Route 1, crashes at each intersection are analyzed. A summary of the crash type at the intersections is presented in **Table 10**.

Table 10: Intersection Crash Type

Intersections	Crash Type												
	1. Rear End	2. Angle	3. Head On	4. Sideswipe - Same Direction	5. Sideswipe - Opposite Direction	6. Fixed Object in Road	8. Non-Collision	9. Fixed Object - Off Road	10. Deer	11. Other Animal	12. Ped	16. Other	Total
Jericho Rd./Roger Clark Blvd.	5	19	0	3	0	0	0	2	1	0	0	2	32
Cedar Fork Rd./Golansville Rd.	1	6	0	0	0	0	1	2	0	0	0	0	10
Lake Caroline Dr.	4	10	0	1	0	0	0	2	0	0	0	0	17
Edmund Pendleton Dr. /Green Rd.	1	11	1	0	0	0	0	0	0	0	0	0	13
Ladysmith Rd.	6	32	2	6	0	0	0	0	1	0	0	0	47
Durricane Rd/Starr Dr.	5	0	0	0	0	0	0	2	0	1	0	0	8
Clara Smith St.	0	1	0	0	0	0	0	0	0	0	0	0	1
Deerfield Rd./Glen Meadow Dr.	1	5	0	0	0	0	0	0	0	0	0	0	6
Ladysmith Common Blvd	0	0	0	0	0	0	0	0	0	0	0	0	0
Pine Tree Dr.	0	1	0	0	0	0	0	0	0	0	0	0	1
Quarters Rd./Cedon Rd.	2	11	0	1	1	0	0	0	0	0	0	0	15
Marye Rd/Paige Rd.	7	14	1	0	0	0	0	1	1	1	0	0	25

The highest frequency of crashes occurred at the intersection of U.S. Route 1 at Ladysmith Road, which is currently under construction. Ladysmith Road is being widened from a two-lane roadway to a four-lane roadway from 0.15 mile west of U.S. Route 1 to 0.84 mile east of U.S. Route 1. At the intersection with U.S. Route 1, Ladysmith Road will have dual left-turn lanes, two through lanes and an exclusive right-turn lane on both approaches. An exclusive right-turn lane will be included for northbound direction. These improvements have potential to enhance the overall safety and operations at the intersection. The second most crashes occurred at the U.S. Route 1 at Jericho Road/Roger Clark Boulevard intersection, and the most prominent crash at the intersection is angle crashes. The eastbound/westbound left-turn movement was previously controlled by permissive phasing. However, the movement control has been updated to protected-permissive phasing, which can potentially mitigate

angle crashes at the intersection. The intersection with the third most crashes along the corridor is U.S. Route 1 at Marye Road/Paige Road. Intersection warning signs with flashers were observed to be recently installed on U.S. Route 1 approaching the intersection in the northbound and southbound directions. This will warn drivers along U.S. Route 1 intersection so they can be aware of traffic entering U.S. Route 1 from Marye Road/Paige Road. The warning sign with flashers can potentially improve safety at the intersection. **Table 11** presents the crash severity at each intersection.

Table 11: Intersection Crashes by severity

Intersection	PDO.	C. Nonvisible Injury	B. Visible Injury	A. Severe Injury	K. Fatal Injury	Total
Jericho Rd./Roger Clark Blvd.	20	0	10	1	1	32
Cedar Fork Rd./Golansville Rd.	6	0	3	1	0	10
Lake Caroline Dr.	13	0	3	1	0	17
Edmund Pendleton Dr. /Green Rd.	4	1	8	0	0	13
Ladysmith Rd.	37	0	8	2	0	47
Durricane Rd/Starr Dr.	6	0	2	0	0	8
Clara Smith St.	1	0	0	0	0	1
Deerfield Rd./Glen Meadow Dr.	2	0	3	1	0	6
Ladysmith Common Blvd	0	0	0	0	0	0
Pine Tree Dr.	0	0	1	0	0	1
Quarters Rd./Cedon Rd.	11	0	4	0	0	15
Marye Rd/Paige Rd.	13	0	4	8	0	25
<b>Totals</b>	<b>113</b>	<b>1</b>	<b>46</b>	<b>14</b>	<b>1</b>	<b>175</b>

Of the 12 intersections, U.S. Route 1 at Jericho Road/Roger Clark Boulevard had a fatal crash. The crash which occurred in 2022 was due to the driver speeding and failing to maintain proper control. The 2021 crash rate of intersections in Caroline County was compared to the crash rate of the 12 study intersections. According to the VDOT intersection crash rate database, the average crash rate of intersections in Caroline County in 2021 is 3.14 crashes per million entering vehicles (MEV). The highest crash rate among the 12 intersections was 1.52 crash per MEV, which occurred at the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard. **This indicates that the intersection crash rates of the study intersections are less than the average intersection crash rate in the County.**

## Public Involvement Survey

The community along U.S. Route 1 was engaged through an online survey platform. The survey was available to the public from July 17-31, 2023. The survey included 12 questions mostly relating to safety, mobility and congestion issues, mode of transportation, and multimodal facilities along U.S. Route 1. The survey garnered 464 participants, 12,133 responses, and 603 comments. Some of the survey questions inquired from the public and the responses are the following:

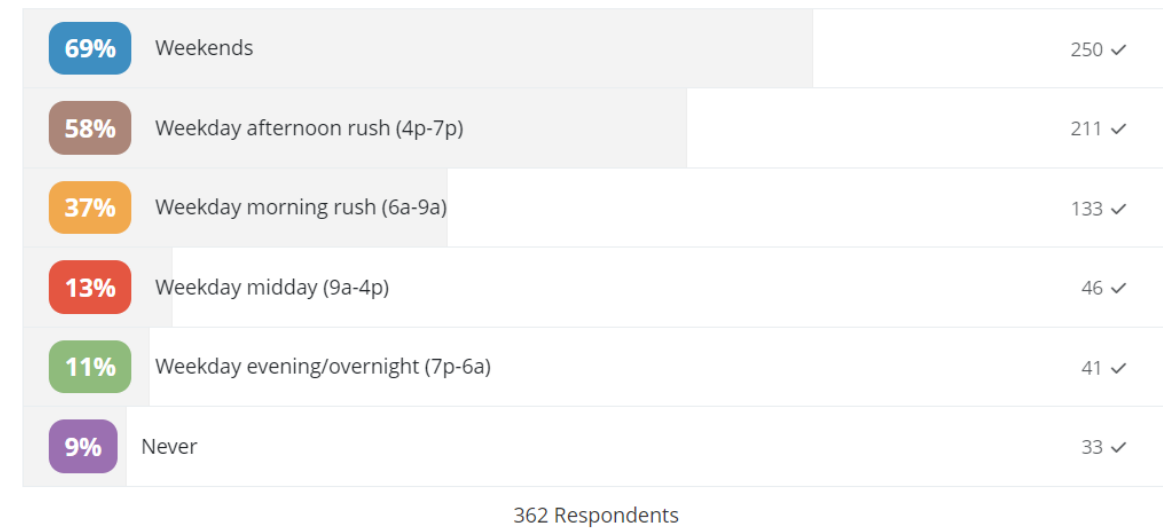
- The following needs have been identified for this study. Do you agree with this initial assessment?



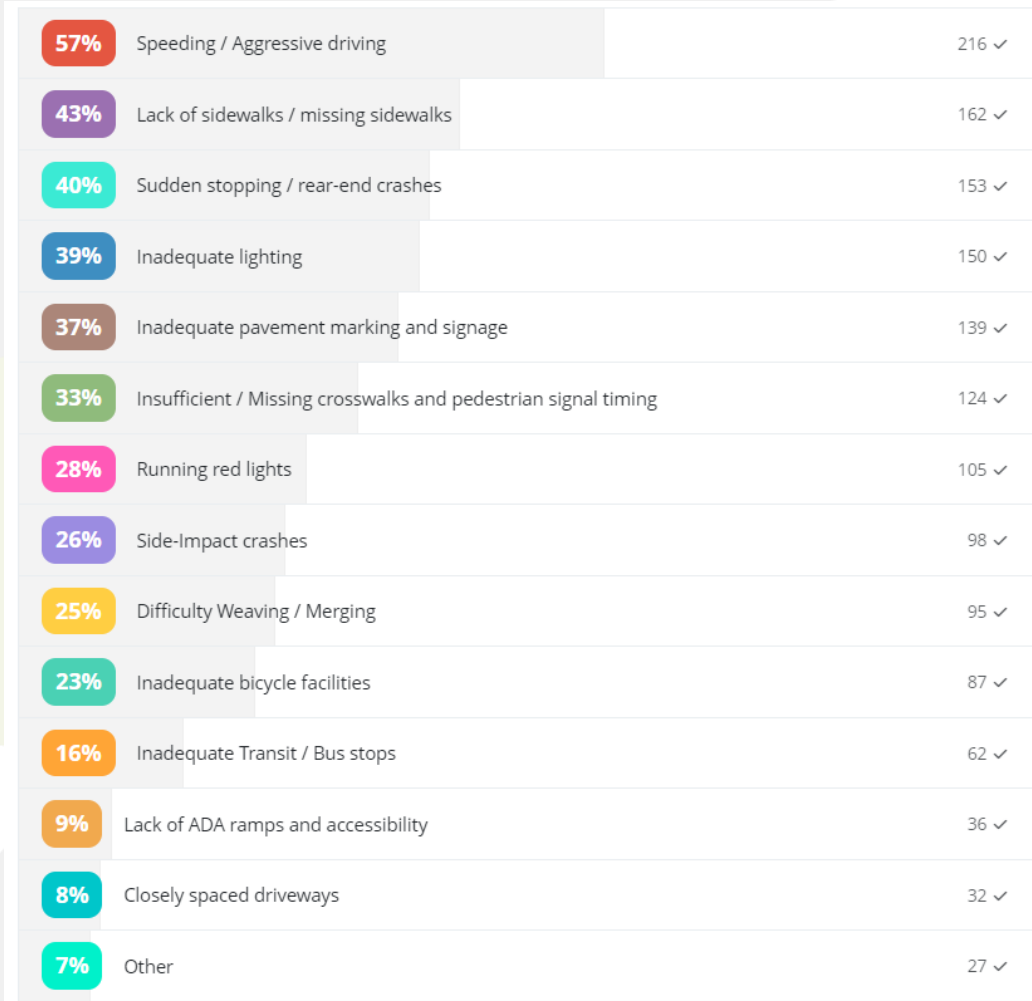
- Rank what is the most important issue to you along the study area.



- Do you experience congestion when traveling along the study area? If so, when?

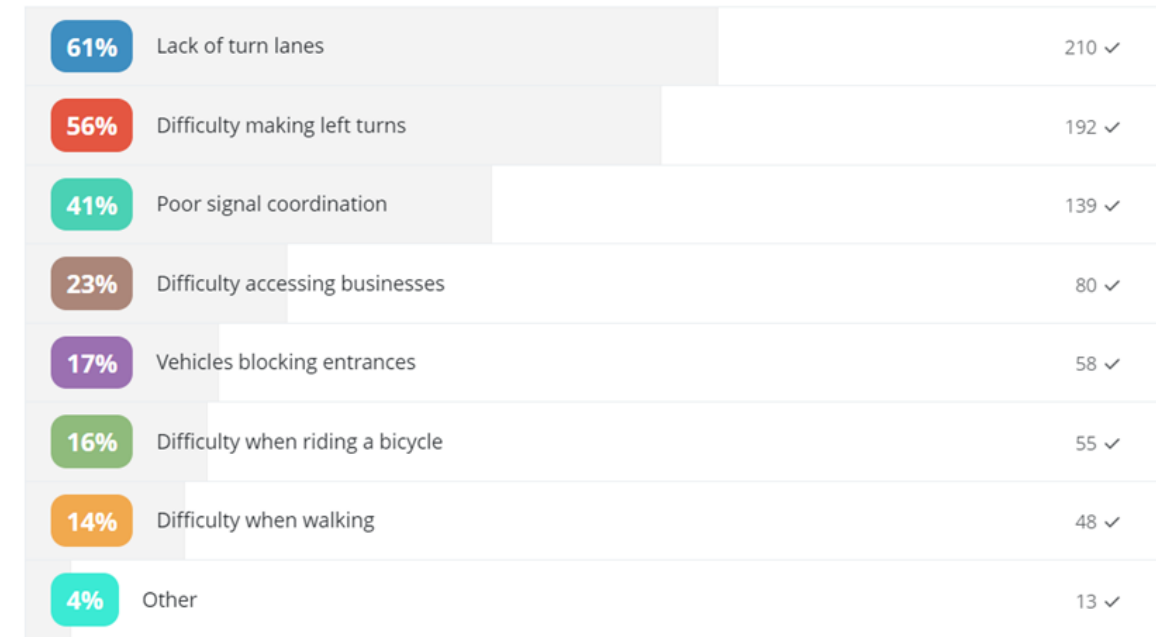


- Which of the following safety issues concern you? (Check all the apply)



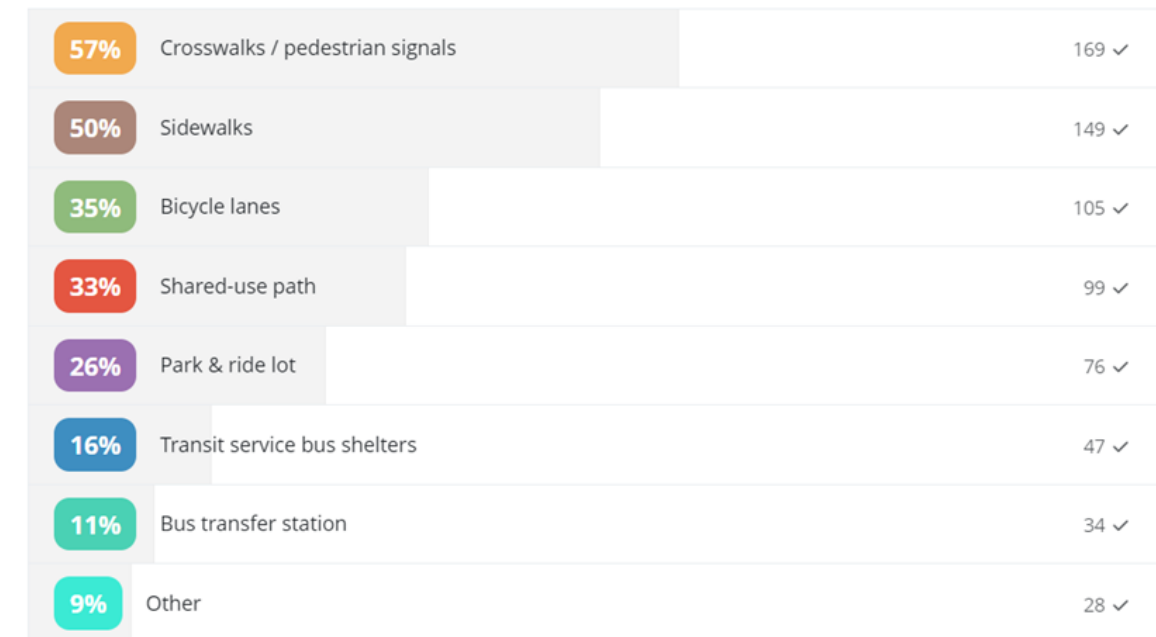
380 Respondents

- What mobility issues do you typically experience when using the study area?



343 Respondents

- What multimodal facilities are needed along this study area? (Check all that apply)



298 Respondents

A summary of the existing issues that were mentioned in the survey comments include the following:

- Congestion and safety issues (due to speeding) along U.S. Route 1, due to detoured traffic from I-95. This occurs when I-95 is either congested or an incident occurred. The I-95 detoured traffic causes operational issues mainly at the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard. Additionally, due to the traffic from I-95, it takes longer for side street traffic to find gap to make a left onto U.S. Route 1. The side streets mainly referenced in the comments are Lake Caroline Drive, and Edmund Pendleton Drive/Green Road.
- Safety issues due to the presence of wildlife. This was also observed from the crash analysis with the deer-related crashes accounting for 14% of the total crashes along U.S. Route 1. There are no deer warning signs along U.S. Route 1.
- Sight distance issues along U.S. Route 1, especially at the intersection of U.S. Route 1 at Cedar Fork Road/Golansville Road. It is difficult for drivers to identify the presence of the intersection because it is located at the crest of a hill in the southbound direction. Additionally, the house located in the northeast quadrant of the intersection blocks the southbound drivers' view. Also, vegetation blockage for drivers was identified as an issue.
- A lack of turn lanes into the side street were identified, especially at Lake Caroline Drive.
- Safety issues of ingress and egress were identified at the shopping center, north of Ladysmith Road. This was also observed from the crash analysis with nine crashes occurring at this access point, seven of which were angle crashes.
- Drainage issues were identified, which causes flooding along U.S. Route 1.
- Lack of street lighting along U.S. Route 1.
- Lack of pedestrian facilities along U.S. Route 1.

## Anticipated Corridor Issues

The operational analysis results showed that there are no operational issues at the 12 study intersections. The final roadway geometry after construction of U.S. Route 1 at Ladysmith Road was modeled as the existing condition.

## Safety

Based on the available crash data, most of the angle crashes along U.S. Route 1 occurred at the 12 study intersections, especially at the intersection of U.S. Route 1 at Jericho Road/Roger Clark Boulevard, and U.S. Route 1 at Ladysmith Road. However, these intersections have been recently modified or are being modified. These improvements could potentially mitigate the angles crashes. There is also a prevalent number of crashes involving deer. There are 47 deer-involved crashes along U.S. Route 1. It was observed that these deer crashes are more frequent between Jericho Road/Roger Clark Boulevard and Cedar Fork Road/Golansville Road. There are 19 (40%) of the 47 deer-involved crashes between Jericho Road/Roger Clark Boulevard and Cedar Fork Road/Golansville Road, which is approximately 3.6 miles in length of the 14 miles.

## Pedestrian/Bike/Transit

JMT did not observe any pedestrian activity along the study corridor. U.S. Route 1 has no pedestrian accommodations along the corridor. However, as part of the improvements at U.S. Route 1 at Ladysmith Road intersection, crosswalks across all legs of the intersection will be installed. No bike activities were observed along the study corridor. U.S. Route 1 has no bike accommodations along the corridor. There is a bike route sign along Cedon Road. U.S. Route 1 corridor is not a bus route; therefore, bus stops or transit stops were not observed along U.S. Route 1.

## Public Involvement Survey

The survey showed that reducing traffic congestion and corridor safety/intersection safety are the two top issues to the public along the corridor. Based on comments from the survey, traffic congestion mostly occurs when I-95 is either congested or an incident occurred. This causes safety issues along the corridor with speeding and aggressive driving. These safety issues were indicated in the crash analysis, which shows that the crash rate along U.S. Route 1 is higher than the average crash rate on roadways with the same functional classification (Other Principal Arterial) state-wide, and of all roadway types in the same district. Lack of turn lanes and difficulty making left turns are the two top mobility issues identified in the survey. Based on the survey comments, this issue also gets worse when traffic from I-95 detours to U.S. Route 1. In general, 76% of the survey respondents agree that safety improvement along U.S. Route 1 is needed. Transit access was the lowest ranked improvement needed according to the survey respondent.



## Potential Corridor Improvements

After a thorough analysis of the historical crash data, existing condition operational analysis, pedestrian and bicycle facilities and the location of access points, several corridor improvements are recommended.

## Pedestrian and Bicycle Improvements

It is recommended to add a shared use path for both pedestrians and cyclists along the U.S. Route 1 corridor starting at Pine Tree Drive and continuing south to the intersection of U.S. Route 1 at Ladysmith Road, as shown in **Figure 15**. With the current construction on Ladysmith Road, crosswalks will be added to all four approaches of the intersection. A 10-foot shared-use path will also be installed on the south side, and a 5-foot sidewalk will be installed on the north side along Ladysmith Road from 0.15 mile west of U.S. Route 1 to 0.84 mile east of U.S. Route 1. According to VTrans, Pedestrian Access and Bicycle Access are a high priority while Pedestrian Safety is a very high priority. These improvements will help address the VTrans needs.



Figure 15: Proposed Pedestrian Improvements

## General Corridor Improvements

Several non-intersection improvements along the corridor are recommended as follows:

- Installation of Deer Warning Signs – 14% of all crashes along the corridor are deer related. There are currently no warning signs along U.S. Route 1 alerting vehicles. Per VDOT IIM-TE-369 (Deer and Other Large Animal Crossing Warning Signs) memorandum guidance, Deer Crossing Warning (W11-3) signs or other large animal crossing warning signs should be installed when the following combination of conditions are satisfied:
  - For any period of two years, there should be at least five reported large animal-vehicle crashes per mile per year; and,
  - The posted speed is 45 mph or greater.

The deer-related crashes occurred in 2020 are six crashes, for 2021 are eight crashes, and for 2022 are 13 crashes. The speed limit along U.S. Route 1 is 45 mph or greater. Therefore, Deer Warning signs are warranted along U.S. Route 1. Potential locations for the Deer Warning signs along U.S. Route 1 are as follows:

- 2.9 Miles South of Route 658/Route 207 (installed with a 3-mile plaque)
  - 0.2 Miles North of Route 658/Route 207 (installed with a 3-mile plaque)
  - 0.5 Miles South of Route 601 (installed with a 3-mile plaque)
  - 0.04 Miles North of Route Pine Tree Drive (installed with a 3-mile plaque)
  - 0.05 Miles South of Route 605 (installed with a 2-mile plaque)
- Move the Food Lion/Brick Sign at the entrance of the shopping plaza north of Ladysmith Road - This access point has nine crashes in close proximity, six of which are angle crashes involving vehicles turning out of the shopping plaza and vehicles traveling northbound on U.S. Route 1. This sign causes sight distance issues to vehicles and is probably the result of these crashes. However, during the technical meeting, VDOT and Caroline County mentioned the sign is privately owned and will be very difficult to relocate.
  - Intersection Warning Signs- adding intersection warning signs, especially to the unsignalized intersections, will alert drivers on U.S. Route 1 that there are intersections present when sight distance might otherwise prevent visibility.
  - Improved Lighting along the corridor - 30% of crashes occur during dark hours. Adding streetlights, when feasible, is recommended.

## Intersection Improvements

After thorough analysis of the historical crash data and existing operational analysis, it was determined VJuST was not needed. All intersections are operating at an acceptable LOS and all intersections are below the countywide crash rates. However, there are still minor changes at some locations that will provide additional safety and operational improvement. It should be noted that the intersection of U.S. Route 1 at Ladysmith Road is currently undergoing construction, so no improvements were suggested for this intersection.

