BLAKE LANE PEDESTRIAN ROAD SAFETY AUDIT

FINAL REPORT

June 2024

FCDOT
Fairfax County Department of Transportation

VDOT

Executive Summary

This report summarizes the findings of the Blake Lane Pedestrian Road Safety Audit (RSA) and associated engineering assessments, which included a detailed and comprehensive investigation of the corridor in order to identify safety concerns and develop potential improvements to address the safety of all road users. This RSA also had a special emphasis on pedestrian and bicyclist safety due to community concerns and recent crashes along the corridor. The study area included a roughly two-mile portion of Blake Lane between Chain Bridge Road (Route 123) to Route 29 and assessed existing conditions and crash history, identified safety concerns, and developed potential safety alternatives for Blake Lane. The alternatives analysis incorporated several quantified measures of effectiveness, including expected crash reduction, pedestrian comfort, enhanced multimodal connectivity, and speed reduction, to aid in evaluating the proposed improvements. It also evaluated five potential safety treatments to determine their feasibility for implementation, leading to a set of multi-tiered recommendations aimed at enhancing safety for all road users on Blake Lane.

This study was guided by the Safe System Approach which recognizes that eliminating all crashes is impractical due to the fact people make mistakes and instead aims to reduce fatalities and serious injuries. The multidisciplinary RSA team included a variety of transportation professionals, including the Virginia Department of Transportation (VDOT), Fairfax County Department of Transportation (FCDOT), Fairfax County Department of Health (FCDH), Fairfax County Public Schools (FCPS), Fairfax County Police Department (FCDP), Fairfax Families for Safe Streets, transit providers, and members of the local community.

A range of treatments were posed as potential safety improvements on the corridor, resulting in a prioritized list of short, intermediate, and long-term countermeasures. Each was chosen based on their potential to reduce fatal and severe injury crashes, while also considering the respective implementation time, funding, dependency on other countermeasures, and potential constraints or challenges. Short- and intermediate-term and safety countermeasures included both infrastructure improvements and behavioral campaigns to address road user safety and to influence the way drivers interpret and react to pedestrians and bicyclists on Blake Lane. Suggested long-term enhancements included significant geometric improvements and potential corridor redesigns for enhancing overall safety.

For the purposes of this study, the estimated time for implementing improvements is 0-1 year for short-term, 1-5 years for intermediate-term, and 5+ years for long-term improvements. Ultimately, implementation timing depends on the funding availability and feasibility of installation. Funding may come from a variety of sources, but is generally allocated through a competitive process that considers the benefit-cost ratio, safety, mobility, and community impacts. Future steps towards implementing these treatments may require buy-in from additional stakeholders, further engineering studies, planning and design, and funding. Some recommendations are dependent on the completion of other improvements, such as installing new crosswalks and pedestrian refuge islands where turn lanes could be removed.

All of the suggested infrastructure improvements require additional engineering and assembly of plans for construction, funding for implementation, and coordination between appropriate entities (VDOT, Fairfax County, etc.). Table 1 outlines a prioritized list of the various countermeasures proposed in this study based on the time needed to implement, primary safety concern(s), and potential locations.

Table 1. Summary of potential safety countermeasures, implementation time, and potential locations.

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Short	Centerline Hardening	Left-turning speeds in crosswalks	$5-10K per location	• Five Oaks Road approaches to Blake Lane • Edgelea Road approach to Blake Lane • Platten Drive approach to Blake Lane • Southbound Palmer Street approach to Blake Lane • Northbound Borge Street approach to Blake Lane
Short	Temporary Curb Extensions	Right-turning speeds in crosswalks	$10-20K per location	• Blake Lane and Bushman Drive • Blake Lane and Borge Street • Blake Lane and Palmer Street • Blake Lane and Gray Street • Blake Lane and Hibbard Street • Blake Lane and Edgelea Road • Blake Lane and Tipperary Pass
Short	Green Paint and Trail Crossing Signage	Bike crossings at intersections connecting to I-66 trail	$10K per location	• Jermantown Road and Borge Street • Blake Lane and Bushman Drive • Blake Lane and Platten Drive (with new bicyclist markings on Platten Drive)
Short	Leading Pedestrian Interval (LPIs)	Driver yielding to crosswalk users at traffic signals	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road (pending intersection redesign)