### U.S. Route 1 at Mayre/Paige Road (Route 605)

This unsignalized intersection is operating at an LOS A in the AM and PM. However, this intersection does have 25 crashes in the study period, 14 of which are angle crashes. Accordingly, a designated southbound left-turn lane is recommended to provide vehicles more time to turn. Also, the southbound left-turn existing volume warrants a left-turn lane. In addition to installing the southbound left-turn lane, installing a northbound left-turn lane is recommended. This is presented in **Figure 16**. Furthermore, the northbound right turning radius was recommended to be improved to be in compliance with the VDOT's geometry standards.



Figure 16: U.S. Route 1 at Marye Road/Paige Road Improvements

## U.S. Route 1 At Quarters Road/Cedon Road (Route 632/Route 661)

This intersection is a five-leg intersection. The layout and configuration of the intersection appears to cause drivers confusion. Potential improvements at the intersection were proposed during the existing condition technical meeting. These improvements were considered and revised by JMT. Following are two potential improvements for the intersection:

- Low-Cost Improvement: This includes the following:
  - Close the southeast leg of Route 632 facing Cedon Road (Route 661). The through movement from Cedon Road (Route 661) to Cedon Road (Route 632) will have to make a left onto U.S. Route 1 then an immediate right to Cedon Road (Route 632).
  - Increase the northbound right-turn radius for adequate right-turn radius at the northeast leg of Cedon Road (Route 632)
- Medium-Cost Improvement as follows:
  - Realign the Quarters Road/Cedon Road (Route 632) legs of the intersection to remove the through movement skew.
  - Close the southeast leg of Route 632 facing Cedon Road (Route 661). The through movement from Cedon Road (Route 661) to Cedon Road (Route 632) will have to make a left onto U.S. Route 1 then an immediate right to Cedon Road (Route 632).
  - Increase the northbound right-turn radius for adequate right-turn radius at the northeast leg of Cedon Road (Route 632).
- High-Cost Improvement as follows (will not be advanced to Phase 2 of this task):
  - Realign the Quarters Road/Cedon Road (Route 632) legs of the intersection to remove the through movement skew.
  - Use the upgraded road to connect Cedon Road (Route 661) to Quarters Road (Route 632). Close the 500 feet stretch of Cedon Road (Route 661) between the upgraded road access and U.S. Route 1, as seen in **Figure 17**.
  - All the traffic from Cedon Road (Route 661) to U.S. Route 1 will be diverted to Quarters Road (Route 632).
  - Close the southeast leg of Route 632 facing Cedon Road (Route 661).  
Increase the northbound right-turn radius for adequate right-turn radius at the northeast leg of Cedon Road (Route 632).

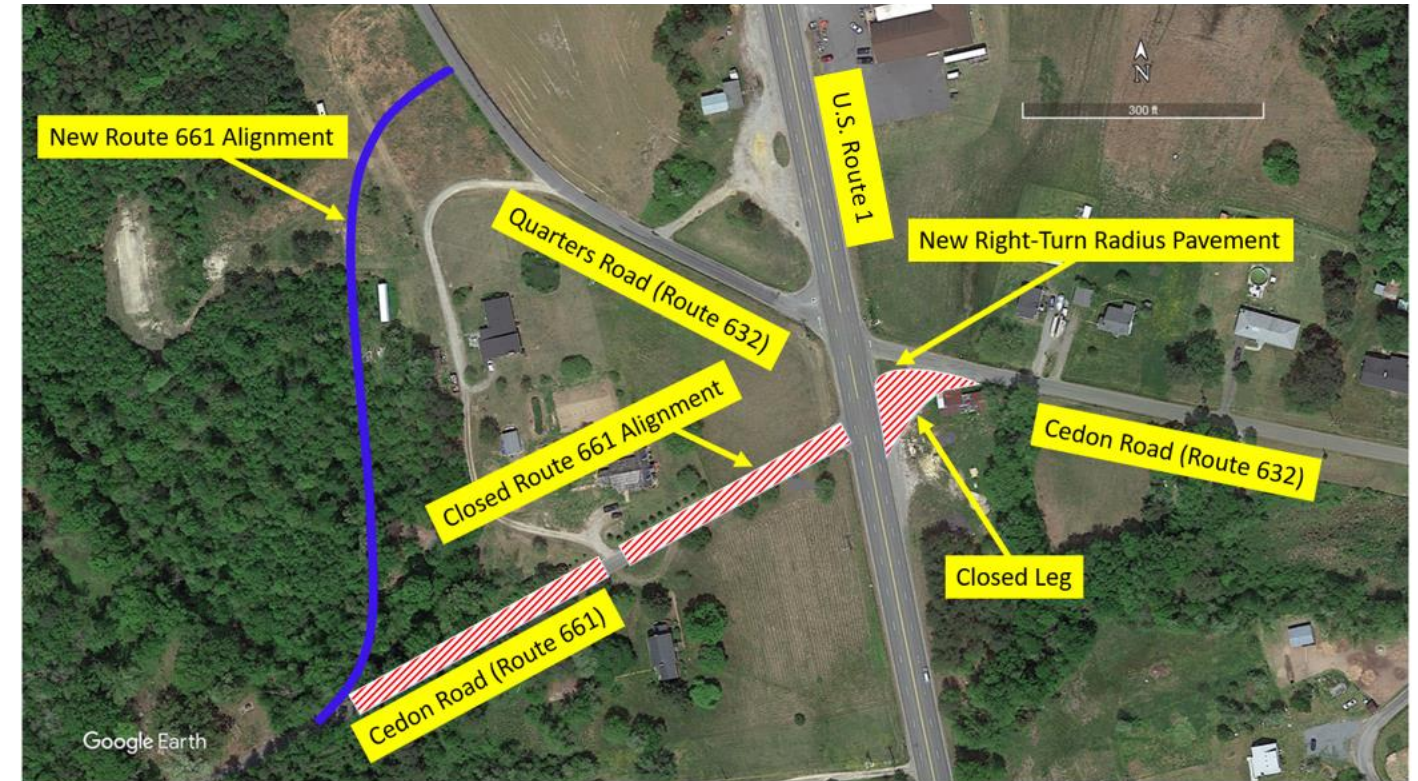


Figure 17: U.S. Route 1 at Quarters Road/Cedon Road High-Cost Improvements

## U.S. Route 1 at Lake Caroline Drive

U.S. Route 1 at Caroline Drive was an intersection mentioned in the public survey as an area with lack of turn lanes into the side street. There are large numbers of right turning vehicles from the southbound direction (174 vehicles per hour (vph) in the PM peak hour) and northbound left turning vehicles (87 vph in the PM peak hour), which currently do not have designated turn lanes. This could create a safety and operational issue, accordingly, an exclusive southbound right-turn lane and exclusive northbound left-turn lane is recommended at the intersection, as shown in **Figure 18**. Likewise, stripe the eastbound lane to separate the left-turn and right-turn movements, the existing lane (lane width is approximately 25 feet) can accommodate both lanes. This will allow vehicles to have their own lane to turn right onto U.S. Route 1 South, instead of waiting for a left-turning vehicle.



Figure 18: U.S. Route 1 at Lake Caroline Drive Improvements

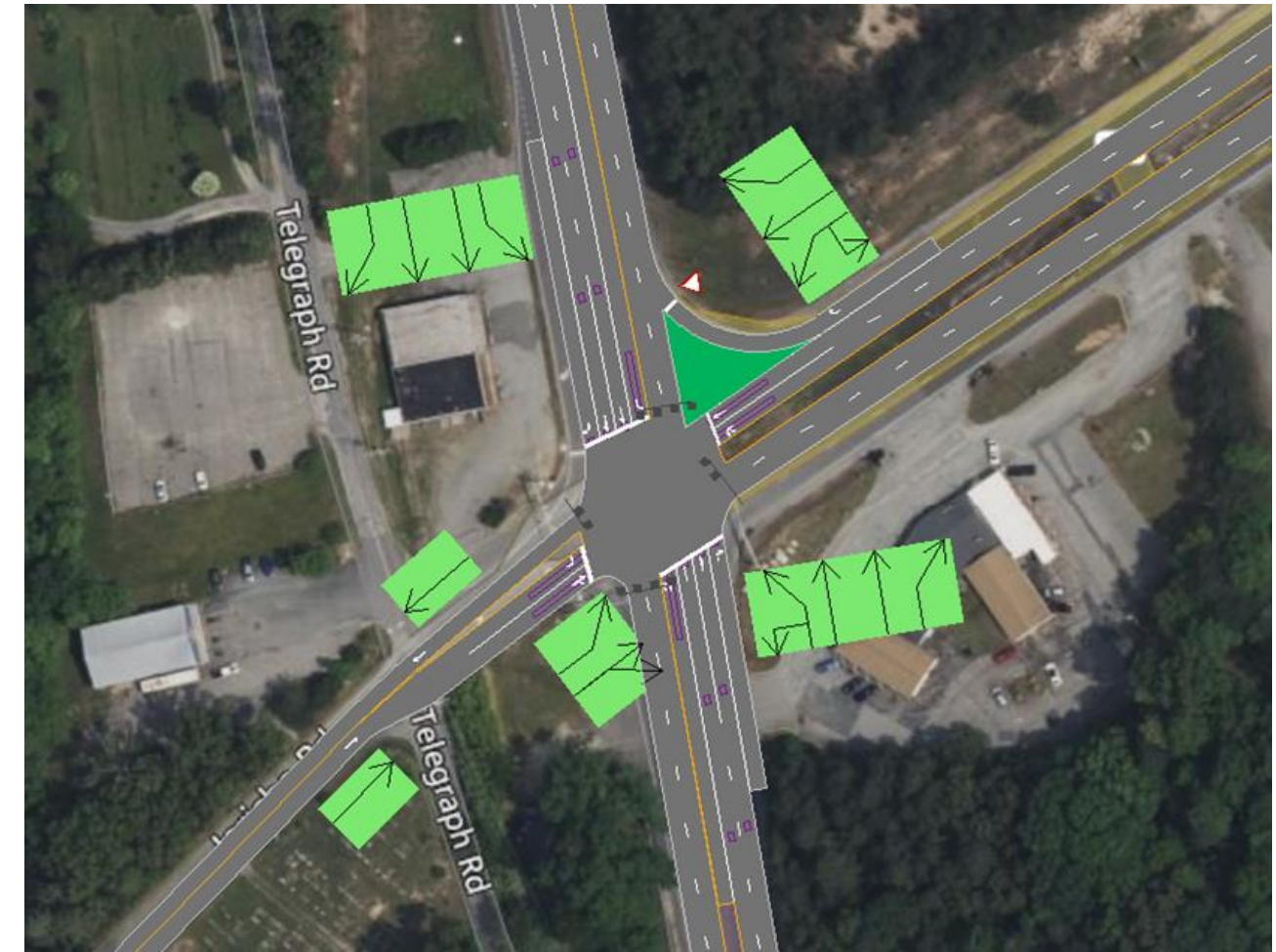


Figure 19: U.S. Route 1 at Jericho/Rogers Clark Improvements

### U.S. Route 1 at Jericho Road/Rogers Clark Blvd (Route 658/207)

This intersection is the only one with any operational concerns, with the northbound approach operating at LOS E in the AM peak hour, and the eastbound approach operating at LOS E in the PM peak hour. It is recommended to optimize the signal timings as well as adding a storage lane for the westbound right-turn movement, as shown in **Figure 19**. The westbound right-turn volume satisfies the warrant for a full-width turn lane and taper, as stated in *VDOT Roadway Design Manual, Appendix F*. This is currently a shared through/right lane with no designated storage area for the right turning vehicles even though a large number of vehicles do this movement, especially when I-95 traffic detour to U.S. Route 1.

## Existing Condition Report Technical Meeting

A technical meeting was held on Wednesday, September 6, 2023, to discuss the existing conditions findings, and the recommended potential corridor improvements. The meeting attendance included personnel from VDOT, Caroline County, George Washington Regional Commission (GWRC), and JMT. During the meeting, the team provided recommendations and input to the existing condition report. Some of the recommendations are presented below:

- GWRC mentioned the East Coast Greenway is planning to include bike routes along U.S. Route 1. This is still in the planning process stage, and it has not been confirmed yet.
- GWRC indicated there is a power pole that is near the eastbound approach, which can impede the sight distance of the drivers. Additionally, the westbound approach left-turn lane has an inadequate turn radius.
- Caroline County mentioned a fatal crash occurred along U.S. Route 1. According to the news, this crash was a hit and run, which involved a pedestrian, occurred in the overnight hours of Tuesday, August 22, 2023, nearly half a mile south of Jericho Road/Roger Clark Boulevard intersection.
- During the field review, pedestrian activities were not observed along U.S. Route 1. However, during the meeting, Caroline County mentioned that there are pedestrian activities along Jericho Road, east of U.S. Route 1. This pedestrian activity occurs mostly on the weekend, between the hotels located in the northeast corner of the intersection to the restaurant and laundromat in the southeast corner of the intersection. Most of these pedestrian activities include midblock crossing on Jericho Road. Further review of these pedestrian activities during the weekend is recommended to propose the appropriate mitigation measures.
- Also, Caroline County mentioned the pedestrian activities along the 1.5-mile stretch of U.S. Route 1 between Gatewood Road (Route 604) and Ladysmith Road. During the field review, pedestrian activities were not observed along this stretch of U.S. Route 1. According to the Caroline County Transportation Plan, a sidewalk is planned along this stretch of U.S. Route 1.

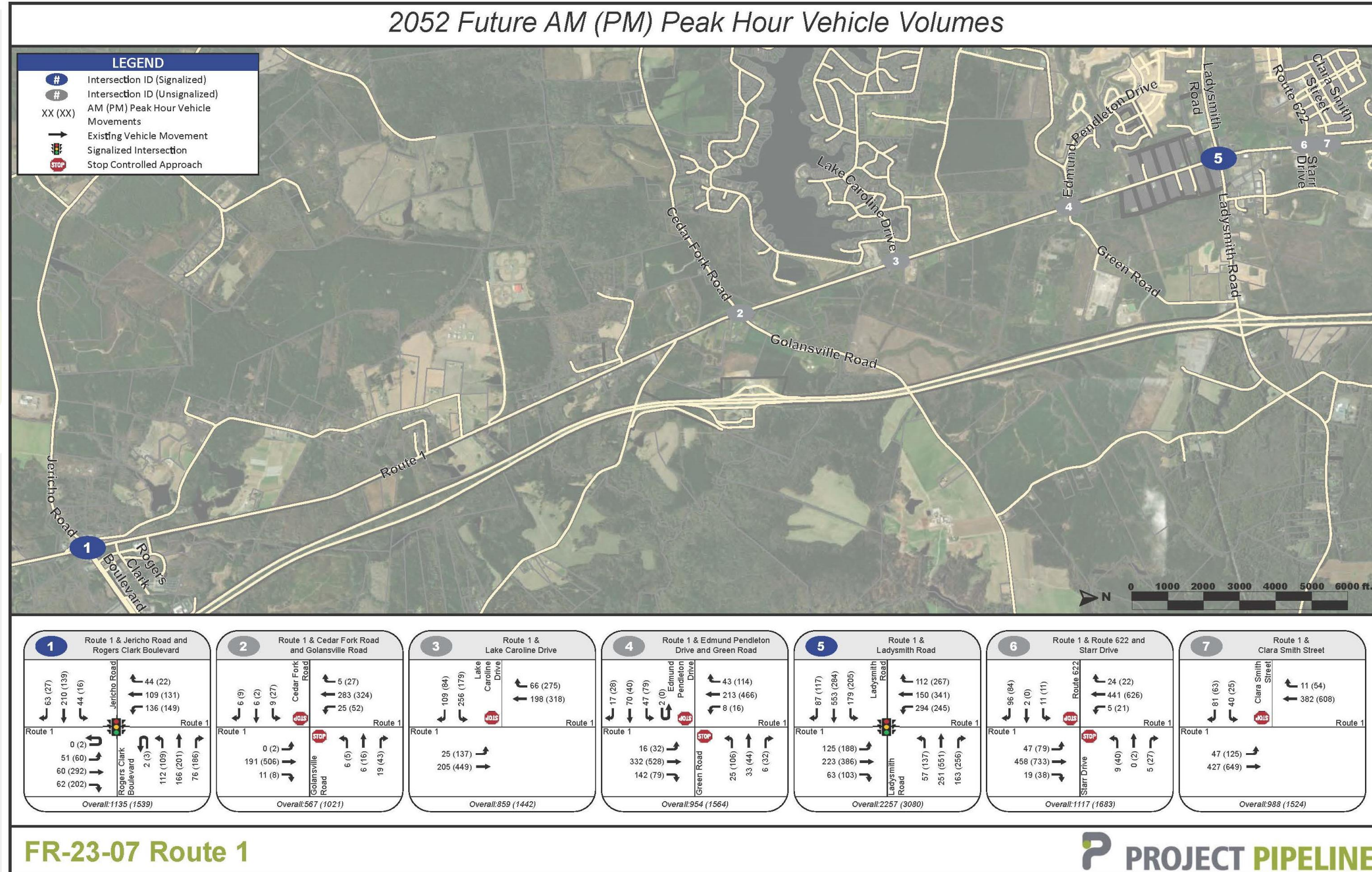
## No-Build Conditions Traffic Operations Analysis

### Design Year (2052) No-Build Volume Development

Traffic operational analyses were conducted to evaluate the overall performance of the study corridor under design year (2052) No-Build AM and PM peak hour conditions. The intent of the design year (2052) No-Build conditions analyses is to provide a general understanding of the baseline future traffic conditions as a starting point for developing improvement concepts.

An Annual growth rate of 2.0% was provided by VDOT and applied to existing traffic volumes to forecast design year (2052) traffic volumes shown in **Figure 20** and **Figure 21**.

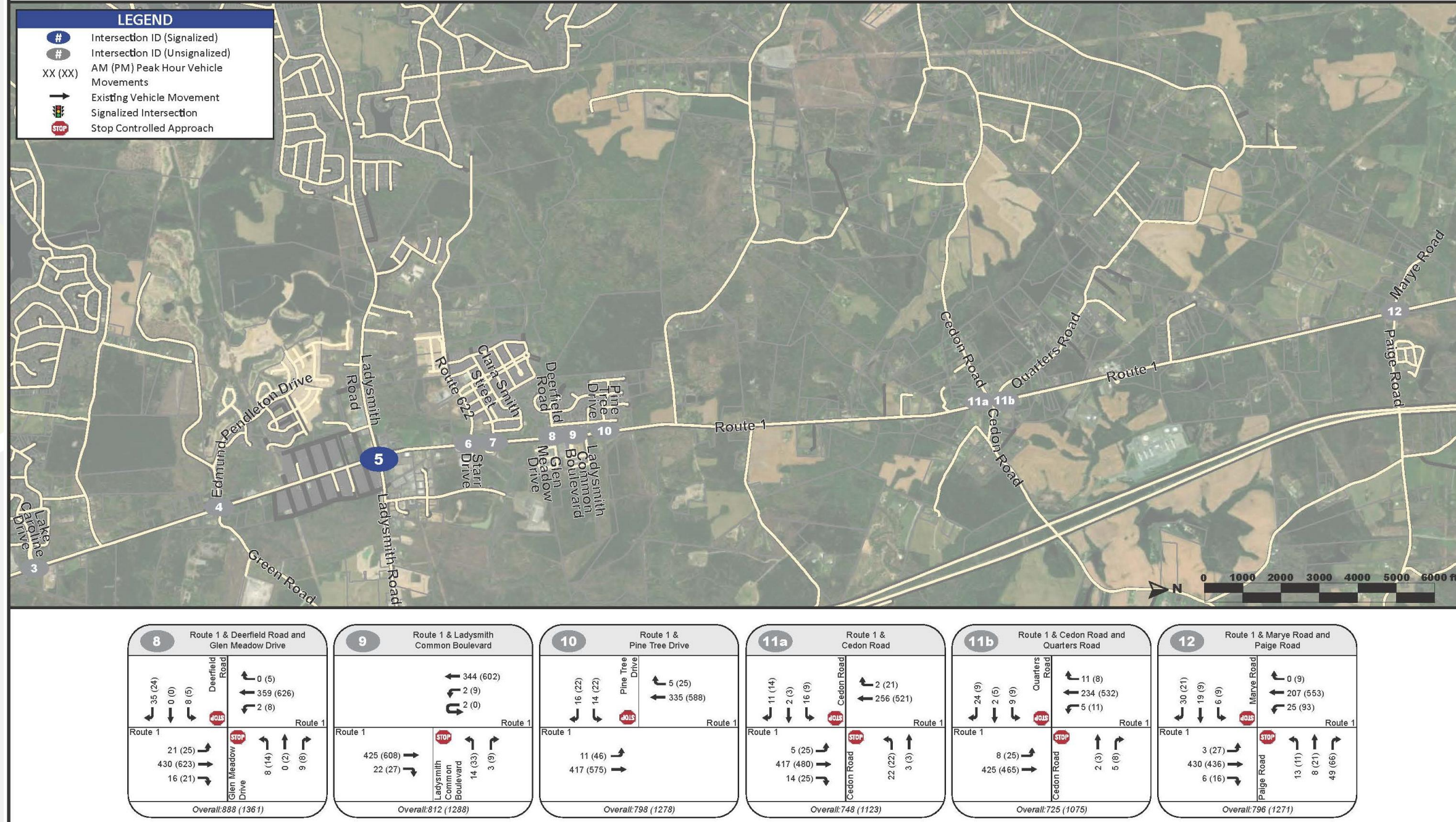
### 2052 Future AM (PM) Peak Hour Vehicle Volumes



**FR-23-07 Route 1**

Figure 20: Design Year (2052) No Build Peak Hour Volumes (southern intersections)

### 2052 Future AM (PM) Peak Hour Vehicle Volumes



### FR-23-07 Route 1

Figure 21: Design Year (2052) No Build Peak Hour Volumes (northern intersections)

## Synchro and SimTraffic Analysis

Design year (2052) No-Build conditions were modeled using Synchro 11 and SimTraffic 11 for the entire study area.

The existing conditions Synchro models were used as a basis to develop the design year (2052) No-Build models for the AM and PM peak hour conditions. The models were updated with the projected design year (2052) No-Build traffic volumes. Traffic signal cycle lengths were assumed to be consistent with existing conditions, while splits and offsets were optimized. Design year (2052) No-Build inputs and analysis methodologies were applied consistently with *TOSAM*. As for the existing conditions analyses, the intersection of U.S. Route 1 at Ladysmith Road was modeled with the final roadway geometry after construction (applied improvements).

Ten simulation runs were conducted for both the AM and PM No-Build SimTraffic models. Control delay (seconds per vehicle) from Synchro, LOS, and maximum queue length (feet) from SimTraffic were selected as measures of effectiveness to quantitatively report the performance of each study intersection. The full Synchro and SimTraffic reports are included in **Appendix C** and shown in **Table 12** through **Table 14**. Any LOS that was reported as “D”, “E”, or “F” have been shown in the tables as **yellow**, **orange**, and **red**, respectively.

Similar trends in delay and queuing were observed under design year (2052) No-Build conditions as observed in Existing conditions. Under design year (2052) No-Build conditions, all signalized intersections operated at overall LOS D or better in both the AM and PM peak hours as did all movements with one exception. The southbound left-turn movement at Lady Smith Road operated at LOS E during the AM peak hour and the southbound left-turn queue increased to more than 400 feet.

Multiple individual minor streets left-turn movements operated at LOS E and LOS F in the PM peak hour at the unsignalized intersections along U.S. Route 1. The most notable approaches were eastbound Lake Caroline Drive (126.1 seconds), westbound Green Road (150.9 seconds), and westbound Starr Drive (112.5 seconds). In addition to the lengthy delay at Lake Caroline Drive the eastbound left-turn queue was 587 feet during the PM peak hour.

Table 12: Design Year (2052) No-Build Conditions Synchro Analysis Results Summary

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	2052 NO-BUILD CONDITIONS					
					AM PEAK			PM PEAK		
					LOS	Delay (S/Veh)	Maximum Queue (ft)	LOS	Delay (S/Veh)	Maximum Queue (ft)
1 (Signalized)	Jericho Road	Eastbound	L	110	C	21.1	60	C	27.0	60
			TR		D	41.8	183	C	28.4	195
			Approach Delay		D	38.9	-	C	28.3	-
	Rogers Clark Boulevard	Westbound	LU		C	30.3	157	C	22.8	143
			TR		C	29.6	176	C	33.5	299
			Approach Delay		C	29.8	-	C	31.1	-
	U.S. Route 1	Northbound	LU	225	D	41.1	126	C	20.8	74
			TH		D	46.2	72	C	29.9	133
			R	150	D	46.0	47	C	27.4	108
		Southbound	Approach Delay		D	44.6	-	C	28.0	-
			L	400	D	44.9	226	C	24.0	142
			T		D	47.3	87	C	25.5	70
		R	200	D	45.7	39	C	24.2	13	
		Approach Delay		D	45.9	-	C	24.6	-	
		Overall Delay		D	38.7	-	C	28.4	-	
2 (Unsignalized)	Cedar Fork Road	Eastbound	LTR		B	12.9	57	C	20.9	68
			Approach Delay		B	12.9	-	C	20.9	-
	Golansville Road	Westbound	LTR		B	11.0	53	C	15.3	68
			Approach Delay		B	11.0	-	C	15.3	-
	U.S. Route 1	Northbound	LT		A	0.0	0	A	0.1	16
			TR		A	0.0	0	A	0.0	38
		Southbound	Approach Delay		A	0.0	-	A	0.0	-
			LT		A	1.3	11	A	2.5	45
TR				A	0.0	0	A	0.0	57	
Approach Delay				A	0.7	-	A	1.4	-	
3 (Unsignalized)	Lake Caroline Drive	Eastbound	L		C	15.7	167	F	126.1	587
			R	75	A	0.0	75	A	0.0	75
			Approach Delay		C	15.7	-	F	126.1	-
	U.S. Route 1	Northbound	LT		A	2.3	55	A	5.5	339
			T		A	0.0	0	A	0.0	321
		Southbound	Approach Delay		A	0.9	-	A	2.7	-
			T		A	0.0	0	A	0.0	650
			TR		A	0.0	6	A	0.0	678
		Approach Delay		A	0.0	-	A	0.0	-	
4 (Unsignalized)	Edmund Pendleton Drive	Eastbound	UL		C	16.0	76	F	61.2	88
			T		C	18.5	87	D	25.9	102
			R	310	A	0.0	59	A	0.0	76
			Approach Delay		C	17.6	-	E	45.0	-
	Green Road	Westbound	LTR		C	18.4	62	F	150.9	238
			Approach Delay		C	18.4	-	F	150.9	-
	U.S. Route 1	Northbound	L	420	A	8.2	35	A	8.9	34
			T		A	0.0	2	A	0.0	29
			R	160	A	0.0	29	A	0.0	11
		Southbound	Approach Delay		A	0.3	-	A	0.4	-
			L	290	A	8.4	8	A	8.9	26
			T		A	0.0	6	A	0.0	34
		R	290	A	0.0	0	A	0.0	9	
		Approach Delay		A	0.3	-	A	0.2	-	



Table 13: Design Year (2052) No-Build Conditions Synchro Analysis Results Summary (cont'd)

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	2052 NO-BUILD CONDITIONS					
					AM PEAK			PM PEAK		
					LOS	Delay (S/Veh)	Maximum Queue (ft)	LOS	Delay (S/Veh)	Maximum Queue (ft)
5 (Signalized)	Ladysmith Road	Eastbound	L	225	C	29.9	209	D	41.8	212
			T		C	27.0	267	C	25.7	219
			R	200	B	17.5	87	B	19.7	69
		Approach Delay			C	26.6	-	C	30.0	-
		Westbound	L	575	D	37.8	105	D	43.6	179
			T		C	31.3	161	C	32.1	266
	R		550	C	23.7	89	C	23.1	150	
	Approach Delay			C	29.5	-	C	31.3	-	
	U.S. Route 1	Northbound	L	225	C	24.8	134	C	27.9	188
			T		C	30.6	113	C	32.3	204
			R	500	C	23.9	66	C	22.9	93
		Approach Delay			C	27.8	-	C	29.6	-
		Southbound	L	500	E	57.3	260	D	38.1	406
			T		C	29.1	108	C	31.2	272
R	712		B	17.5	66	C	23.2	126		
Approach Delay			D	41.6	-	C	30.7	-		
Overall Delay				C	31.1	-	C	30.5	-	
6 (Unsignalized)	Durette Road	Eastbound	LTR		B	12.5	75	C	17.2	160
			Approach Delay	B	12.5		C	17.2		
	Starr Drive	Westbound	LT		D	26.1	39	F	112.5	161
			Approach Delay	A	9.8	30	B	11.8	74	
	U.S. Route 1	Northbound	LT		A	1.9	51	A	2.6	184
			TR		A	0.0	0	A	0.0	170
			Approach Delay	A	1.0		A	1.4		
		Southbound	LT		A	0.3	28	A	1.2	116
			T		A	0.0	0	A	0.0	80
			R	300	A	0.0	1	A	0.0	16
Approach Delay			A	0.1		A	0.4			
7 (Unsignalized)	Clara Smith Street	Eastbound	L		C	17.3	47	E	38.4	65
			R		B	10.0	44	B	11.1	72
			Approach Delay	B	12.4		C	18.8		
	U.S. Route 1	Northbound	L	190	A	8.5	50	A	9.8	137
			T		A	0.0	0	A	0.0	0
		Approach Delay	A	0.8		A	1.6			
Southbound	T		A	0.0	0	A	0.0	53		
	R	345	A	0.0	0	A	0.0	46		
Approach Delay			A	0.0		A	0.0			
8 (Unsignalized)	Deerfield Road	Eastbound	LTR		B	11.1	55	B	13.8	57
			Approach Delay	B	11.1		B	13.8		
	Glen Meadow Drive	Westbound	LTR		B	14.2	56	D	26.6	65
			Approach Delay	B	14.2		D	26.6		
	U.S. Route 1	Northbound	LT		A	1.2	26	A	1.2	82
			T		A	0.0	0	A	0.0	32
			R	200	A	0.0	0	A	0.0	49
		Approach Delay			A	0.4		A	0.4	
Southbound		LT		A	0.1	13	A	0.3	60	
		TR		A	0.0	0	A	0.0	38	
Approach Delay			A	0.1		A	0.2			

Table 14: Design Year (2052) No-Build Conditions Synchro Analysis Results Summary (cont'd)

INTERSECTION #	ROADWAY	DIRECTION	LANE	STORAGE LANE (FEET)	2052 NO-BUILD CONDITIONS					
					AM PEAK			PM PEAK		
					LOS	Delay (S/Veh)	Maximum Queue (ft)	LOS	Delay (S/Veh)	Maximum Queue (ft)
9 (Unsignalized)	Ladysmith Common Boulevard	Westbound	L		B	14.9	61	C	22.8	62
			R		B	10.6	48	B	10.4	27
			Approach Delay	B	14.2		C	20.1		
	U.S. Route 1	Northbound	T		A	0.0	0	A	0.0	3
			R	265	A	0.0	0	A	0.0	54
		Approach Delay	A	0.0		A	0.0			
Southbound	UL	350	A	8.3	15	A	9.0	37		
	T		A	0.0	0	A	0.0	7		
Approach Delay			A	0.0		A	0.1			
10 (Unsignalized)	Pine Tree Drive	Eastbound	LR		B	11.8	56	C	18.3	61
			Approach Delay	B	11.8		C	18.3		
	U.S. Route 1	Northbound	LT		A	0.7	31	A	2.2	92
			T		A	0.0	0	A	0.0	15
		Approach Delay			A	0.2		A	0.8	
		Southbound	T		A	0.0	0	A	0.0	10
TR			A	0.0	0	A	0.0	55		
Approach Delay			A	0.0		A	0.0			
11a (Unsignalized)	Cedon Road	Eastbound	LTR		B	12.1	35	C	16.4	75
			Approach Delay	B	12.1		C	16.4		
	Westbound	LT		C	16.1	51	C	23.4	50	
		Approach Delay	C	16.1		C	23.4			
	U.S. Route 1	Northbound	LT		A	0.2	7	A	1.1	58
			TR		A	0.0	0	A	0.0	39
		Approach Delay			A	0.1		A	0.6	
		Westbound	T		A	0.0	5	A	0.0	0
TR			A	0.0	0	A	0.0	42		
Approach Delay			A	0.0		A	0.0			
11b (Unsignalized)	Quarters Road	Eastbound	LTR		B	10.8	22	C	18.8	41
			Approach Delay	B	10.8		C	18.8		
	Cedon Road	Westbound	TR		B	11.4	20	B	14.0	50
			Approach Delay	B	11.4		B	14.0		
	U.S. Route 1	Northbound	LT		A	0.5	14	A	1.5	43
			T		A	0.0	0	A	0.0	10
Approach Delay			A	0.2		A	0.5			
Southbound		LT		A	0.4	7	A	0.5	38	
	TR		A	0.0	0	A	0.0	38		
Approach Delay			A	0.2		A	0.2			
12 (Unsignalized)	Marye Road	Eastbound	LTR		B	13.7	50	D	29.1	80
			Approach Delay	B	13.7		D	29.1		
	Paige Road	Westbound	LTR		B	13.3	72	C	22.0	126
			Approach Delay	B	13.3		C	22.0		
	U.S. Route 1	Northbound	LT		A	0.1	5	A	1.2	52
			TR		A	0.0	0	A	0.0	53
		Approach Delay			A	0.1		A	0.6	
		Southbound	LT		A	1.8	27	A	2.5	73
TR			A	0.0	0	A	0.0	38		
Approach Delay			A	1.0		A	1.6			

## Chapter 2:

# CONCEPT DEVELOPMENT AND REFINEMENT

## Introduction

As part of Phase 1 efforts, the study team developed alternative concepts along U.S. Route 1 to enhance multimodal access and address safety, geometric, and operational deficiencies in the study area. The study team then screened the alternatives based on anticipated safety benefits, operational performance, multimodal access, constructability, and input from the SWG. A SWG meeting was held on December 18, 2023 to review preliminary alternatives. The meeting materials can be found in **Appendix D**. The study team selected seven alternatives to present to the public and gather feedback.

The primary goal of the Phase 2 alternatives development effort was to prepare a refined set of alternatives to present to the public and solicit feedback. The study team compared each alternative across several metrics, including traffic operations, safety, pedestrian and bicycle access, and cost, to determine the refined list of concepts to present to the public.

Phase 2 also included running the VDOT Junction Screening Tool (VJuST) to identify any potential additional intersection improvement concepts that could address the congestion mitigation needs. Due to the type of improvements considered, VJuST was only used at the intersection of U.S. Route 1 and Lake Caroline Drive.

It should be noted that all of the recommended improvements have a positive impact on congestion reduction. Understanding that Route 1 is part of the CoSS that includes I-95, and that it is the alternative route used for incident management related to I-95, congestion management is of the utmost importance.

The following sections present the details for each improvement considered.

## Alternative Analysis

### Jericho Road (658)/Rogers Clark Boulevard (207)

This concept includes optimizing the signal timing and adding a storage lane for the westbound right-turn movement. Pedestrian features will be constructed including crosswalks, pedestrian signals, a pedestrian refuge island in the median of the westbound approach, and a concrete island separating the westbound right-turn and through movements. This concept will provide sidewalks on both sides of Rogers Clark Boulevard connecting to the east and a crosswalk at Welcome Way Drive. Per the GIS based property lines, right-of way will be needed on the northwest corner of the intersection and along both sides of Rogers Clark Boulevard to accommodate the proposed sidewalks.

**Figure 22** presents a conceptual sketch of the improvements. Based on input from the SWG this alternative was included in the public survey.

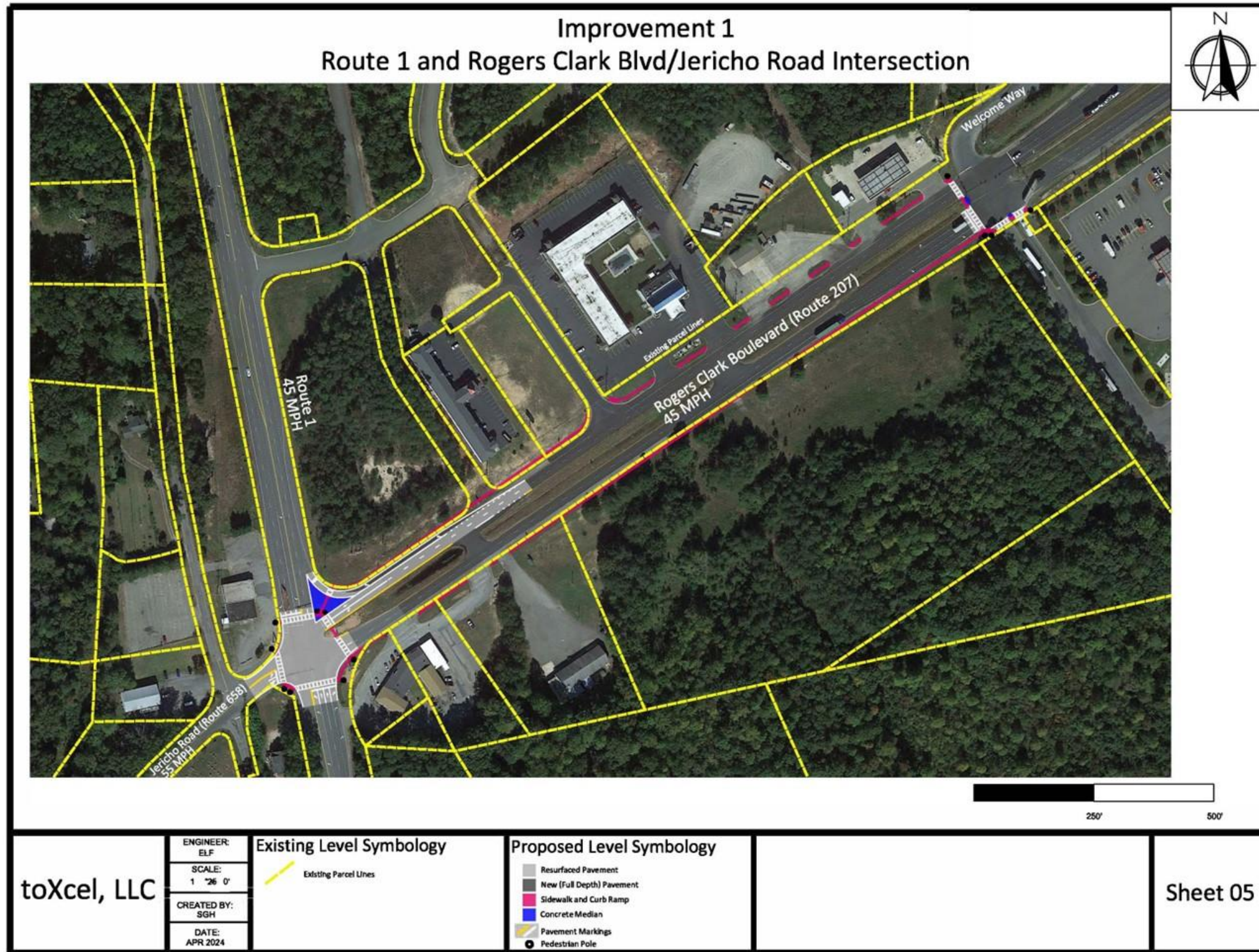


Figure 22: Jericho Road (658)/Rogers Clark Boulevard (207) Improvements

## Lake Caroline Drive

### VJuST/iCAP Screening

The VJuST tool was applied at the intersection of U.S. Route 1 and Lake Caroline Drive, using the PM peak hour turning movement volumes. The applicable results from the VJust (iCAP Stage 1) screening are shown in **Table 15**.

Table 15: VJuST (iCAP Stage 1) Screening Results

Type	Congestion	Pedestrian	Safety
	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points
Turn Lanes	0.66		48
Unsignalized CG-T	0.47	-	12
Signalized CG-T	0.32	-	12

Green cells indicate V/C ratios below 0.75, pedestrian benefits, or Conflict Points up to 20.

Yellow cells indicate V/C ratios between 0.75 and 0.9, no change to pedestrian accommodations, or Conflict Points between 21 and 40.

Red cells indicate V/C ratios above 0.9, disadvantages to pedestrian accommodations, or Conflict Points above 40.

The three alternatives were further compared across additional metrics including traffic operations (using Synchro), safety, pedestrian access and cost through the iCAP Stage 2 process. The safety metrics used in this screening are based on SMART SCALE Planning Level crash modification factors (CMFs). The applicable results from the iCAP Stage 2 screening are shown in **Table 16**. The VJust/iCAP output is included in **Appendix E**.

Table 16: iCAP Stage 2 Screening Summary

Alternative	Control Delay MOE Score	Safety	Ped/Bike Access	VJuST-C Cost Estimate	Stage 2 Score	Advance to Public Engagement
Turn Lanes	0.5	1.0	0.5	\$1.567M	5.0	Yes
Unsignalized CG-T	1.0	0.3	0.0	\$2M	3.4	No
Signalized CG-T	0.6	0.3	0.0	\$2.325M	2.5	No

Three potential concepts were considered for this intersection. Two of the three concepts are innovative intersection configurations. More information about how these configurations work, including

descriptions, illustrations, and examples, is available on VDOT's Innovative Intersections webpage: [https://virginiadot.org/info/innovative\\_intersections\\_and\\_interchanges/virginia\\_icap.asp](https://virginiadot.org/info/innovative_intersections_and_interchanges/virginia_icap.asp).

The three concepts considered at Lake Caroline Drive were: (1) adding turn lanes, (2) an unsignalized continuous Green-T, and (3) a signalized continuous Green-T and are discussed in detail below.

#### Turn Lanes

This concept includes constructing an exclusive southbound right-turn lane, northbound left-turn lane, and restriping the eastbound approach for separate left and right-turn lanes.

#### Unsignalized Continuous Green-T

This concept converts the intersection to an unsignalized Continuous Green-T where U.S. Route 1 traffic continues through the intersection without stopping. Left turns from Lake Caroline Drive will use a channelized receiving lane to merge onto northbound U.S. Route 1.

#### Signalized Continuous Green-T

This concept converts the intersection to a signalized Continuous Green-T where northbound U.S. Route 1 can continue through the intersection without stopping. Southbound U.S. Route 1 would be controlled by a traffic signal. Left turns from Lake Caroline Drive will use a channelized receiving lane to merge onto northbound U.S. Route 1.

The study team presented the results of the iCAP screening at the December 2023 SWG meeting. Based on this information the SWG chose to present the turn lanes concept in the survey for public feedback. It was the opinion of the SWG that the cost of the CG-T improvements outweighed the benefits for the intersection with a private roadway. **Figure 23** presents a conceptual sketch of the turn lane improvements.

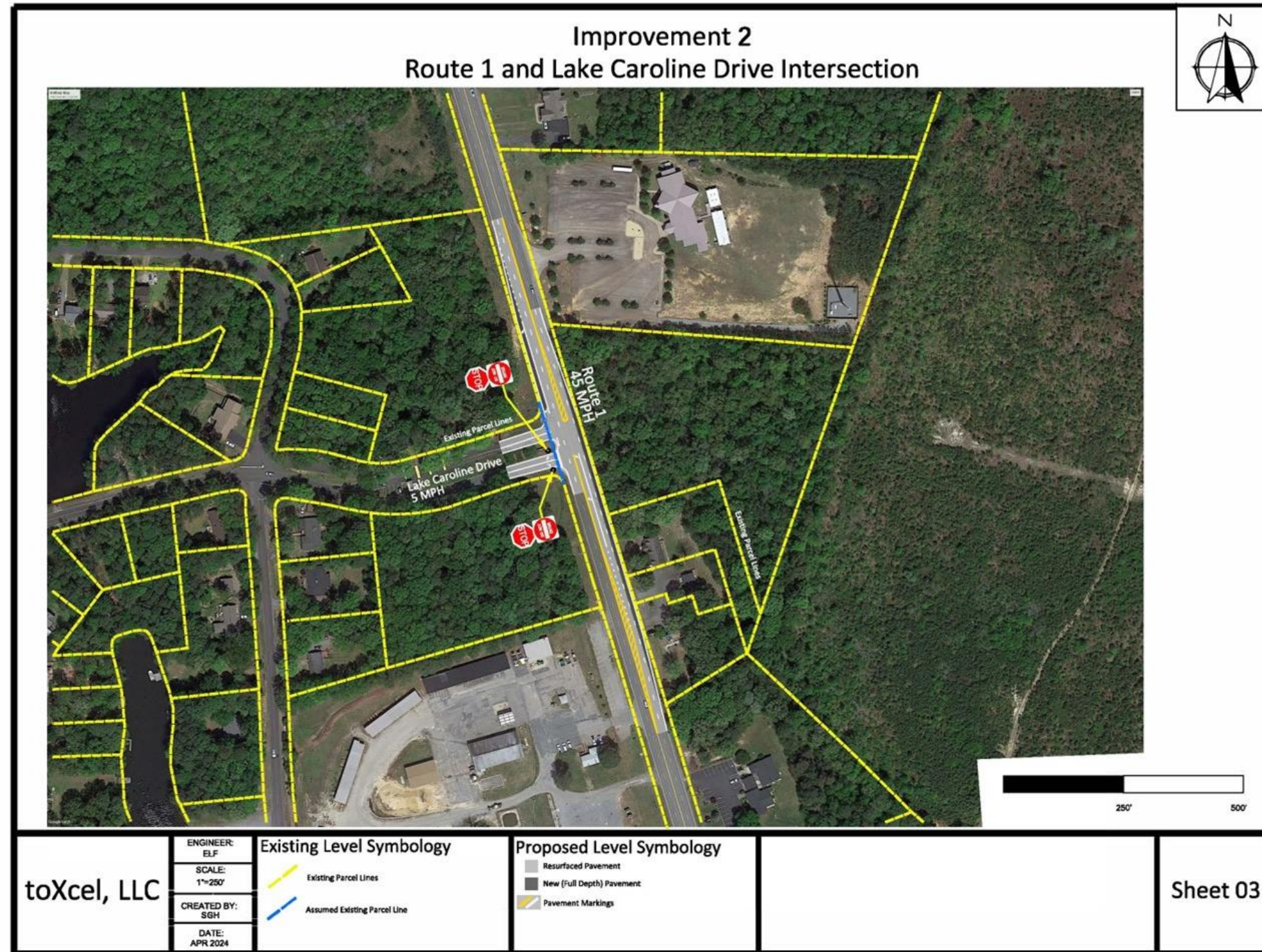


Figure 23: Lake Caroline Drive Turn Lane Improvements

### Access Management north of Ladysmith Road (Food Lion)

This concept restricts left-turn egress from the Food Lion shopping center and limits the commercial entrance north of CVS to right-in/right-out only. Drivers exiting these driveways will be forced to turn right. **Figure 24** presents a conceptual sketch of the improvements. Based on input from the SWG this alternative was included in the public survey.