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
				• Blake Lane and Five Oaks Road • Blake Lane and Kingsbridge Drive
Short	Pedestrian Recall	Pedestrian level of service at signalized intersections	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road (pending intersection redesign) • Blake Lane and Five Oaks Road • Blake Lane and Kingsbridge Drive
Short	Flashing Yellow Arrow for Left Turning Vehicles	Reduction of left-turning vehicle conflicts	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road • Blake Lane and Kingsbridge Drive
Short	No Turn on Red Restrictions	Reduction of turning vehicle conflicts with pedestrians	$5K per intersection	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road • Blake Lane and Kingsbridge Drive
Short	Intersection Warning Sign	Kingsbridge Drive Intersection Safety	$5K per project	• Blake Lane and Kingsbridge Drive
Short	Vegetation Trimming	Sight distance challenges	$200 per crew hour	• Corridor wide
Short	Blake Lane and Sutton Road Signal Improvements	Pedestrian/ bicyclist crossing safety	As part of Vienna Metro Station Bicycle and Pedestrian Improvements ($10.5M)	• Blake Lane and Sutton Road
Short	Continue community-based education/ engagement campaigns	Speeding, pedestrian/ bicyclist safety	N/A	• Corridor wide

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Intermediate	Red Light Extension Technology	Kingsbridge Drive intersection safety	$20K per intersection approach	• Blake Lane and Kingsbridge Drive
Intermediate	Reduction of Unwarranted Left and Right Turn Lanes	Pedestrian/ bicyclist crossing safety	$200-300K per lane closure	• Northbound Left-Turn onto Cedar Grove Drive • Westbound Left-Turn onto Platten Drive • Westbound Left-Turn onto Sugar Lane • Westbound Left-Turn into Townhomes at Hibbard Street • Eastbound Right-Turn onto Windwood Farms Drive • Eastbound Left-Turn onto Borge Street
Intermediate	Pedestrian Refuge Islands / New Crosswalks	Pedestrian/ bicyclist crossing safety	$30-80K per crossing (varies by size)	• [Relocated or Additional] South Crosswalk at Bel Glade Street • [Relocated] East Crosswalk at Edgelea Road / Platten Drive (pending intersection treatment) • [Relocated] East Crosswalk Hibbard Street • [New] West Crosswalk at Bushman Drive
Intermediate	Oakton High School Educational Campaign	Student safety, for drivers, pedestrians, and bicyclists	N/A	• Corridor wide
Intermediate	Transit Stop Optimizing	Pedestrian crossing safety and transit access	$40-60K per stop	• Corridor wide
Intermediate/ Long	Blake Lane between Lindenbrook and Route 29 Pedestrian Improvements	Pedestrian crossing safety and transit access	$5-10M per project	• Blake Lane between Lindenbrook and Route 29
Intermediate/ Long	Blake Lane and Bushman Drive Geometric Improvements	Safety of All Road Users	$3-5M per project	• Blake Lane and Bushman Drive

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Intermediate/ Long	Reduced Conflict Corridor	Safety of All Road Users	$1-3M per intersection	• Corridor wide
Intermediate/ Long	Roadway Reconfiguration / Complete Streets Project	Speed Management, Safety of All Road Users	$20M+	• Corridor wide

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Acronyms

AADT – annual average daily traffic

AASHTO – American Association of State Highway and Transportation Officials

ADA – Americans with Disabilities Act

CMF – crash modification factor

DOT – Department of Transportation

EPDO – equivalent property damage only

FCDOT – Fairfax County Department of Transportation

FCPD – Fairfax County Police Department

FCPS – Fairfax County Public Schools

FCDH – Fairfax County Department of Health

FHWA – Federal Highway Administration

FYA – flashing yellow arrow

HCM – Highway Capacity Manual

HSM – Highway Safety Manual

IA – Interim Approval

IIM – Instructional and Informational Memoranda

LOS – level of service

MPH – miles per hour

MUTCD – Manual on Uniform Traffic Control Devices for Streets and Highways

NCHRP – National Cooperative Highway Research Program

PHB – pedestrian hybrid beacon

PHF – peak hour factor

RCUT – Restricted Crossing U-Turn

RLR – red light running

RRFB – rectangular rapid flashing beacon

RSA – road safety audit

TMC – turning movement counts

TOSAM – Traffic Operations and Safety Analysis Manual

UVC – Uniform Vehicle Code

VDOT – Virginia Department of Transportation

VPD – vehicles per day

WMATA – Washington Metropolitan Council of Governments

Applicable Guidance and Standards

Manual on Uniform Traffic Control Devices (MUTCD), 2009
https://mutcd.fhwa.dot.gov/