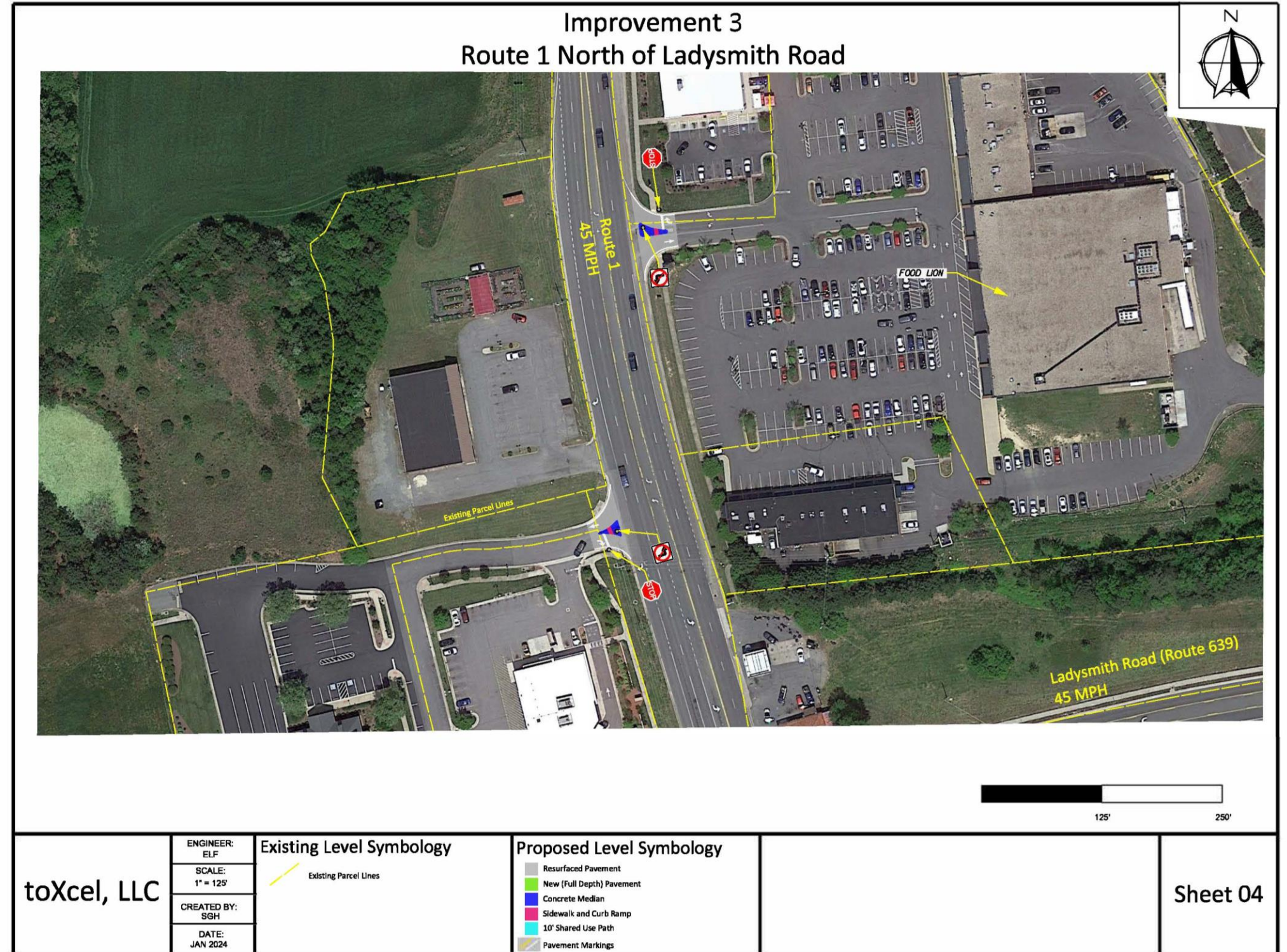


Figure 24: Access Management Improvements north of Ladysmith Road

## Ladysmith Road (639) to Pine Tree Drive

This concept adds turn lanes and bicycle/pedestrian improvements at the locations listed below.

### Turn Lanes

- Northbound left-turn at Durrette Road/Starr Drive
- Southbound left-turn lane at Durrett Road/Starr Drive
- Northbound left-turn lane at Deerfield Road/Glenn Meadows Drive
- Southbound left-turn lane at Deerfield Road/Glenn Meadows Drive
- Northbound left-turn lane at Pine Tree Drive
- Southbound right-turn lane at Pine Tree Drive.

### Bicycle and Pedestrian Improvements

- New sidewalk on the west side of U.S. Route 1 between Ladysmith Road and Pine Tree Drive
- New shared use path on the east side of U.S. Route 1 between Ladysmith Road and Pine Tree Drive

Figure 25 presents a conceptual sketch of the improvements. Based on input from the SWG this alternative was included in the public survey.

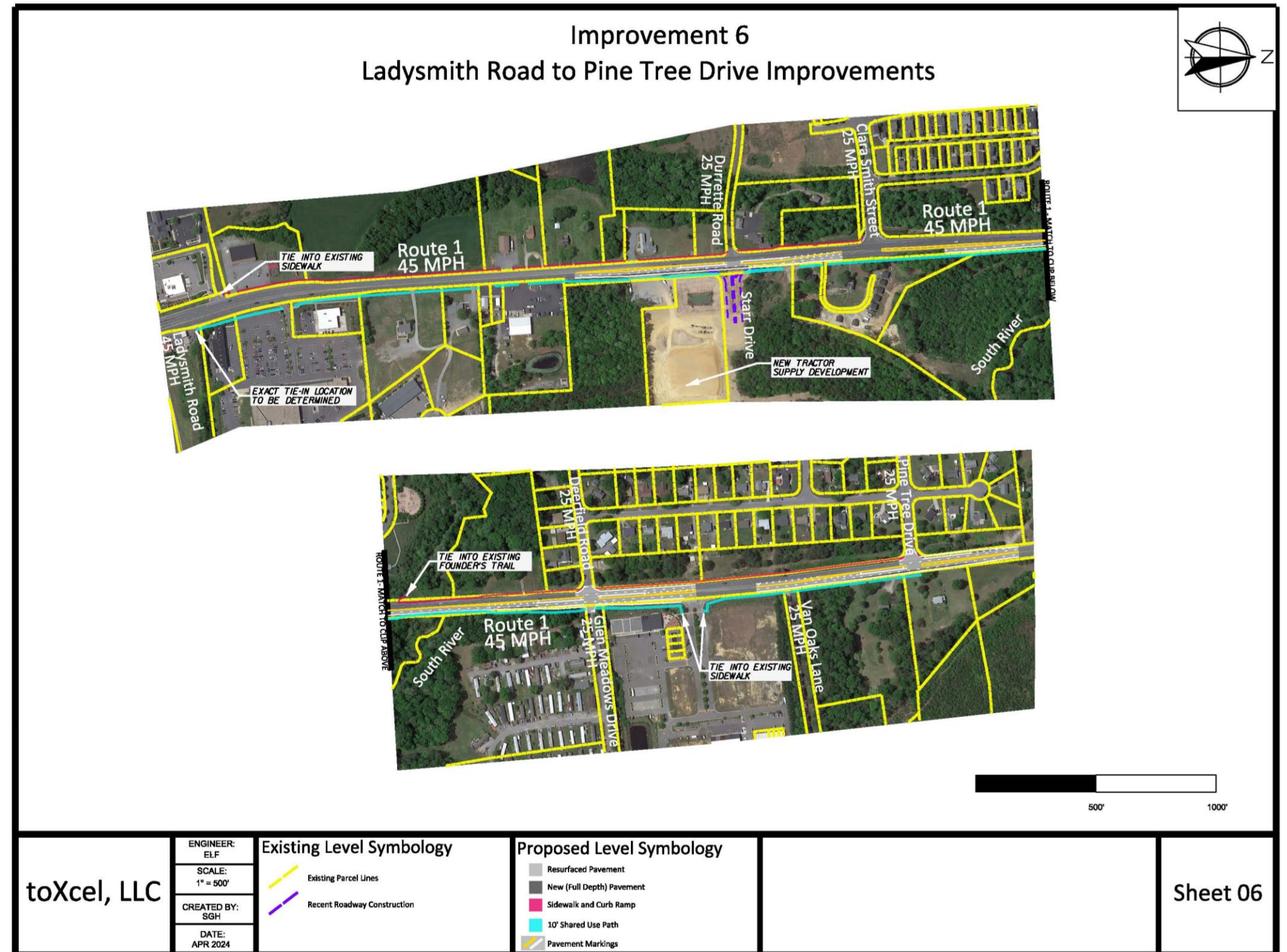


Figure 25: Ladysmith Road to Pine Tree Drive Improvements



### Quarters Road (632)/ Cedon Road (632/661)

Of the low-cost, medium-cost, and high-cost improvements considered in Phase 1, only the low-cost option was pursued in Phase 2. This concept closes the southeast leg of Route 632, increases the northbound right-turn radius on the northeast leg of Route 632, and adds northbound left-turn lanes at Cedon Road and Quarters Road, and adds a southbound left-turn lane to the northeast leg of Cedon Road. **Figure 26** presents a conceptual sketch of the improvements. Based on input from the SWG this alternative was included in the public survey.

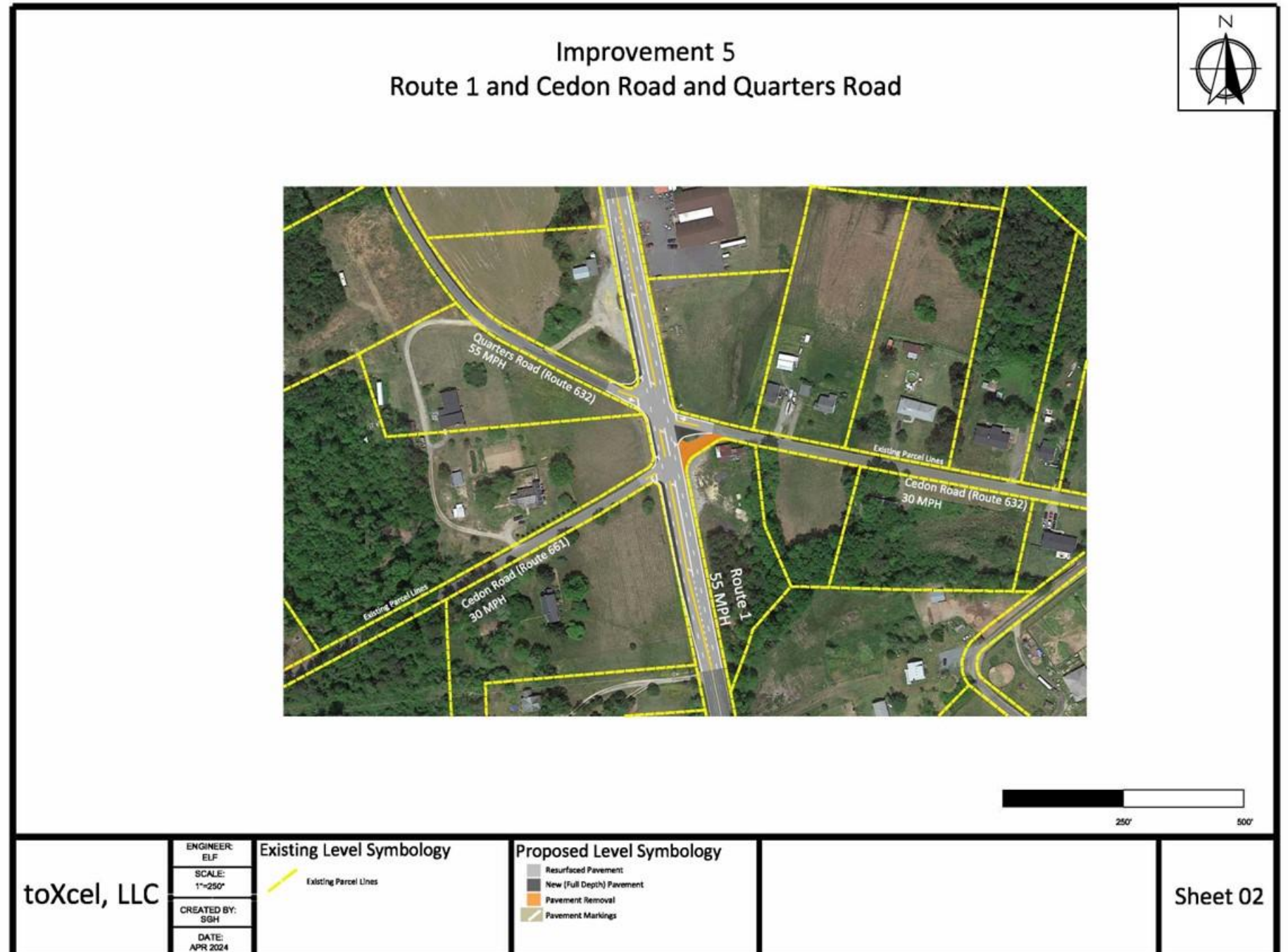


Figure 26: Quarters Road (632)/Cedon Road (623/661) Improvements

**Route 605 (Marye Road/Paige Road)**

This concept adds northbound and southbound left-turn lanes and improves the northbound right-turn radius. **Figure 27** presents a conceptual sketch of the improvements. Based on input from the SWG this alternative was included in the public survey.

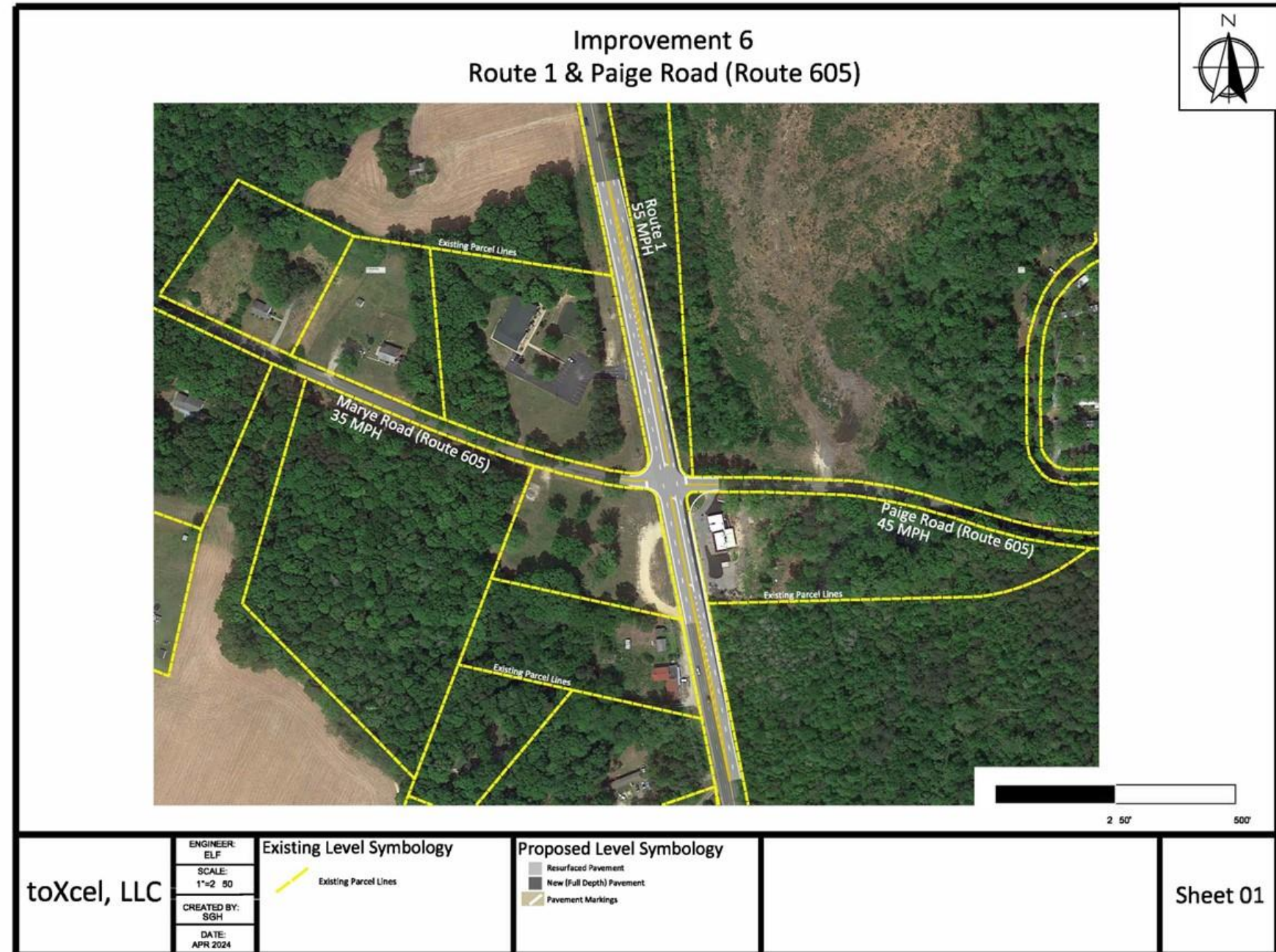


Figure 27: Route 605 (Marye Road/Paige Road) Improvements

## Anticipated Crash Reduction for Improvements

The study team reviewed crash modification factors (CMFs) to determine the potential safety benefits for each alternative. CMFs were selected from the SMART SCALE Planning Level CMF List for Round 6. **Table 17** lists the improvements by location and related CMF for those improvements with an appropriate CMF.

Table 17: Improvement Crash Modification Factors – SMART SCALE Planning Level CMFs – Round 6

Location	Improvement	CMF
Jericho Road (658)/Rogers Clark Boulevard (207)	signal timing optimization	0.958
	right-turn lane	0.87
	Crosswalk (high visibility)	0.60
	Countdown pedestrian timer	0.85
	pedestrian refuge island	0.69
	sidewalk	0.598
Lake Caroline Drive	right-turn lane	0.77
	left-turn lane	0.45 rural
Quarters Road (632)/Cedon Road (632/661)	left-turn lane	0.42
	increase intersection radii	0.95
Route 605 (Marye Road/Paige Road)	left-turn lane	0.42
	increase intersection radii	0.95
Ladysmith Road (639) to Pinetree Drive	left-turn lane	0.42 (four leg intersections) 0.45 (3 leg intersections)
	sidewalk	0.598
	Shared-use path	0.598 (pedestrian) 0.41 bicyclist
Access Management	left turn egress restriction	0.20*
	right-in/right-out only	0.20
	Increase intersection radii	0.95

\*No CMF for this improvement. Right-in/right-out only CMF noted.

## Chapter 3:

# PUBLIC AND STAKEHOLDER OUTREACH AND FEEDBACK

## Public Involvement:

Following the development and analysis of the improvement alternatives, a public involvement survey was developed to determine the public's response to the recommended improvements and what their preferred alternatives were. This survey was available online from March 18, 2024, to April 1, 2024.

## Survey Design

Public involvement for this study took place in the form of an online survey developed in PublicInput, which is an online community engagement platform that is designed to increase awareness of initiatives and gather feedback from the public. The beginning of the survey can be seen to the right, in **Figure 28**. The goals of this public outreach effort were to present relevant issues, educate the public on the recommended improvement concepts outlined in Chapter 2, and to receive the public's feedback on the proposed improvements along U.S. Route 1.

Overall, the survey was divided into three sections, which included the following:

1. Introduction
2. Questions on the proposed improvements
3. Wrap Up
4. The Introduction to the survey included a brief description of Project Pipeline, a list of the study partners, a brief background on the purpose of the study, and an image depicting the study location. The Questions portion of the survey had images of each proposed alternatives as well as a written description of the proposed improvements. The survey participants were then asked questions about the proposed improvements. For each improvement, participants were asked to rate the concept on a scale from 1 to 5 (1 = Strongly oppose, 2 = Somewhat oppose, 3 = Neutral, 4 = Somewhat support, and 5 = Strongly support). The participant's ratings for each concept were used to calculate an average score for each alternative. Participants were also able to leave a comment on each improvement question if desired.

Lastly, the Wrap Up section included several demographic questions and provided an opportunity to make additional comments about all of the suggested improvements. This survey was taken by 1,084 participants.

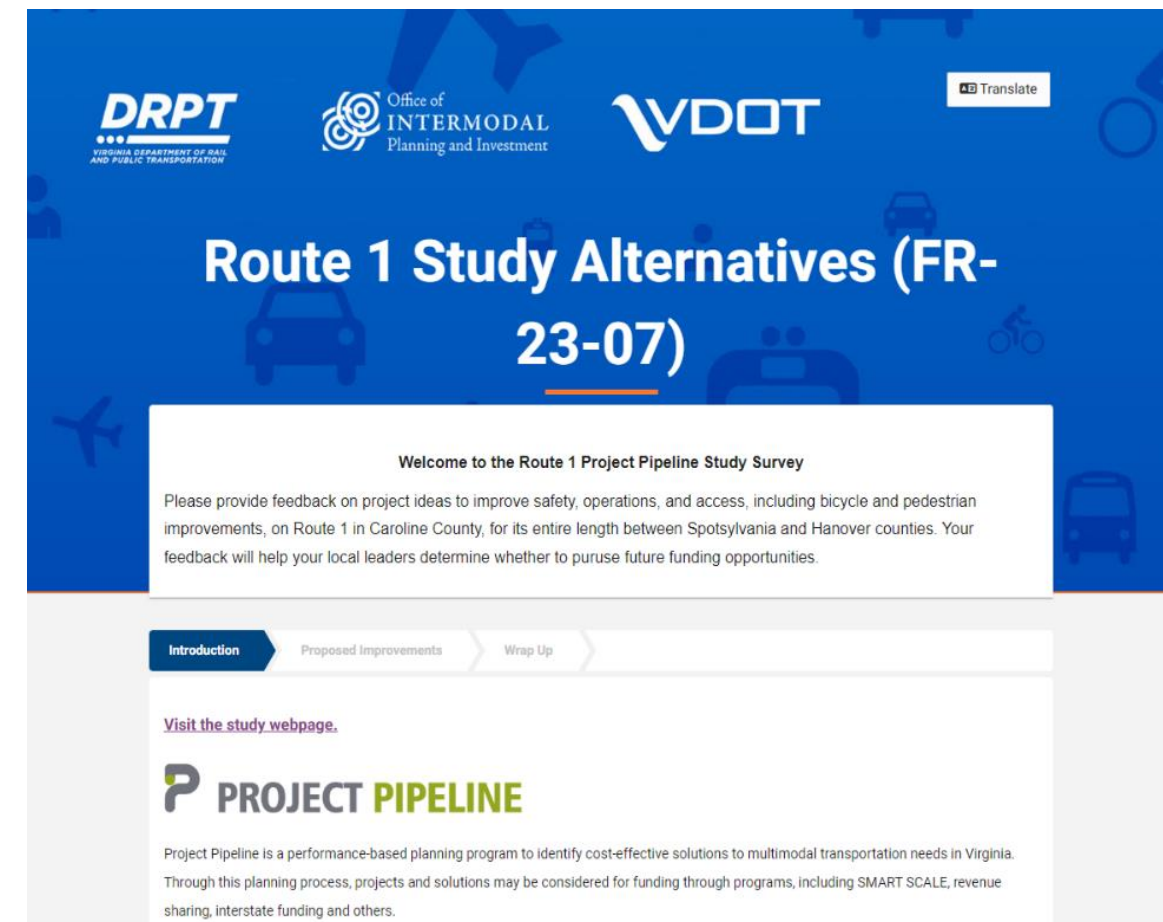


Figure 28: Public Survey Layout

## Survey Questions and Results

Overall, the improvements suggested in the survey were generally supported by the public. There were many survey participants that commented that these improvements were needed to increase safety and access for vehicles, pedestrians, and bicyclists along U.S. Route 1. Survey respondents stated that the influx of development in the area has increased traffic volume and speeding- the future development of the Kalahari Resort and Convention Center was mentioned several times. It was also noted by several respondents that when there is a crash or backup on Route 95, traffic is rerouted onto U.S. Route 1, causing more strain on the existing traffic patterns.

### Improvement 1: U.S. Route 1 and Rogers Clark Boulevard/Jericho Road Intersection

About half of the survey respondents either strongly or somewhat supported the intersection improvements at Rogers Clark Boulevard/Jericho Road and U.S. Route 1. This included marked crosswalks with ramps and pedestrian pushbuttons at the intersection. A dedicated right-turn lane was also proposed on the east leg of the intersection. Additionally, sidewalks with ramps at all driveways were proposed on both sides of Rogers Clark Boulevard, leading to marked crosswalks with ramps and pushbuttons on the south and west legs of the intersection of Rogers Clark Boulevard (Route 207) and Welcome Way Drive. Twenty-seven percent (27%) of respondents were indifferent toward this improvement, while nine percent (9%) somewhat opposed, and ten percent (10%) strongly opposed this improvement. This improvement had an average score of 3.60, making it the second least desirable proposed improvement. The respondent feedback for Improvement 1 is displayed to the right in **Figure 29**.

Most comments left by respondents expressed concern that there is not enough foot traffic in this area to warrant the pedestrian crosswalks and sidewalks. Many respondents voiced that this improvement seemed expensive and unnecessary due to lack of foot traffic in the area.

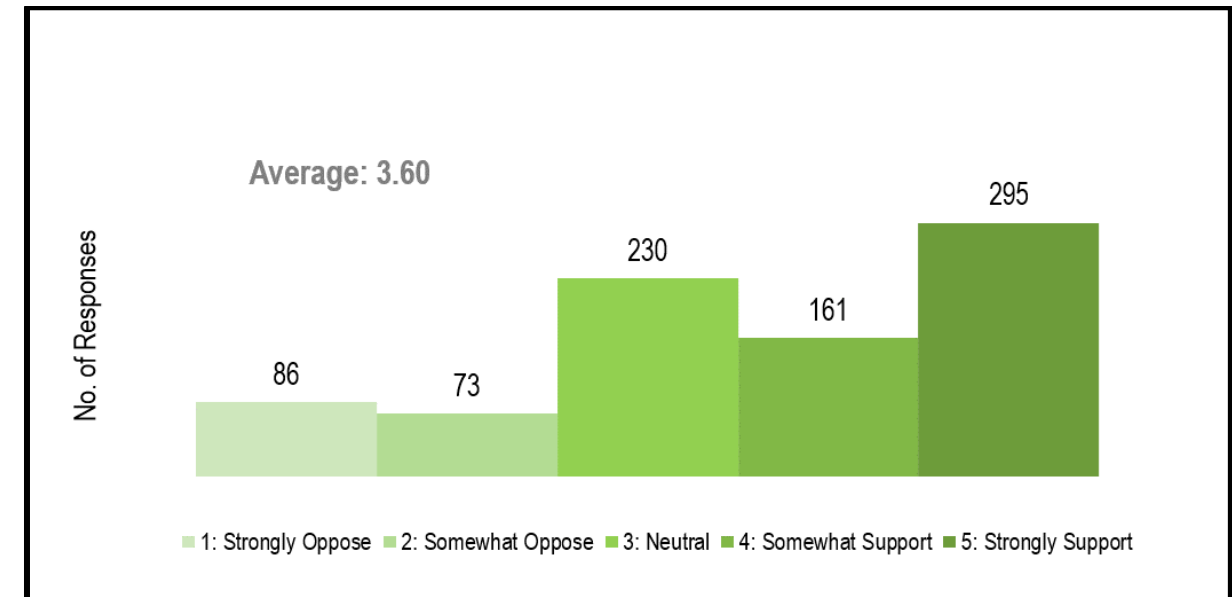


Figure 29: Respondent Feedback on Improvement 1 – U.S. Route 1 and Rogers Clark Boulevard/Jericho Road Intersection

### Improvement 2: U.S. Route 1 and Lake Caroline Drive Intersection

Improvement 2 had the greatest positive response, with over three-quarters (78%) of respondents strongly supporting the improvement at U.S. Route 1 and Lake Caroline Drive. This improvement had the highest average score of 4.60. This improvement included adding a northbound left-turn lane and a southbound right-turn lane on U.S. Route 1 at Lake Caroline Drive. This improvement also included new signing at the Lake Caroline Drive exit onto U.S. Route 1. “Do Not Enter” and “STOP” signs would be placed on either side of the Lake Caroline Drive Exit to avoid wrong way driving. The respondent feedback for Improvement 3 is displayed below in **Figure 30**.

Many survey respondents made comments in the survey that they supported adding the northbound left-turn lane on U.S. Route 1 at Lake Caroline Drive because there are many rear-end collisions as vehicles wait to turn left into the Lake Caroline residential community. Respondents also commented that during peak hours, vehicles attempting to turn onto Lake Caroline Drive cause congestion and delays on U.S. Route 1.

Survey participants were concerned about the financial cost of this project and what entity would fund it. Many participants expressed that the gated Lake Caroline residential community should fund this improvement, not VDOT. Another concern mentioned by respondents was the potential need for a traffic signal at this location to aid vehicles turning left out of the Lake Caroline community, especially during peak hours. Survey participants indicated that it is difficult and dangerous to try to leave the community at certain times because of the speeding that occurs in this area along U.S. Route 1.

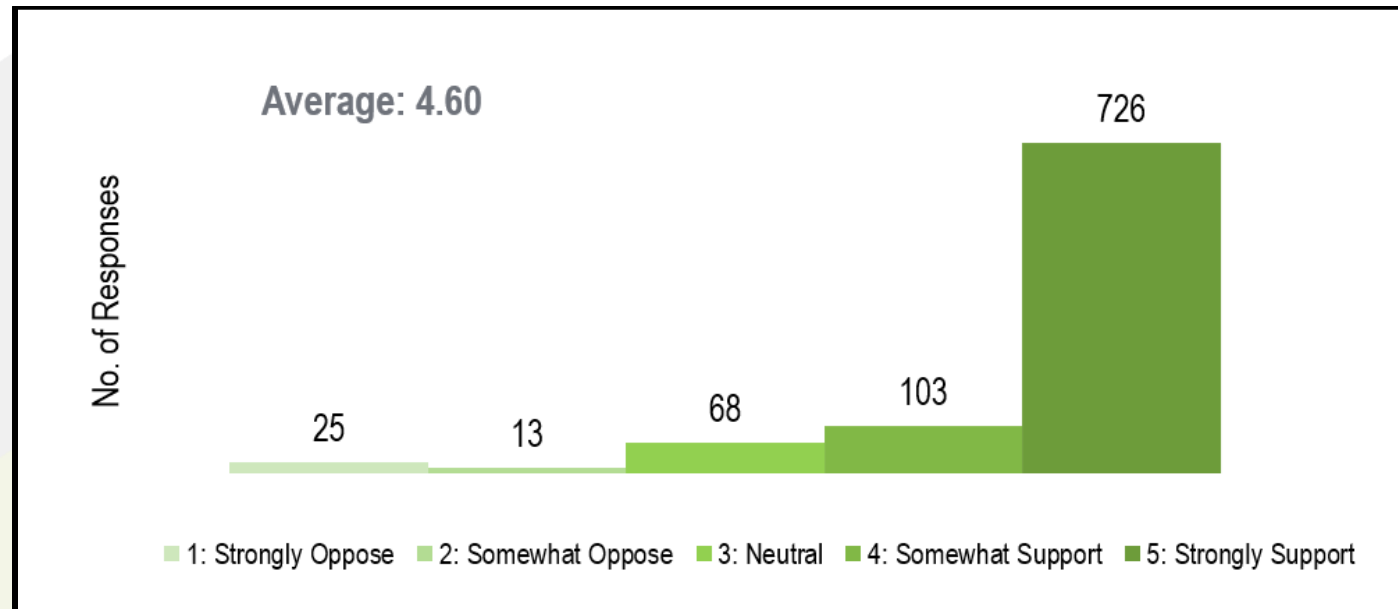


Figure 30: Respondent Feedback on Improvement 2 – U.S. Route 1 and Lake Caroline Drive Intersection

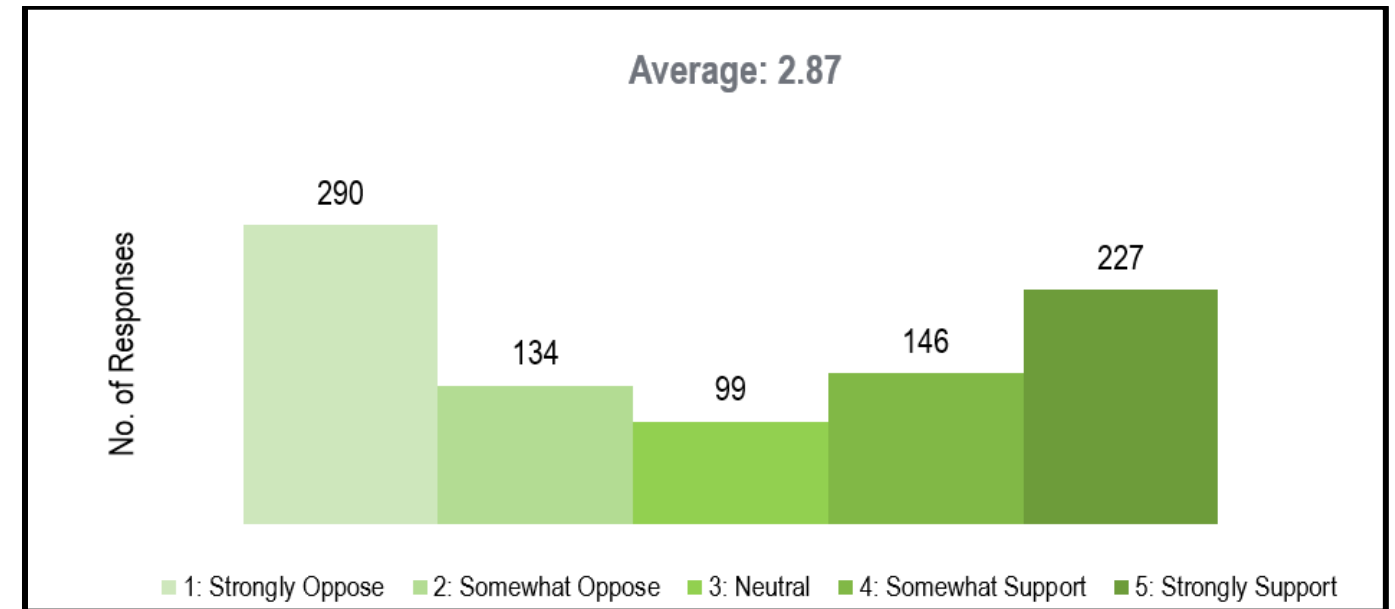


Figure 31: Respondent Feedback on Improvement 3 – U.S. Route 1 North of Ladysmith Road

### Improvement 3: U.S. Route 1 North of Ladysmith Road

The concept that received the least favorable response in the survey was Improvement 3: U.S. Route 1 North of Ladysmith Road. This suggested improvement location is just north of the U.S. Route 1 and Ladysmith Road intersection, specifically at the entrance/exit to the CVS parking lot and the Food Lion shopping center parking lot. The improvement prohibited left-turns out of the Food Lion shopping center and prohibited left-turns into and out of the CVS parking lot.

Approximately one-third (32%) of the responses strongly opposed this improvement and the concept had the lowest average score of 2.87. An additional fifteen percent (15%) of respondents somewhat opposed the improvement, while only one-quarter (25%) of responses indicated that they strongly supported the improvement. The response breakdown is displayed in **Figure 31**.

Many survey participants commented that the restricted movements into and out of the parking lots would create a need for inconvenient detours to get to and from the CVS and Food Lion. The recent improvement of the Ladysmith Road and U.S. Route 1 intersection added a median, thus eliminating the left-turn option to exit the CVS parking lot onto Ladysmith Road. The accessibility of these parking lots is a pain point amongst local drivers. Respondents worried they would have to make unsafe U-turns to get to their destinations.

### Improvement 4: Ladysmith Road to Pine Tree Drive Improvements

Survey participants were asked their opinion on two different variations for the sidewalk and shared-use path placement along U.S. Route 1 from Ladysmith Road to Pine Tree Drive. The first option presented in the survey proposed the 5' sidewalk on the west side of U.S. Route 1 and the 10' shared-use path on the east side of U.S. Route 1. Option 2 proposed the sidewalk on the east side of U.S. Route 1 and the shared-use path on the west side of U.S. Route 1.

The results for both questions were very similar. For both options, fifty-seven percent (57%) of participants somewhat or strongly supported the improvement, approximately one-third (32%) of survey participants felt neutral, and eleven percent of participants (11%) somewhat or strongly opposed the improvement. The majority of respondents did not have a strong preference of which side the sidewalk and shared-use path were located. Thirteen (13) respondents were concerned that there was not a need for this improvement and that this would not be a good use of funding.

A follow up question was presented to participants asking their preferred location for a crosswalk across U.S. Route 1 within the corridor. There were four choices presented. The results are shown **Figure 34**. Sixty percent (60%) of respondents selected the Ladysmith Commons Boulevard location. Respondents commented that Ladysmith Commons Boulevard would be the best location for a crosswalk because of the shops and restaurants nearby. Some respondents were worried that adding a crosswalk on U.S. Route 1 would encourage more foot traffic in the area and lead to more congestion and create unsafe situations for pedestrians due to speeding that often occurs on U.S. Route 1. The respondent feedback for Improvement 4 is displayed in **Figure 32**, **Figure 33**, and **Figure 34**.

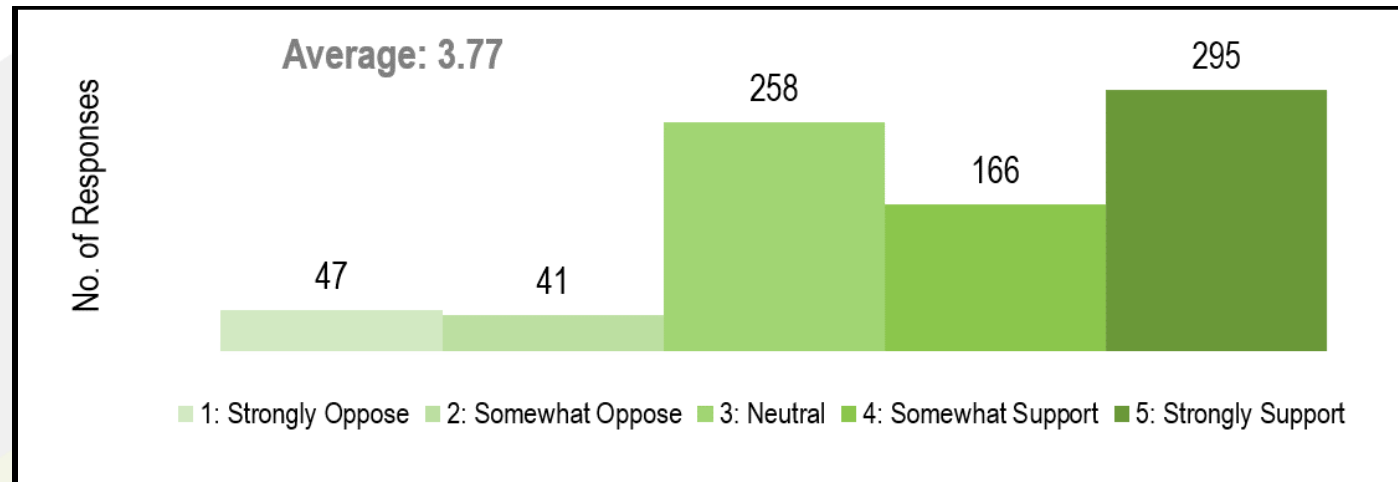


Figure 32: Respondent Feedback on Improvement 4 – Ladysmith Road to Pine Tree Drive Option 1

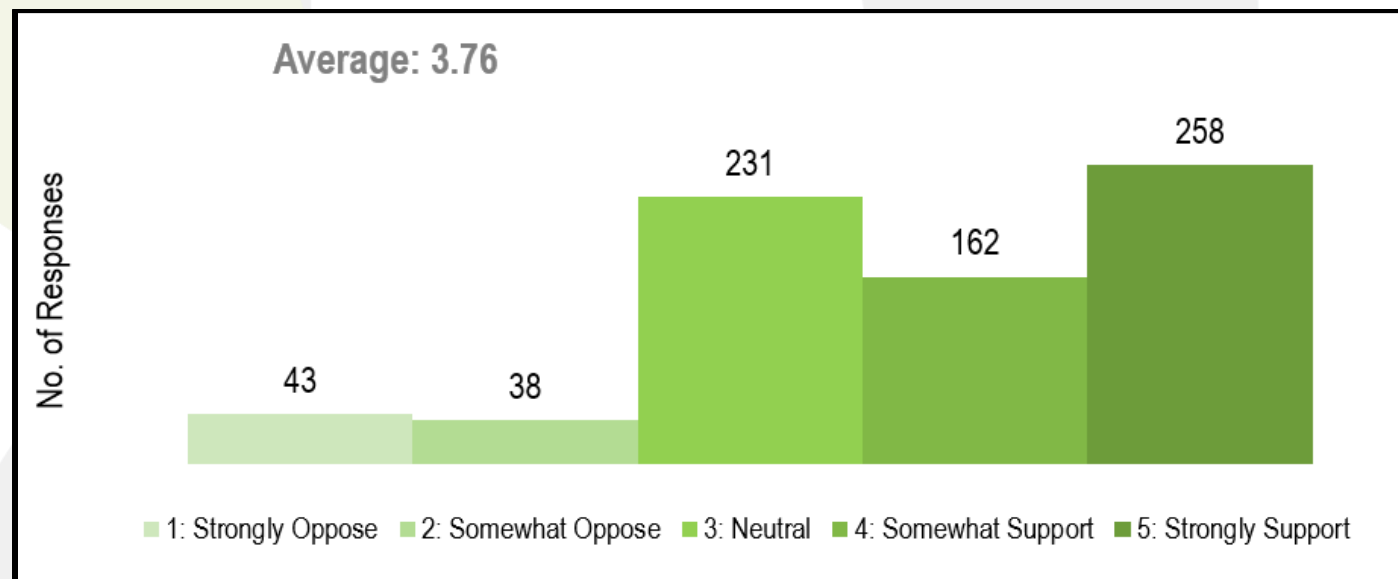


Figure 33: Respondent Feedback on Improvement 4-Ladysmith Road to Pine Tree Drive Option 2

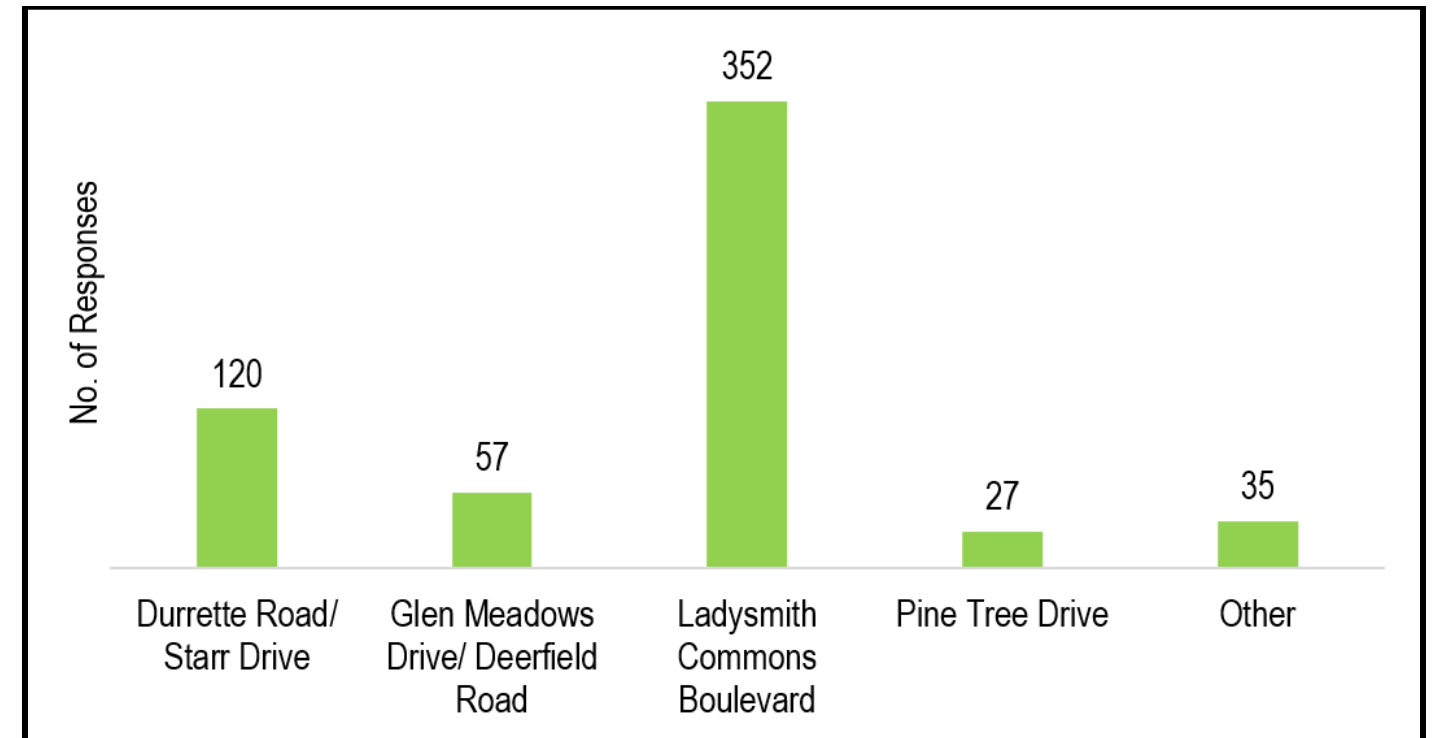


Figure 34: Preferred Location for Crosswalk on U.S. Route 1

### Improvement 5: U.S. Route 1 and Cedon Road and Quarters Road

Forty percent (40%) of respondents strongly supported the addition of left-turn lanes on U.S. Route 1 at Cedon Road and Quarters Road and the elimination of the cut-through on the southeast corner of the intersection. Twenty percent (20%) of respondents somewhat supported these improvements, while almost one-third of respondents were neutral. Eleven percent (11%) of respondents opposed the improvements, either strongly or somewhat, resulting in an average score of 3.83. The respondent feedback for Improvement 5 is displayed below in **Figure 35**.