MUTCD Interim Approval for Optional Use of an Alternative Signal Warrant 7 – Crash Experience (IA-19)
https://mutcd.fhwa.dot.gov/resources/interim_approval/ia19/index.htm

AASHTO Policy on Geometric Design of Highways and Streets, 2018
https://store.transportation.org/item/collectiondetail/180

AASHTO Highway Safety Manual (HSM), 2010
https://www.highwaysafetymanual.org/

Highway Capacity Manual, 2022
https://nap.nationalacademies.org/catalog/26432/highway-capacity-manual-7th-edition-a-guide-for-multimodal-mobility

VDOT IIM-TE-384.1 Pedestrian Crossing Accommodations at Unsignalized Locations
https://www.virginiadot.org/business/resources/IIM/TE-384.1_Pedestrian_Crossing_Accommodations_at_Unsignalized_Approaches_acc081622.pdf

VDOT IIM-TE-387 Signal Justification Reports (SJRs) For New and Reconstructed Signals
https://www.virginiadot.org/business/resources/iim/te-387_signal_justification_reports.pdf

VDOT Supplement to the MUTCD (Version 1)
https://www.virginiadot.org/business/virginia_mutcd_supplement.asp

1. Introduction

This report summarizes the findings of the Blake Lane Pedestrian Road Safety Audit (RSA) and contains documentation of existing conditions, crash history, identified safety concerns, potential safety treatments, and engineering assessments for treatments requiring a better understanding of feasibility. According to the Federal Highway Administration's (FHWA) *Pedestrian and Bicyclist Road Safety Audit Guidelines and Prompt Lists*, an RSA is a formal safety examination of a future roadway plan or project or an in-service facility and is conducted by an independent, experienced, and multidisciplinary RSA team. RSAs seek to enhance safety by identifying potential safety issues affecting all road users under a variety of conditions and suggest treatments to improve safety. The potential safety enhancement alternatives are then compared to assess potential trade-offs in safety, funding, and time needed for implementation.

The Blake Lane RSA incorporated an additional step in evaluating five potential safety treatments through engineering assessments. These assessments were conducted to determine if such treatments could be carried forward into implementation or should be studied further for feasibility. Additionally, the range of potential improvements contains treatments that have not been implemented widely on the state roadway system, so additional coordination and buy-in by VDOT and Fairfax County maintenance are needed to coordinate feasibility. The evaluation focused on a prioritized list of safety improvements and included the identification of implementation time frame, dependency on other countermeasures/factors, potential benefits, and potential constraints or challenges.

1.1. Study Purpose and Area

Pedestrian safety has been a concern for the Blake Lane community. This RSA and the subsequent engineering assessments are in response to the community concern and recent pedestrian fatalities. *Specifically, the purpose of this study is to identify safety risks and develop potential improvements to address the safety of all road users, with an emphasis on pedestrian and bicyclist safety.* The study area includes 2.1 miles of Blake Lane/Jermantown Road (Route 655) from Chain Bridge Road (Route 123) to Route 29 (Blenheim Boulevard/Lee Highway) as illustrated in Figure 1.

Figure 1. Overview of the Blake Lane Study corridor.

1.2. RSA

To identify and better understand the safety needs and the potential for improvement, the project team conducted a pedestrian-focused RSA, which included data analysis, a field review, and post field review analysis. The field review with the full RSA team was held on April 26, 2023, from 7:00 am to 11:30 am. Additional field observations throughout the corridor were conducted by a focus team during the afternoon and evening hours. This allowed the RSA team to gather input and observations with the broader group, while still observing the corridor during a variety of times of day/conditions. Prior to that, a preliminary walk-audit was hosted by VDOT and FCDOT, in December of 2022. The findings of that field review were also taken into consideration by the RSA team.