Several survey participants supported removing the cut-through on the east side of U.S. Route 1 and mentioned realigning the eastern leg of the intersection to improve the angled approach of Cedon Road. However, other respondents were worried about vehicles and bicyclists crossing over U.S. Route 1 from Cedon Road (west of U.S. Route 1) to Cedon Road (east of U.S. Route 1) and vice versa. Removing the cut-through would force vehicles and bicyclists traveling on Cedon Road to turn onto U.S. Route 1 and travel a short distance before turning onto the other side of Cedon Road. Despite these concerns, most respondents had no comments on this improvement.



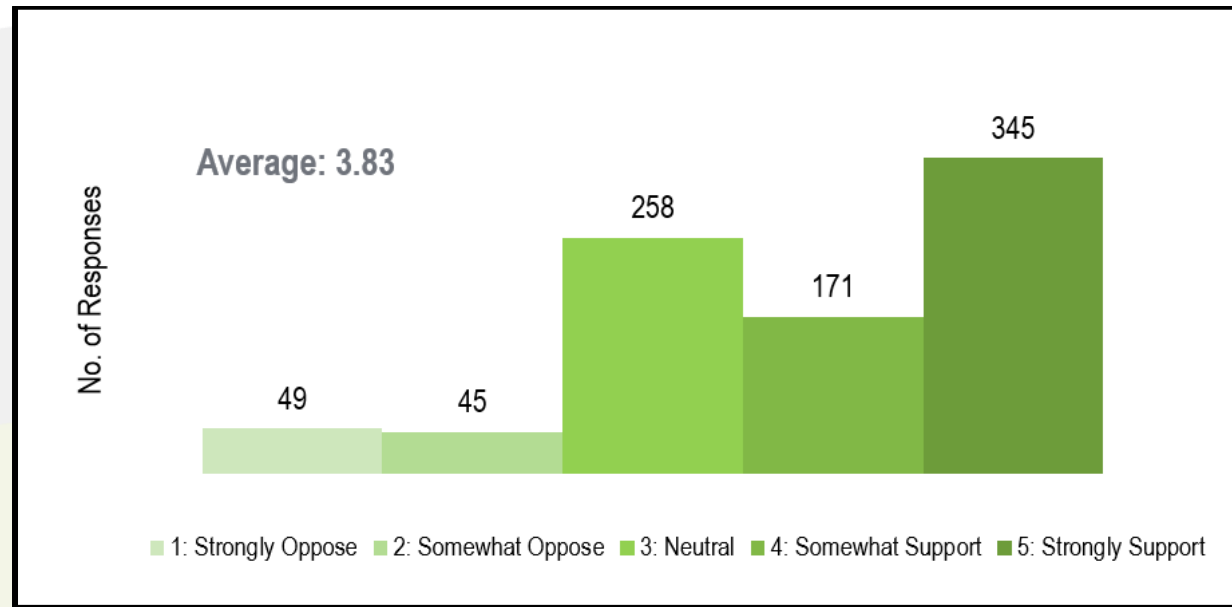


Figure 35: Respondent Feedback on Improvement 5 – U.S. Route 1 and Cedon Road and Quarters Road

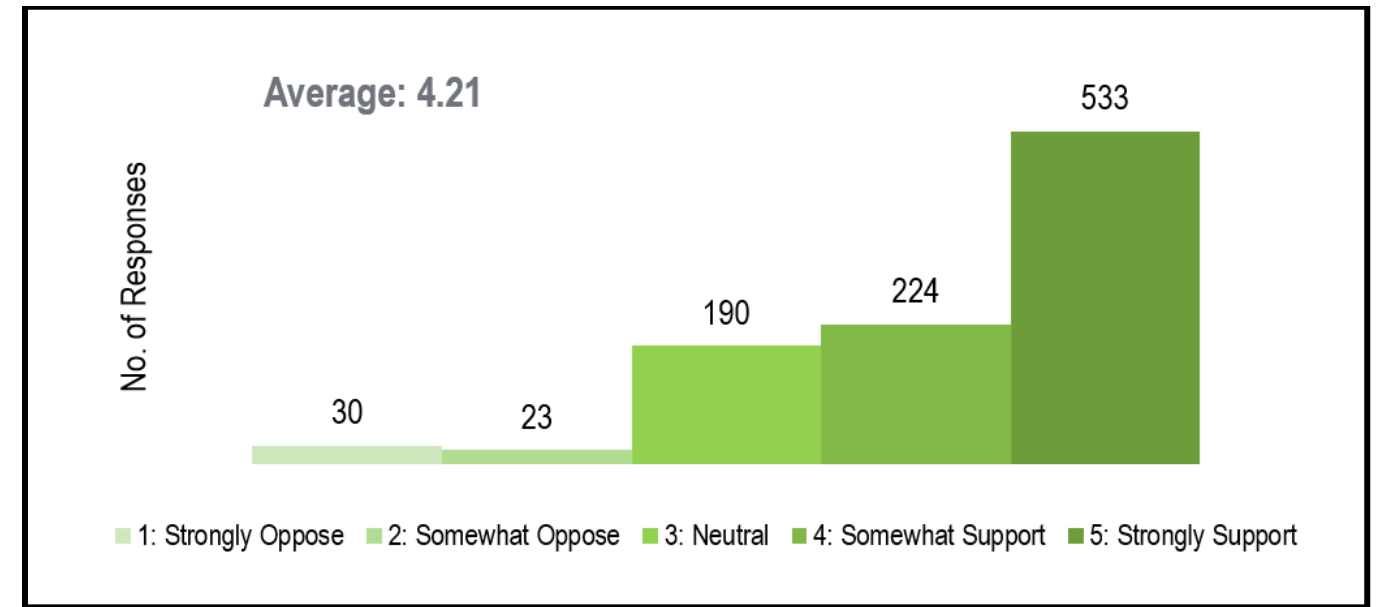


Figure 36: Respondent Feedback on Improvement 6 - U.S. Route 1 and Paige Road (Route 605)

### Improvement 6: U.S. Route 1 and Paige Road (Route 605)

Overall, this improvement was supported by most participants, with an average score of 4.21. Adding left-turn lanes on U.S. Route 1 at Paige Road and Marye Road and adjusting the radius of the northwest and southeast corners of the intersection was strongly supported by fifty-three percent (53%) of respondents and somewhat supported by twenty-three percent (23%) of respondents. Only five percent (5%) of respondents strongly or somewhat opposed the improvement. The respondent feedback for Improvement 6 is displayed below in **Figure 36**.

Survey participants noted that there is a high number of crashes at this location and safety measures are needed for queued left-turning vehicles. Respondents also mentioned that a traffic signal may be helpful at this location due to limited visibility on Paige Road approaching U.S. Route 1.

### Improvement 7: U.S. Route 1 and Durette Road/Starr Drive Improvements

Improvement 7 was somewhat or strongly supported by most (63%) of respondents and scored an average of 3.91. Nearly one-third (31%) of respondents were neutral toward the proposed turn lanes for Durette Road and Starr Drive. Most supporters of this improvement and those who were indifferent did not make comments about this concept. Some stated that they believed adding turn lanes would make this area safer. The breakdown of the results is shown in **Figure 37**.

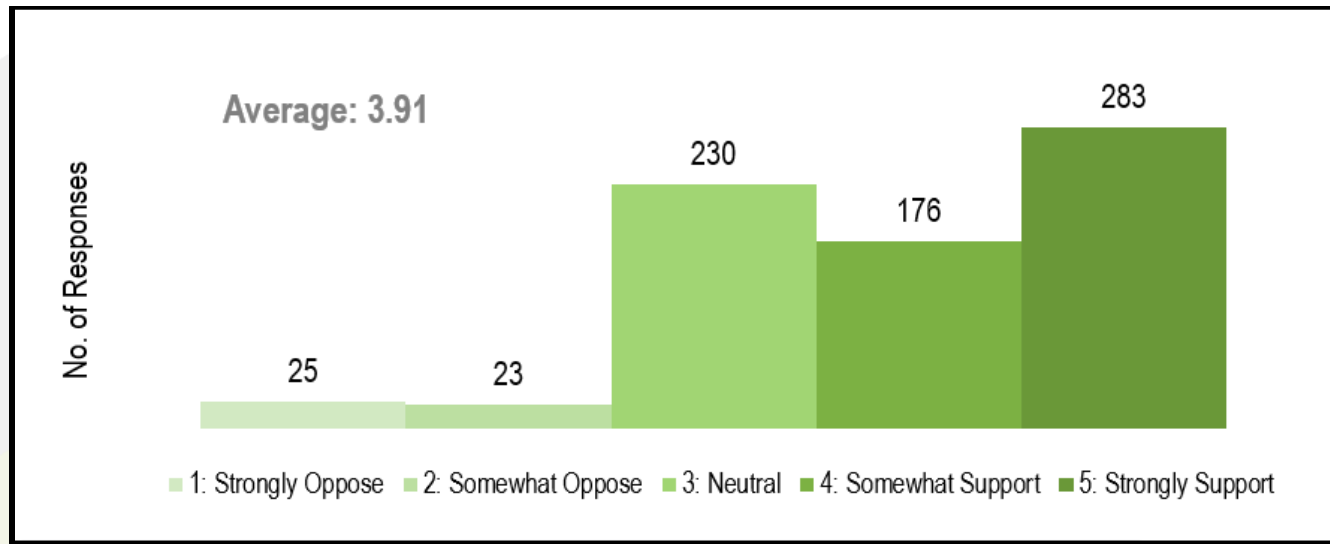


Figure 37: Respondent Feedback on Improvement 7 – Route 1 and Durrette Road/Starr Drive

### Improvement 8: U.S. Route 1 and Deerfield Road/Glen Meadows Drive Improvements

Improvement 8 was supported amongst most survey participants. The proposed turn lanes at Deerfield Road/Glen Meadows Drive and Ladysmith Commons Boulevard scored an average of 3.95 amongst respondents. Twenty-eight percent (28%) of respondents were indifferent toward this improvement. Most supporters of this improvement and those who were neutral did not make comments about this concept. Several respondents commented that this improvement should help reduce traffic queuing on U.S. Route 1 due to turning vehicles. The results are shown in **Figure 38**.

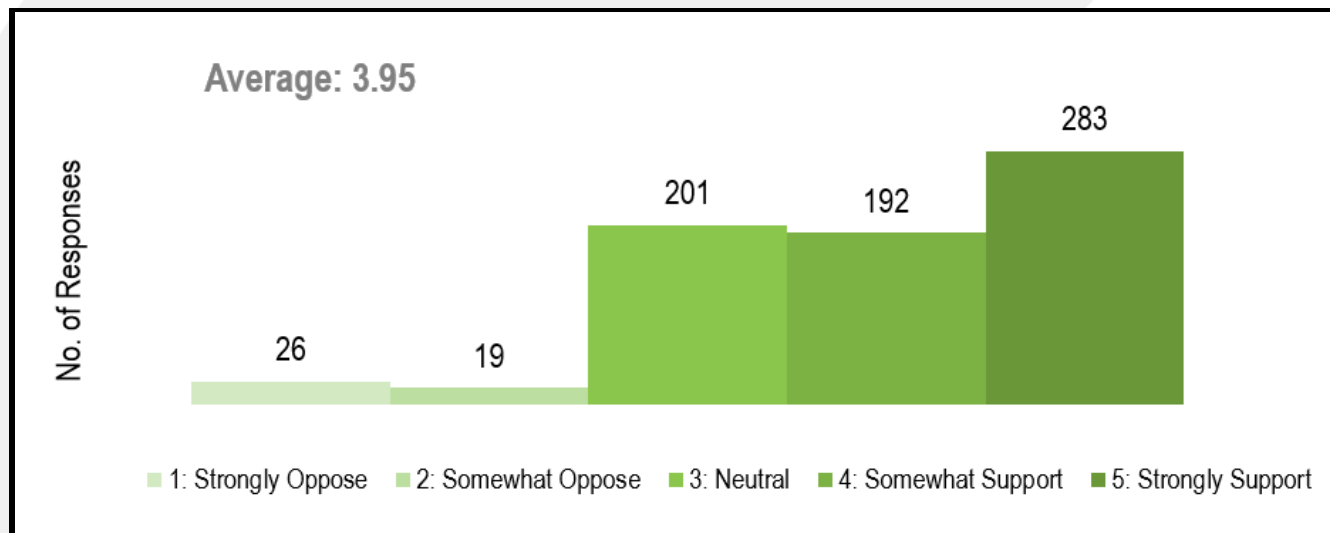


Figure 38: Respondent Feedback on Improvement 8 – Route 1 and Deerfield Road/Glen Meadows Drive

### Improvement 9: U.S. Route 1 and Pine Tree Drive Intersection Improvements

Very few respondents left comments about this improvement. Fifty-seven percent (57%) of respondents somewhat or strongly supported this improvement, while thirty-six percent (36%) of respondents were indifferent toward the improvement. This improvement had an average score of 3.79. The results are shown in **Figure 42**.

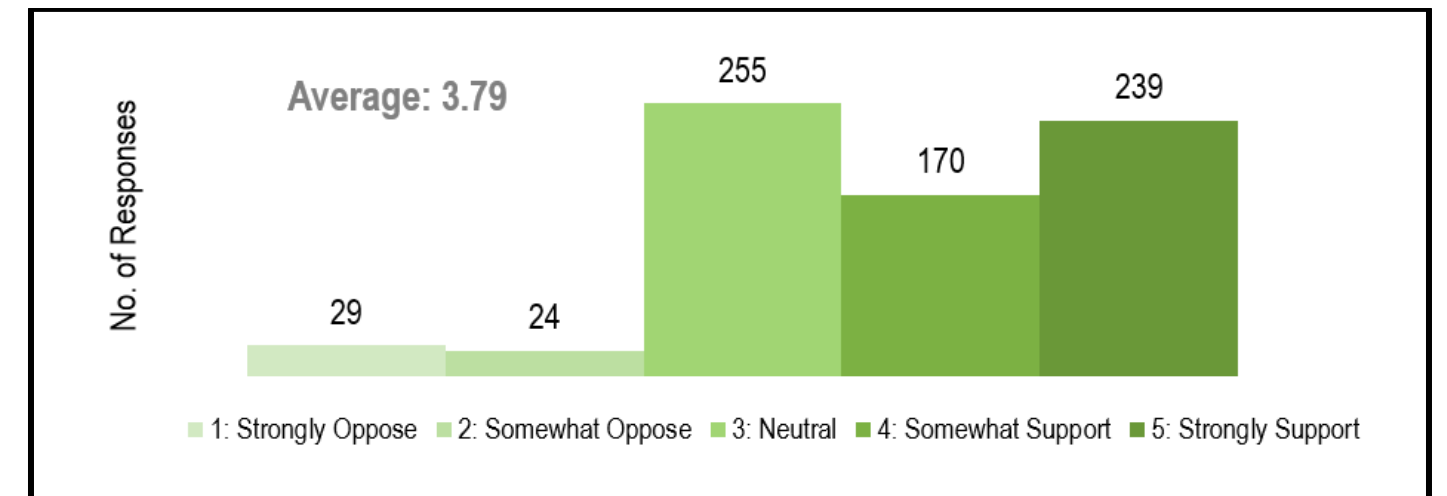


Figure 39: Respondent Feedback on Improvement 8 – U.S. Route 1 and Pine Tree Drive

Survey respondents had the option to enter freeform comments as a general response to the survey or regarding specific improvements. A selection of respondents' comments is shown in **Table 18** with the study team responses. A compilation of all freeform public comments can be found in **Appendix F**.

Table 18: Highlight of Public Comments and Study Team Responses

Public Comments and Study Team Responses		
	Public Comment	Study Team Response
Lake Caroline Drive	"The Private community should be paying for improvements to their entrance. Will Ladysmith Village, Lake Land'Or, or Pendleton see the same improvement?"	The proposed improvements are outside of the gated community and impact safety and operations on the VDOT owned and maintained roadway of U.S. Route 1.
Cedon Road/Quarters Road	"Will this force cars from the west side Cedon Rd to turn left onto Rte 1, slow and turn onto the east side of Cedon Rd? Might this create a safety concern because they would be in U.S. Rte 1 longer?"	Elimination of the cut-through reduces conflict points at this intersection and reducing conflict points is a method to improve safety.
Sidewalk and Shared Use Path along U.S. Route 1 from Ladysmith Road to Pine Tree Drive	"Is this needed?"	The pedestrian facilities proposed in this concept connect residential communities and existing trails to commercial properties along Ladysmith Road. This concept was supported by 57% of respondents and only opposed by 11%.

## Preferred Alternatives

Based on stakeholder and public feedback, the following alternatives were selected as preferred alternatives which were submitted for pre-application for the STARS Program:

Improvement 1: U.S. Route 1 and Paige Road (Route 605)

Improvement 2: U.S. Route 1 and Cedon Road and Quarters Road

Improvement 3: U.S. Route 1 and Lake Caroline Drive Intersection

Improvement 4: U.S. Route 1 from Ladysmith Road to Pine Tree Drive

Improvement 5: U.S. Route 1 and Rogers Clark Boulevard/Jericho Road Intersection

## Chapter 4:

# PREFERRED ALTERNATIVE DESIGN REFINEMENT & INVESTMENT STRATEGY

## Intent of Phase 3

The intent of Phase 3 of the Project Pipeline effort is to further develop the selected preferred alternatives from Phase 2 that will carry through to funding applications and project validation. The goal is to ensure that projects are defined to the maximum extent possible and to identify and mitigate potential risks. Utilizing technical resources of both VDOT and consultant teams, a multi-disciplinary approach is part of the overall effort that provides the needed input and problem-solving to ensure funding applications are thoroughly vetted and taken past a planning level sketch and estimate.

The goal is to develop more detailed, quantity based, deterministic estimates and designs paired with thoughtful risk assessment and mitigation. The team will use practical design and common-sense engineering methods to document the assumptions and approaches that lead to the most efficient and effective project scopes. The effort maintains focus on the purpose and needs identified through Phase 1 and 2 that address the VTRANS priorities.

Technical resources utilize Phase 3 for thorough communication and collaboration with District, Central Office, FHWA, or other key partners and stakeholders that may have decision making authority or input on final designs if projects are selected for funding. An intended outcome is that projects, if funded, will have the documentation and support for innovation and flexibility that may be necessary to achieve success.

The Phase 3 Technical Team developed the analysis, design, deliverables, and documentation that will serve as the basis for future Preliminary Engineering work on the projects. At the conclusion of Phase 3, projects should achieve a solid foundation of understanding from a planning and preliminary engineering focus that will ensure applications are well validated, reasonably scoped, meet the needs originally established in studies, and have a high probability of success.

More detailed information for each of the alternatives presented in the subsequent sections can be found in **Appendix G – Basis of Design Memorandums**.

## Preferred Alternative #1: U.S. Route 1 and Paige Road/Marye Road

### Design Assumptions

The following are key design assumptions that informed the concept development and the cost estimate preparation:

- Roadway Geometry – Pavement widening will be required to accommodate new northbound and southbound turn lanes at the intersection of U.S. Route 1 at Paige Road/Marye Road. The widening will impact the property lines on the east side of U.S. Route 1. To accommodate the new lane shift, pavement widening will begin approximately 1,100 ft south of Paige Road and will merge back on existing pavement approximately 1,100 ft north of Paige Road.
- Hydraulics – New drainage ditches will be implemented where the pavement is being widened. Due to the roadway shift, drainage ditches are proposed within the limit of the shift to tie into the existing drainage ditch.
- Right of Way – Additional right of way and easement will be required on the east side of U.S. Route 1. The improvements will impact four parcels along U.S. Route 1. The right of way is based on available GIS parcel information. VDOT district will prepare the right of way estimate.
- Utility Impact – Out of plan utility impacts are anticipated. Underground utility information was not available. On the east side of U.S. Route 1, overhead utility poles and underground communications, electrical service, and junction box will be impacted. VDOT district will prepare the utility impact estimate.
- Design Waivers/Exceptions – None are anticipated for this project.
- Environmental Considerations – The level of environmental document anticipated is a Categorical Exclusion, either a PCE or a CE depending on final project impacts/scope. VDOT indicated that cultural resources considerations would need to be addressed during the design phase due to the historical marker at the southeast quadrant of the intersection.
- Constructability & Maintenance of Traffic Assessment - Lane closures and flagging operation will be necessary during the roadwork for the maintenance of traffic.

Based on VDOT and Stakeholder input from Phase 2 and the site visit performed at the commencement of Phase 3, the concept was advanced, refining key elements of the preferred alternative, as shown in **Figure 40**.

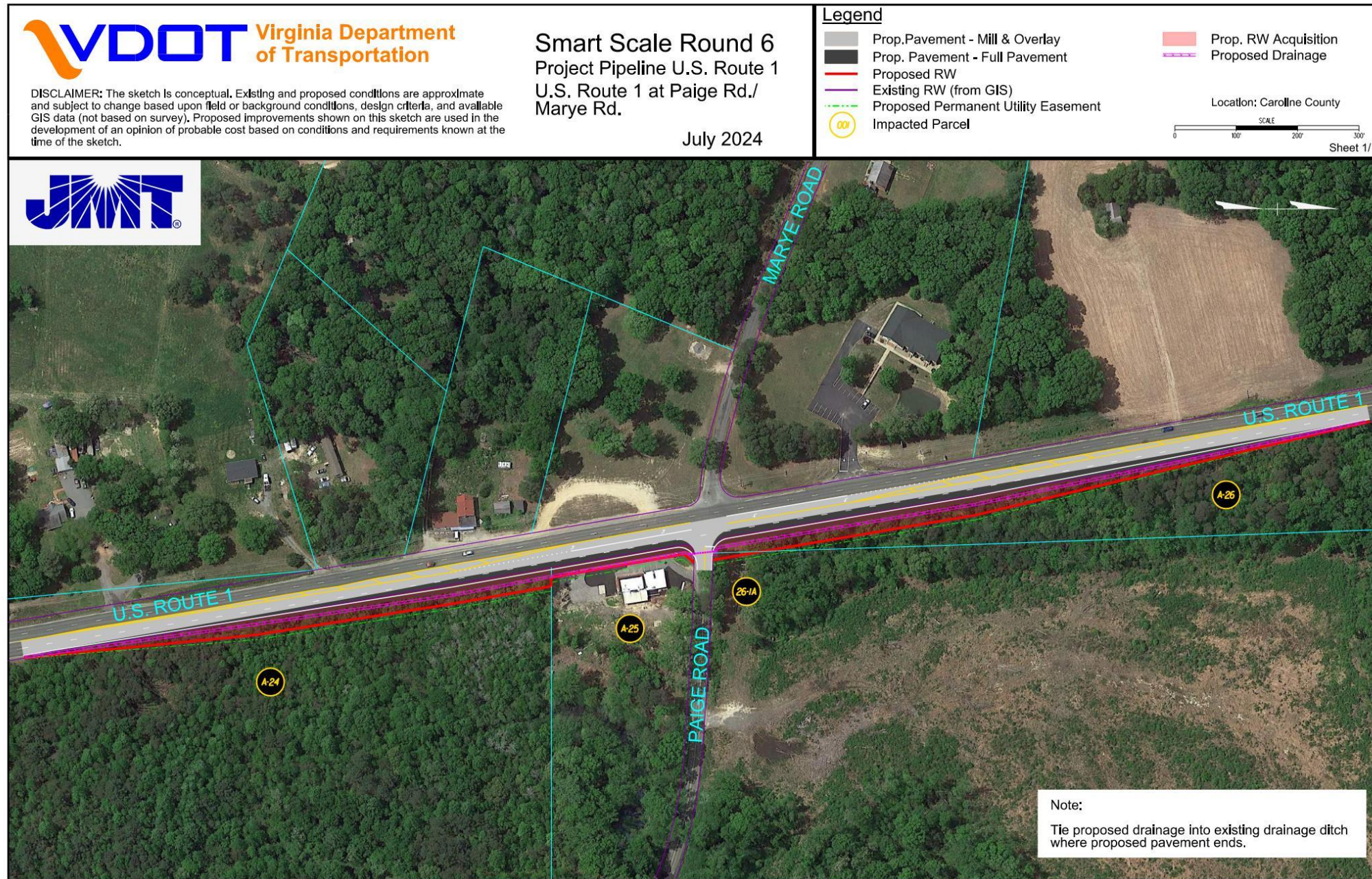


Figure 40: U.S. Route 1 at Paige Rd./Marye Rd. Improvements

## Project Risk and Contingency

This project is considered Moderately Complex and at a Pre-Scoping Phase; however, the level of concept design development is relatively detailed, therefore, the Most Likely Estimate (MLE) contingency would be most accurate 50%, in accordance with VDOT's cost estimating manual. Project specific risks were identified and assessed based on data collected, field visits, stakeholder input and concept design development. In addition, other typical project risks were assessed as applicable. Risks were organized by broad categories/phases including Preliminary Engineering, Roadway, Right of Way, Environmental, Utilities, Geotechnical, Drainage, and Construction. Individual risk within each phase were "scored" based on probability, cost impact and time impact. Scoring was used to assign contingencies per risk line item. These line-item risk contingencies were then aggregated to determine a contingency amount per category/phase:

- Preliminary Engineering – 30%
- Roadway – Updated survey information and final design may identify additional roadway design risks but are not anticipated to be significant. It is recommended to utilize 45% risk contingency.
- Right of Way – Final design may change some of the limit of construction. The right of way impacts is based on available GIS parcel information. It is recommended to utilize 60% risk contingency.
- Environmental – Updated environmental review, survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 50% risk contingency.
- Utilities – Underground utility information was not available. Final design and survey may identify additional utility conflicts. It is recommended to utilize 75% risk contingency.
- Geotechnical – Updated survey, geotechnical information and final design may identify additional earthwork, but not expected. It is recommended to utilize 30% risk contingency.
- Drainage – Updated survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 40% risk contingency.
- Construction/MOT – MOT plans have not been developed at this stage. It is recommended to utilize 75% risk contingency.

## Cost Estimate

### Methodology

The cost estimate was developed using VDOT's Pre-Quantity Tool with the methodology described below:

- Understanding the goals of the project and scope of improvements to be implemented

- Gathering and reviewing all available information about the project including site visits and stakeholder input
- Establishing design criteria and requirements to develop detailed design concepts
- Performing quantity takes offs and using VDOT Pre-Quantity Tool Bid Item Unit Costs
- Develop additional allowances to be allocated to various phases of project construction
- Performing a risk assessment as outlined above and identifying appropriate contingency percentages by category
- Developing Preliminary Engineering costs by category based on a percentage of the Construction cost (See the Cost Estimate Workbook for more details).

### Cost Estimate Breakdown

The total project cost is estimated at \$8,045,073 and broken down by Phase/Major area as follows:

- Preliminary Engineering Phase – \$1,549,210
- Right of Way and Utilities Phase – \$415,000\*
- Construction (without CEI) – \$5,341,545
- Construction (with CEI) – \$6,080,863

\*Final right of way and utility costs will be updated by VDOT

## Preferred Alternative #2: U.S. Route 1 and Cedon Road/Quarters Road

Through meetings with stakeholders, it was determined that this alternative will not move forward to Phase 3. VDOT, however, provided an updated concept image that shows the anticipated improvements that may be studied in future applications. The revised concept can be seen in **Figure 41**.



Figure 41: U.S. Route 1 at Cedon Rd./Quarters Rd.

## Preferred Alternative #3: U.S. Route 1 and Lake Caroline Drive

### Design Assumptions

The following are key design assumptions that informed the concept development and the cost estimate preparation:

- **Roadway Geometry** – Pavement widening will be required to accommodate new northbound and southbound turn lanes at the intersection of U.S. Route 1 at Lake Caroline Drive. The widening will impact the existing right turn lane north of the intersection of U.S. Route 1 at Lake Caroline Drive into Vision Baptist Church, and the property line of the church. Due to this, the right turn lane into the church will be reconstructed to a standard 200-foot storage and taper length. The shift will occur from just south of the VDOT's Ladysmith Area Headquarter on the east side of U.S. Route 1, and merge back on existing pavement approximately 700 feet north of Lake Caroline Drive.
- **Hydraulics** – New drainage ditches will be implemented where the pavement is being widened. New drainage pipes will be needed under the Lake Caroline Drive entrance, and other driveways being impacted by the new pavement. Due to the roadway shift, drainage ditches are proposed within the limit of the shift to tie into the existing drainage ditch.
- **Traffic** – Per recommendation from VDOT, offset right turn lane is proposed for the southbound direction, in lieu of a traditional right turn lane. This will provide a better view of the southbound through traffic for drivers exiting Lake Caroline Drive.
- **Right of Way** – Additional right of way and easement will be required on the east and west sides of U.S. Route 1. The improvement will impact seven properties along U.S. Route 1. The right of way is based on available GIS parcel information. VDOT district will prepare the right of way estimate.
- **Utility Impact** – Out of plan utility impacts are anticipated. Underground utility information was not available. On the west side of U.S. Route 1, overhead utility poles and underground water pipes will be impacted, based on the field visit observation. On the east side, underground fiber optics, communication transformer, communication junction box, and fire hydrant will be impacted. VDOT district will prepare the utility impact estimate.
- **Design Waivers/Exceptions** – None are anticipated for this project.
- **Environmental Considerations** – The level of environmental document anticipated is a Categorical Exclusion, either a PCPE or a CE depending on final project impacts/scope.
- **Constructability & Maintenance of Traffic Assessment** - Lane closures and flagging operation will be necessary during the roadwork for the maintenance of traffic.



Based on VDOT and Stakeholder input from Phase 2 and the site visit performed at the commencement of Phase 3, the concept was advanced, refining key elements of the preferred alternative, as shown in **Figure 42**.

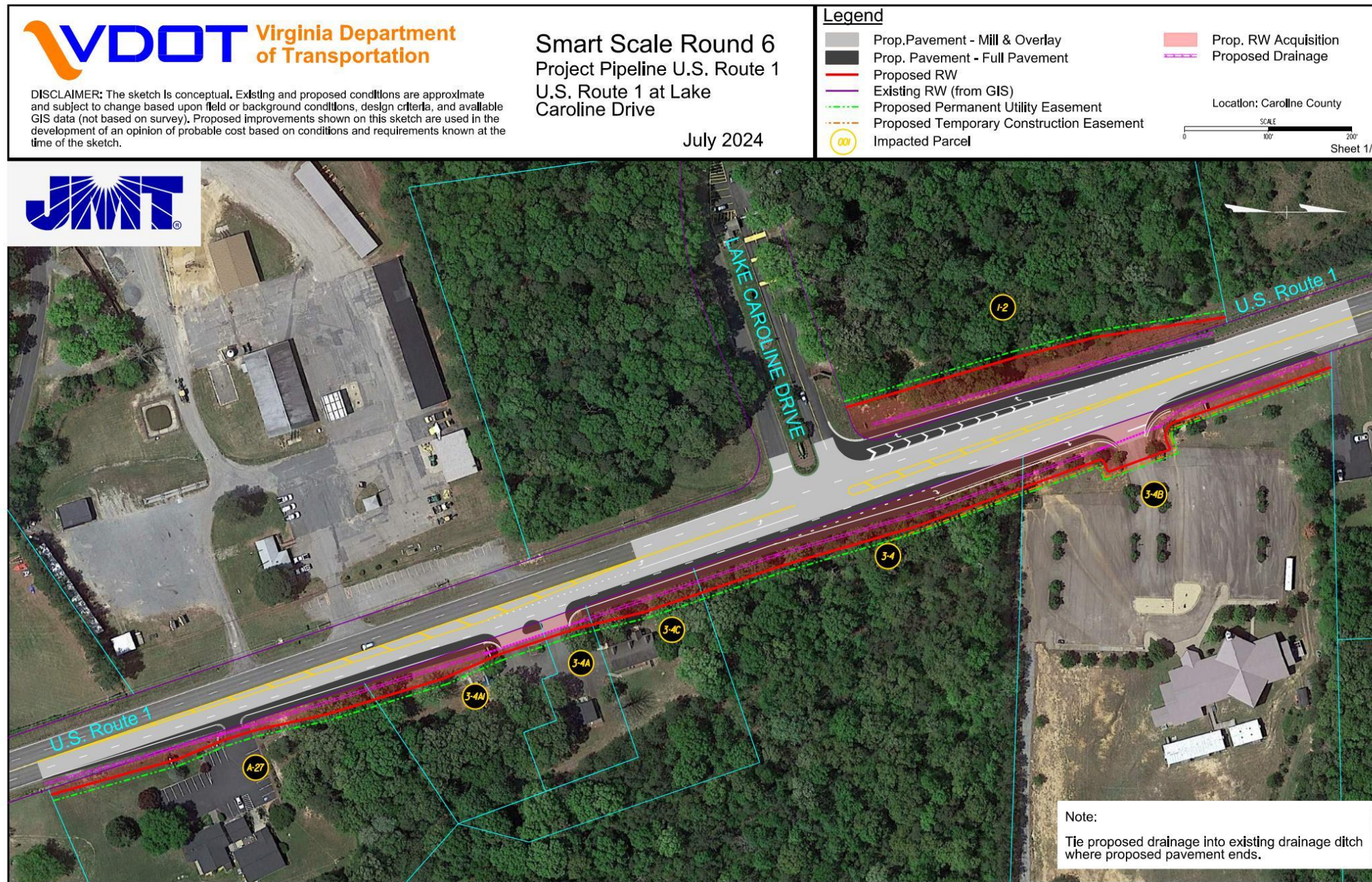


Figure 42: U.S. Route 1 at Lake Caroline Drive Improvements

## Project Risk and Contingency

This project is considered Moderately Complex and at a Pre-Scoping Phase; however, the level of concept design development is relatively detailed, therefore, the Most Likely Estimate (MLE) contingency would be most accurate 50%, in accordance with VDOT's cost estimating manual. Project specific risks were identified and assessed based on data collected, field visits, stakeholder input and concept design development. In addition, other typical project risks were assessed as applicable. Risks were organized by broad categories/phases including Preliminary Engineering, Roadway, Right of Way, Environmental, Utilities, Geotechnical, Drainage, and Construction. Individual risk within each phase were "scored" based on probability, cost impact and time. Scoring was used to assign contingencies per risk line item. These line-item risk contingencies were then aggregated to determine a contingency amount per category/phase:

- Preliminary Engineering – 30%
- Roadway – Updated survey information and final design may identify additional roadway design risks but are not anticipated to be significant. It is recommended to utilize 45% risk contingency.
- Right of Way – Final design may change some of the limit of construction. The right of way impacts is based on available GIS parcel information. It is recommended to utilize 55% risk contingency.
- Environmental – Updated environmental review, survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 55% risk contingency.
- Utilities – Underground utility information was not available. Final design and survey may identify additional utility conflicts. It is recommended to utilize 75% risk contingency.
- Geotechnical – Updated survey, geotechnical information and final design may identify additional earthwork, but not expected. It is recommended to utilize 30% risk contingency.
- Drainage – Updated survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 35% risk contingency.
- Construction/MOT – MOT plans have not been developed at this stage. It is recommended to utilize 75% risk contingency.

## Cost Estimate

### Methodology

The cost estimate was developed using VDOT's Pre-Quantity Tool with the methodology described below:

- Understanding the goals of the project and scope of improvements to be implemented.

- Gathering and reviewing all available information about the project including site visits and stakeholder input.
- Establishing design criteria and requirements to develop detailed design concepts
- Determining required area of right of way acquisition based on the design concept
- Develop additional allowances to be allocated to various phases of project construction
- Identifying corresponding risk contingency value in the Pre-Quantity Tool for each task

### Cost Estimate Breakdown

The total project cost is estimated at \$8,067,582 and broken down by Phase/Major area as follows:

- Preliminary Engineering Phase – \$1,549,210
- Right of Way and Utilities Phase – \$407,500\*
- Construction (without CEI) – \$5,321,690
- Construction (with CEI) – \$6,110,872

\*Final right of way and utility costs will be updated by VDOT

## Preferred Alternative #4: U.S. Route 1 and Roger Clark Boulevard/Jericho Road

### Design Assumptions

The following are assumptions used to design the concepts and create the cost estimate:

- Roadway Geometry – Pavement widening will be required to accommodate the new westbound right turn lane at the intersection of U.S. Route 1 at Rogers Clark Boulevard. The widening will impact the existing parcel on the northeast quadrant of the intersection. The new pavement will begin approximately 450 ft before the channelized right turn and will terminate where the channelized right turn lane merges into U.S. Route 1.
- Pedestrian Accommodations – New 5-foot-wide concrete sidewalk will be constructed along both sides of Rogers Clark Boulevard between U.S. Route 1 and Welcome Way. Pedestrian crosswalks will be installed across the four legs of intersection of Rogers Clark Boulevard at U.S. Route 1, and across the east and south legs of the intersection of Rogers Clark Boulevard at Welcome Way, with ADA compliant curb ramps, and pedestrian signals.
- Hydraulics – New drainage ditches will be implemented where new sidewalks are being constructed. New drainage pipes will be required under several driveways along Rogers Clark Boulevard where drainage is impacted by the sidewalks. Due to the sidewalk locations, new drainage is proposed between the sidewalk and roadway.

- Right of Way – Additional right of way and easement will be required on the north and south sides of Rogers Clark Boulevard, as well as all four quadrants of the U.S. Route 1 at Rogers Clark Boulevard intersection. The improvements will impact 11 parcels along Rogers Clark Boulevard. The right of way is based on available GIS parcel information. VDOT district will prepare the right of way estimate.
- Utility Impact – Out of plan utility impacts are anticipated. Underground utility information was not available. On the north side of Rogers Clark Boulevard, overhead utility poles and underground water pipes will be impacted. On the south side, underground utilities and a fire hydrant will be impacted. In addition, traffic junction boxes will be impacted at the northwest, southwest and southeast quadrant of the intersection of U.S. Route 1 and Rogers Clark Boulevard/Jericho Road. VDOT district will prepare the utility impact estimate.
- Design Waiver – None are anticipated for this project.
- Environmental Considerations - The level of environmental document anticipated is a Categorical Exclusion, either a PCE or a CE depending on final project impacts/scope. The considerations that need to be addressed during the design phase are anticipated to be an Archaeological review and a Petroleum release site investigation.
- Constructability & maintenance of Traffic Assessment - Lane closures and flagging operation will be necessary during the roadwork for the maintenance of traffic.

Based on VDOT and Stakeholder input from Phase 2 and the site visit performed at the commencement of Phase 3, the concept was advanced, refining key elements of the preferred alternative, as shown in **Figure 43**.

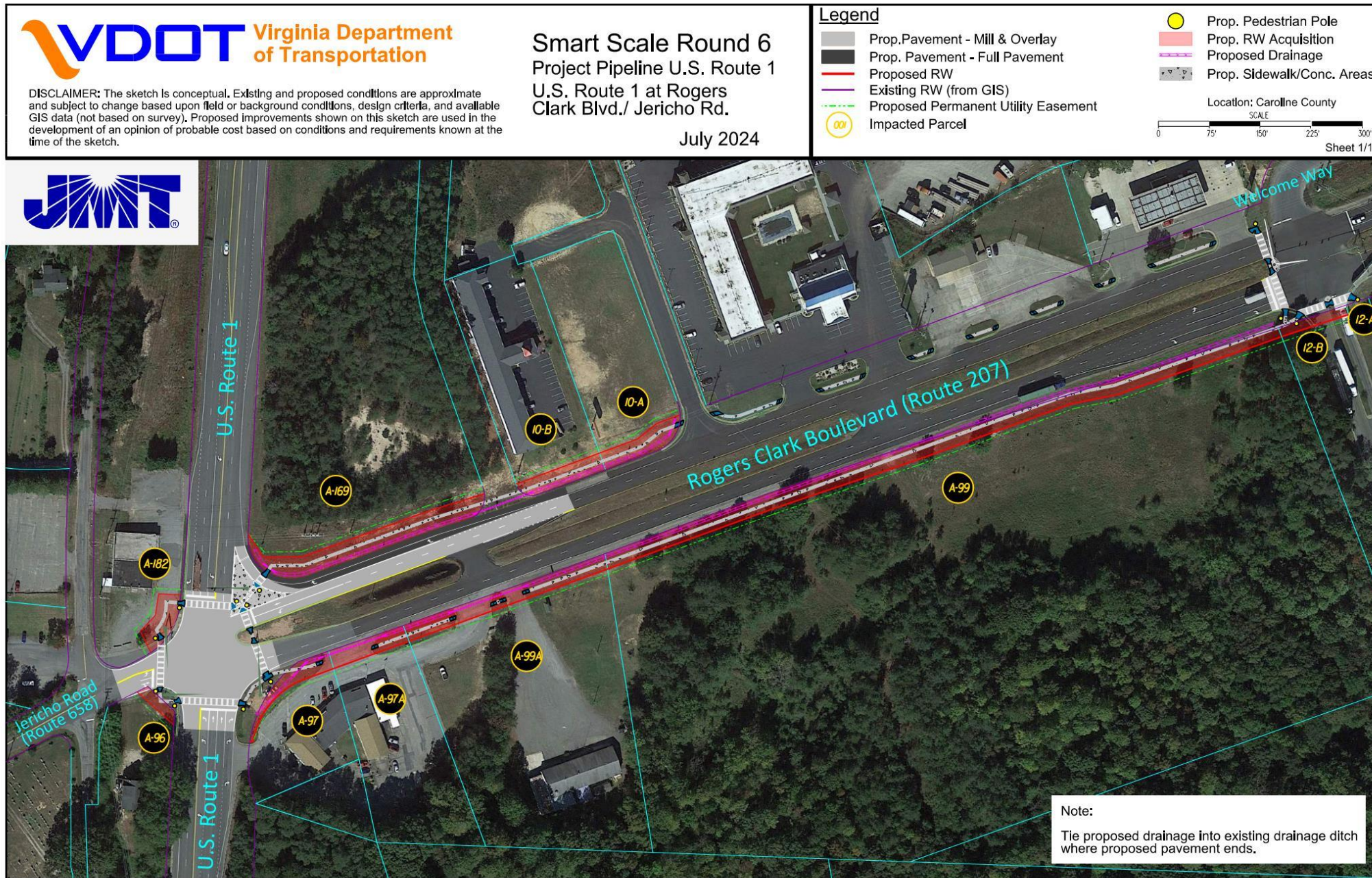


Figure 43: U.S. Route 1 at Rogers Clark Blvd./Jericho Rd. Improvements

## Project Risk and Contingency

This project is considered Moderately Complex and at a Pre-Scoping Phase; however, the level of concept design development is relatively detailed, therefore, the Most Likely Estimate (MLE) contingency would be most accurate 50%, in accordance with VDOT's cost estimating manual. Project specific risks were identified and assessed based on data collected, field visits, stakeholder input and concept design development. In addition, other typical project risks were assessed as applicable. Risks were organized by broad categories/phases including Preliminary Engineering, Roadway, Right of Way, Environmental, Utilities, Geotechnical, Drainage, and Construction. See Appendix D for the project's risk register. Individual risk within each phase were "scored" based on probability, cost impact and time impact (See Appendix D for the Cost Estimate Contingency Worksheet). Scoring was used to assign contingencies per risk line item. These line-item risk contingencies were then aggregated to determine a contingency amount per category/phase:

- Preliminary Engineering – 30%
- Roadway – Updated survey information and final design may identify additional roadway design risks but are not anticipated to be significant. It is recommended to utilize 45% risk contingency.
- Right of Way – Final design may change some of the limit of construction. The right of way impacts is based on available GIS parcel information. It is recommended to utilize 60% risk contingency.
- Environmental – Updated environmental review, survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 45% risk contingency.
- Utilities – Underground utility information was not available. Final design and survey may identify additional utility conflicts. It is recommended to utilize 60% risk contingency.
- Geotechnical – Updated survey, geotechnical information and final design may identify additional earthwork, but not expected. It is recommended to utilize 30% risk contingency.
- Drainage – Updated survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 40% risk contingency.
- Construction/MOT – MOT plans have not been developed at this stage. It is recommended to utilize 75% risk contingency.