RSA attendees included:

- Geoff Sarmac (VDOT)
- Gil Chlewicki (VDOT)
- Heidi Mitter (VDOT)
- Don Moyer (FCDOT)
- Zachary DesJardins (FCDOT)
- Derrick Gwyn (FCPS)
- Merari Zemany (FCPS)
- Anna Ricklin (FCHD)
- Brian Rochefort (FCPD)
- Sonya Breehey (Fairfax Families for Safe Streets)
- Aimee Emerich (Blake Lane Task Force)
- Alan Alonso (Blake Lane Task Force)
- Kim Jaramillo (Providence District)
- Juan Morale (Providence District)
- Elissa Goughnour (VHB)
- Taylor Bonner (VHB)
- Christine Potocki (VHB)
- Alvaro Calle (VHB)

1.3. Integrating Safe System Approach Principles

VDOT's 2022-2026 Strategic Highway Safety Plan adopts the Safe System Approach, which uses a holistic approach to safety to reduce fatalities and serious injuries. The Safe System Approach recognizes that eliminating all crashes is impractical due to the fact people make mistakes, and instead focusing on eliminating fatal and serious injuries.[1] In recognizing that people make mistakes, there are elements that can be built into our transportation system to reduce, and hopefully eliminate severe injury and fatal crashes that occur because of those mistakes. The five elements of a Safe System include safer people, safer roads, safer vehicles, safer speeds, and post-crash care. Each of these five elements have been taken into consideration throughout this study.

Ultimately, this study includes recommendations specifically related to safer people, roads, and speeds, but recognizes the impact that education, engagement, enforcement, and emergency response all have on reaching zero fatalities and serious injuries. Alternatives proposed in the report acknowledge that each treatment may have differing effects on crash potential, but ultimately seek to reduce the risk of severe injury and fatal crashes.

2. Existing Conditions

2.1. Corridor Characteristics

Blake Lane is an eastbound-westbound oriented minor arterial that connects to several principal arterial roadways, including Blenheim Boulevard (Route 29), Chain Bridge Road (Route 123), and Fairfax Boulevard (Route 50). Within the study area, Blake Lane is a four-lane divided roadway, commonly featuring right and left turn lanes at intersections along the corridor. The corridor is generally referred to as "Blake Lane" throughout this report, but the road technically changes names to Jermantown Road west of Trevor House Drive. On Blake Lane, traffic control at intersections range from either signal-controlled or stop-controlled, with the stop signs controlling the side streets. The majority of the corridor is relatively straight with good visibility while driving on Blake Lane to react to changes in the roadway, with the exception of the horizontal curve at the intersection of Blake Lane and Sutton Road where sight distance is limited due to geometry and foliage alongside the road. There are also several side streets have sight distance limitations between drivers looking to turn onto Blake Lane and through traveling vehicles due to the intersection skew and infringing foliage, which is discussed further in Section 3.[2]

There is also a significant grade change between Bushman Drive and Cyrandall Valley Road that limits vertical sight distance of the marked crosswalk at Hibbard Road. Sidewalks are present on both sides of Blake Lane throughout the study area with connecting sidewalk facilities on most side streets. For bike

[1] Federal Highway Administration. "What Is a Safe System Approach?". 2022. https://www.transportation.gov/NRSS/SafeSystem
[2] Observations of sight distance and visibility on Blaek Lane are anecdotal based on field reviews and was not formally measured as part of this study.

facilities, there are separated bike lanes on Borge Street that connect with bike lanes on Bushman Drive and bike facilities on Sutton Road that connect with a cycle track on Country Creek Road to the Vienna Metro Station. Additionally, Blake Lane between Thaiss Memorial Park / Mantua Park (south of Route 50, Blake Lane becomes Pickett Road) and Oakton Park (west of Elmendorf Drive) is part of the Gerry Connolly Cross County Trail, despite no shared use path or separated bike facilities on within the study area of Blake Lane. Access to the I-66 trail is also available from Blake Lane through connections at Sutton Road, Platten Drive, and the bike lanes on Bushman Drive and Borge Street.

Land use along this corridor is primarily medium and low-density residential, though higher-density housing is planned on the previous AT&T campus located on the west side if the corridor at Jermantown Road and Chain Bridge Road. The corridor also features the newly renovated Oakton High School at the intersection of Blake Lane and Sutton Road, as well as a community park accessible between Bushman Drive and Hibbard Road. A summary of the corridor characteristics is shown in Table 2.