## Cost Estimate

### Methodology

The cost estimate was developed using VDOT's Pre-Quantity Tool with the methodology described below:

- Understanding the goals of the project and scope of improvements to be implemented
- Gathering and reviewing all available information about the project including site visits and stakeholder input
- Establishing design criteria and requirements to develop detailed design concepts
- Performing quantity takes offs and using VDOT Pre-Quantity Tool Bid Item Unit Costs
- Develop additional allowances to be allocated to various phases of project construction
- Performing a risk assessment as outlined above and identifying appropriate contingency percentages by category
- Developing Preliminary Engineering costs by category based on a percentage of the Construction cost (See the Cost Estimate Workbook for more details).

### Cost Estimate Breakdown

The Total project cost is estimated at \$5,479,821 and broken down by Phase/Major area as follows:

- Preliminary Engineering Phase – \$1,090,050
- Right of Way and Utilities Phase – \$400,000\*
- Construction (without CEI) – \$3,415,900
- Construction (with CEI) – \$3,989,771

\*Final right of way and utility costs will be updated by VDOT

## Preferred Alternative #5: U.S. Route 1 at Pine Tree Drive, Deerfield Road, and Durette Road

### Design Assumptions

The following are key design assumptions that informed the concept development and the cost estimate preparation:

- Roadway Geometry – Pavement widening will be required to accommodate turn lanes at the intersections. Roadway shift will be used to accommodate the widening to tie back into existing pavement. The shift will be on both side of U.S. Route 1 at Deerfield Road/Glen Meadows Drive to not impact the bridge located approximately 550 feet south of Deerfield Road/Glen Meadows Drive. However, majority of the shift between Pine Tree Drive and Ladysmith Road will be on the east side of U.S. Route 1. Milling and overlay will occur mostly at the intersections' limits, and along the northbound approach between Pine Tree Drive and Ladysmith Road.

- Pedestrian Accommodations – A new 5-foot sidewalk will be constructed on the west side of U.S Route 1 from Clara Smith Street, to tie into the existing sidewalk at the CVS Pharmacy. The buffer between the roadway and the sidewalk without existing curb and gutter ranges from 15 feet to 18 feet. The existing curb and gutter, where available, between Clara Smith Street and the CVS Pharmacy will be retained.
- Hydraulics – New drainage ditches will be required where pavement widening is proposed. Due to the roadway shift and proposed sidewalk, drainage ditches are proposed within the limit of the shift to tie into the existing drainage ditch. Several driveways, roads, and commercial entrances may need new drainage pipes with the proposed improvements.
- Right of Way – Additional right of way and easement will be required on the east and west sides of U.S. Route 1. These improvements at the intersections with the sidewalks will impact 28 properties along U.S. Route 1. The right of way is based on available GIS parcel information. VDOT district will prepare the right of way estimate.
- Utility Impact – Out of plan utility impacts are anticipated. Underground utility information was not available. Overhead utility poles, underground fiber optics, communication transformer, communication junction box, and fire hydrant will be impacted. VDOT district will prepare the utility impact estimate.
- Design Waivers/Exceptions - One design waiver was submitted for turn lane taper length for the following location.
  - Northbound left turn onto Deerfield Road taper length reduced to 100 feet.
  - Northbound right turn onto Glen Meadows Drive taper length reduced to 100 feet.
  - Northbound right turn onto Ladysmith Commons Drive taper length reduced to 150 feet.
  - Southbound left turn onto Glen Meadows Drive taper length reduced to 150 feet.
- Environmental Considerations – The level of environmental document anticipated is a Categorical Exclusion, either a PCE or a CE depending on final project impacts/scope. The considerations that need to be addressed during the design phase are anticipated to be; Archaeological review, NEPA study, and a Petroleum release site investigation.
- Constructability & Maintenance of Traffic Assessment - Lane closures and flagging operation will be necessary during the roadwork for the maintenance of traffic.

Based on VDOT and Stakeholder input from Phase 2 and the site visit performed at the commencement of Phase 3, the concepts were advanced, refining key elements of the preferred alternative, as shown in **Figure 44**, **Figure 45**, **Figure 46**, and **Figure 47**.

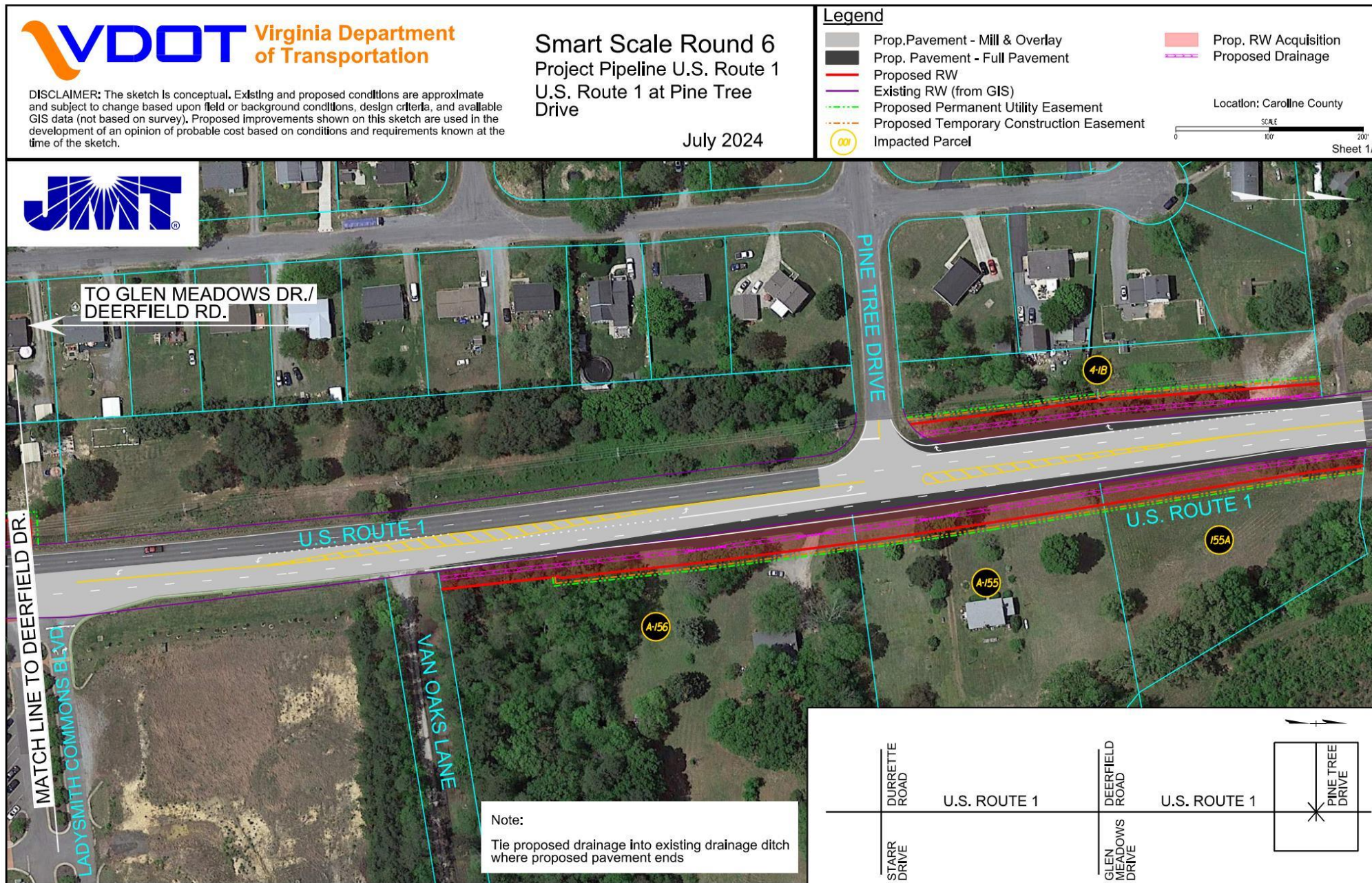


Figure 44: U.S. Route 1 at Pine Tree Drive Improvements



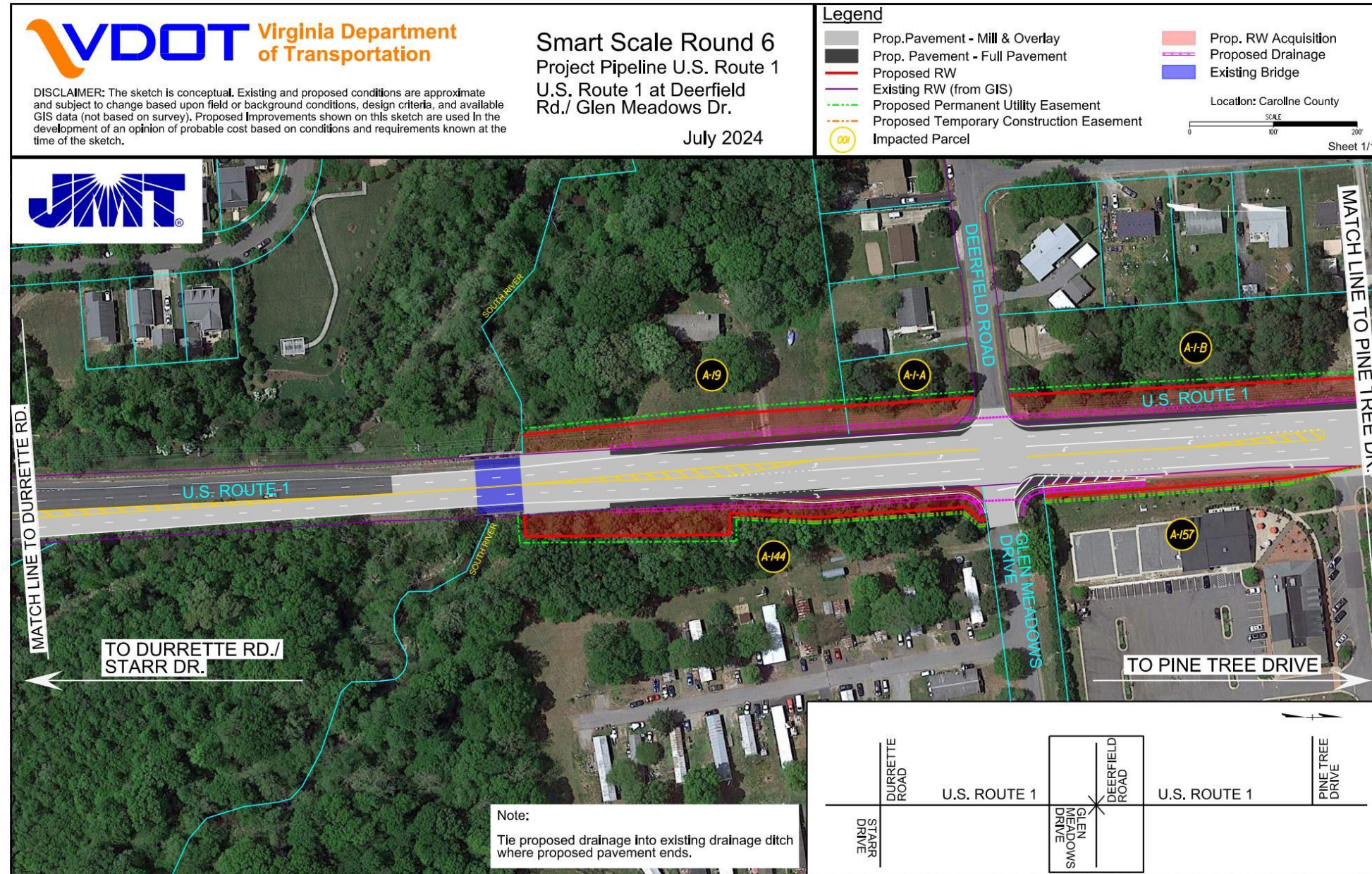


Figure 45: U.S. Route 1 at Deerfield Rd./Glen Meadows Dr. Improvements

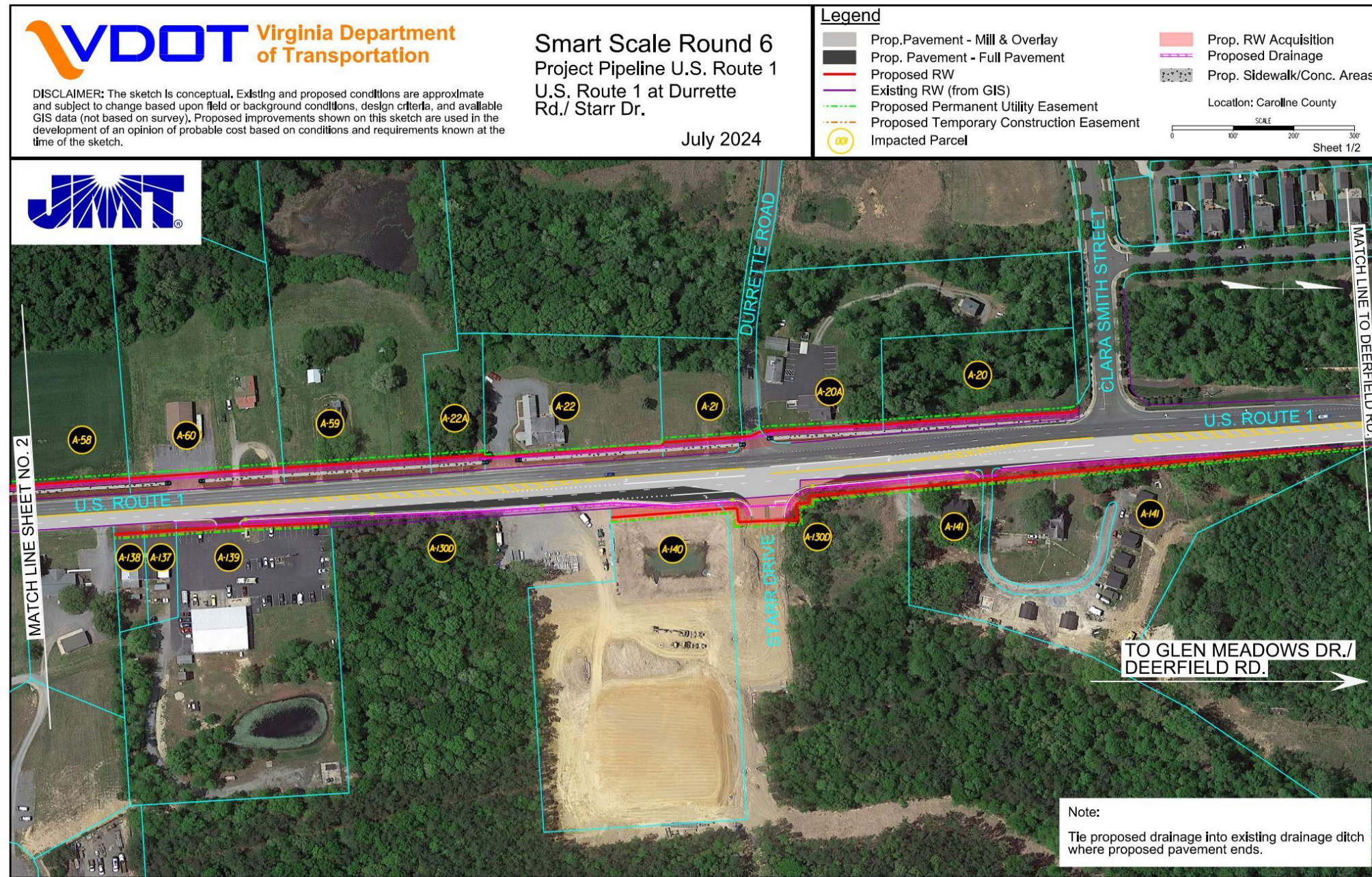


Figure 46: U.S. Route 1 at Durette Rd./Starr Dr. Improvements

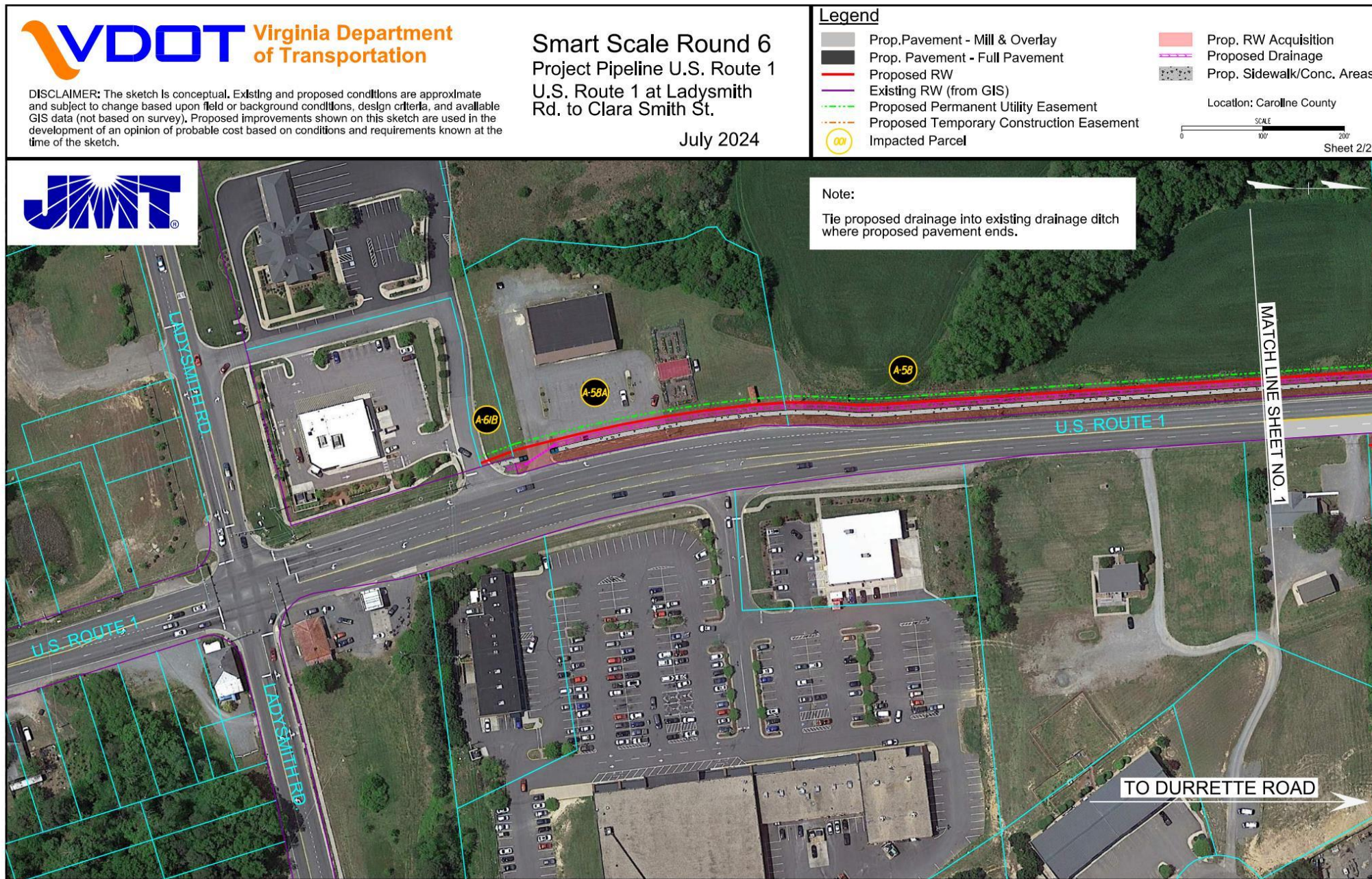


Figure 47: U.S. Route 1 at Durette Rd./Starr Dr. Improvements (Cont'd)

## Project Risk and Contingency

This project is considered Moderately Complex and at a Pre-Scoping Phase; however, the level of concept design development is relatively detailed, therefore, the Most Likely Estimate (MLE) contingency would be most accurate 50%, in accordance with VDOT's cost estimating manual. Project specific risks were identified and assessed based on data collected, field visits, stakeholder input and concept design development. In addition, other typical project risks were assessed as applicable. Risks were organized by broad categories/phases including Preliminary Engineering, Roadway, Right of Way, Environmental, Utilities, Geotechnical, Drainage, and Construction. Individual risk within each phase were "scored" based on probability, cost impact and time impact. Scoring was used to assign contingencies per risk line item. These line-item risk contingencies were then aggregated to determine a contingency amount per category/phase:

- Preliminary Engineering – 30%
- Roadway – Updated survey information and final design may identify additional roadway design risks but are not anticipated to be significant. It is recommended to utilize 50% risk contingency.
- Right of Way – Final design may change some of the limits of construction. The right of way impacts is based on available GIS parcel information. It is recommended to utilize 60% risk contingency.
- Environmental – Updated environmental review, survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 45% risk contingency.
- Utilities – Underground utility information was not available. Final design and survey may identify additional utility conflicts. It is recommended to utilize 75% risk contingency.
- Geotechnical – Updated survey, geotechnical information and final design may identify additional earthwork, but not expected. It is recommended to utilize 30% risk contingency.
- Drainage – Updated survey information and final design is not anticipated to add significant design or construction risks. It is recommended to utilize 50% risk contingency.
- Construction/MOT – MOT plans have not been developed at this stage. It is recommended to utilize 75% risk contingency.

## Cost Estimate

### Methodology

The cost estimate was developed using VDOT's Pre-Quantity Tool with the methodology described below:

- Understanding the goals of the project and scope of improvements to be implemented
- Gathering and reviewing all available information about the project including site visits and stakeholder input
- Establishing design criteria and requirements to develop detailed design concepts
- Performing quantity takes offs and using VDOT Pre-Quantity Tool Bid Item Unit Costs
- Develop additional allowances to be allocated to various phases of project construction
- Performing a risk assessment as outlined above and identifying appropriate contingency percentages by category
- Developing Preliminary Engineering costs by category based on a percentage of the Construction cost (See the Cost Estimate Workbook for more details).

### Cost Estimate Breakdown

The Total project cost (with CEI) is estimated at \$20,322,849 and broken down by Phase/Major area as follows:

- Preliminary Engineering – \$2,741,700
- Right of Way and Utilities – \$1,485,000\*
- Construction (without CEI) – \$14,337,465
- Construction (with CEI) – \$16,096,149

\*Final right of way and utility costs will be updated by VDOT