Table 2. Corridor characteristics.

Characteristics	Description
Orientation	East-West
Functional Classification	Minor Arterial
Annual Average Daily Traffic (AADT) in 2022 (vehicles per day)	17,000-21,000
Speed Limit (miles per hour)	35 mph
Number of Lanes	4 (two in each direction)
Lane Widths (feet)	11' (typical)
Signalized Intersections	Route 123/Chain Bridge Road, Trevor House Drive, Sutton Road, Five Oaks Road, Kingsbridge Drive, Route 29/Blenheim Boulevard
Land Uses	Medium and Low Density Residential, Commercial (near Blenheim Boulevard), Institutional (Oakton High School)
Transit Presence	12 stops in each direction –3 transit providers Washington Metropolitan Area Transit Authority (WMATA): Route 2B Fairfax County Connector: Route 466 City of Fairfax's CUE service: Route Gold 1, Route Gold 2
Pedestrian Facilities	Sidewalks are present on both sides of the road for the entire corridor. Marked crosswalks are provided across Blake Lane at the intersections with the following side streets: Chain Bridge Road (east and west side), Borge Street (east and west sides), Trevor House Drive (east side), Hibbard Street (west side), Edgelea Road/Platten Drive (west side), Sutton Road (west side),

	Five Oaks Road (east and west sides), Kingsbridge Drive (east side), Blenheim Boulevard (east and west sides)
Bike Facilities	Blake Lane is part of the Gerry Connolly Cross County Trail, which is designated on the north sidewalk. West of Chain Bridge Road, Blake Lane/Jermantown Road has a shared-use path on the north side. Bike facilities on intersecting side streets include bike lanes on Borge Street and Bushman Drive, shared lanes on Sutton Road, and the I-66 trail, which is south of Blake Lane but can be accessed via Platten Drive and the bike lanes on Bushman Drive and Borge Street.

2.2. Turning Movement Counts on Blake Lane

16-hour turning movement counts (TMCs) were collected at eight intersections along Blake Lane on October 25, 2023, from 6:00 am to 10:00 pm. These counts were used for the Road Diet engineering assessment, discussed in Section 5.1. TMCs for AM/PM peak hours at eight intersections along Blake Lane are presented in Figure 2 and Figure 3.

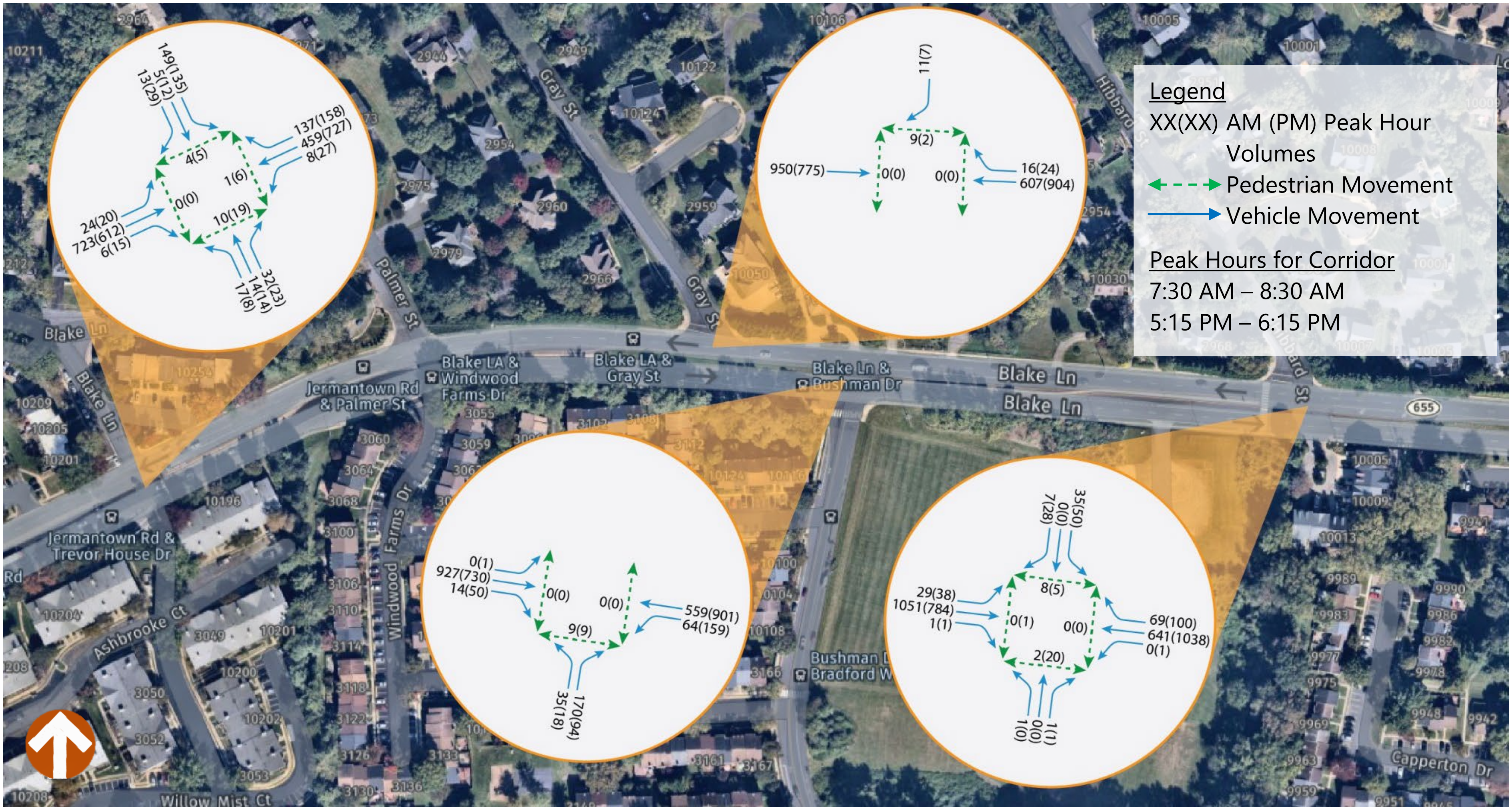

Figure 2. Turning movement counts for intersections on Blake Lane (Trevor House Drive, Gray Street/ Bushman Drive, Hibbard Street).

Figure 3. Turning movement counts for intersections on Blake Lane (Edgelea Road / Platten Drive and Sutton Road).

2.3. Previous Signal Warrant Studies

Most of these unsignalized intersections on Blake Lane connect solely to residential neighborhoods, which generally do not supply the traffic volume to warrant a traffic signal. However, the community has requested the installation of traffic signals in the past for three intersections within the study area. Signal warrant studies have been conducted at the following intersections in previous years:

- Blake Lane and Bushman Drive (2016)
- Blake Lane and Hibbard Street (2021)
- Blake Lane and Edgelea Road / Platten Drive (2012)

Based on previous signal warrant studies, all of these intersections satisfy warrant requirements for major approach volume but do not satisfy the requirements for minor approach volume or the volume of pedestrians crossing the major approach needed for a traffic signal. In reviewing traffic counts collected through this study, it appears that these intersections are still unlikely to meet signal warrants. However, they have been evaluated for other safety improvements, and Section 4.3.1 and Section 4.3.5 include the potential recommendations for Edgelea Road / Platten Drive and Hibbard Street, respectively. Section 5.4 contains one of the engineering assessments, which focused on geometric design improvements at Blake Lane and Bushman Drive.

2.4. Speed Data

Speed data was collected over a 26-hour period using an Automatic Traffic Recorder (ATR) at one location on Blake Lane from 10:00 AM Tuesday, January 12, 2021 to 12:00 AM Wednesday, January 13, 2021. In accordance with VDOT's Traffic Operations and Safety Analysis Manual (TOSAM), the data was recorded in 15-minute increments and reported in terms of average (i.e., mean) speed and 85th percentile speed over the data collection period. [3,4,5]

Table 3 presents a summary of the speed data by direction and Figure 4 presents 85th percentile speed for both eastbound and westbound direction during different times of the day.

[3] Virginia Department of Transportation. *Traffic Operations and Safety Analysis Manual*. Virginia Department of Transportation. 2020.
[4] *Average Speed* is the summation of spot-measured speeds of vehicles at a specific location divided by the number of vehicles observed.
[5] *85th percentile speed* is the speed at or below which 85 percent of vehicles travel.

Table 3. Speed data summary.

	Eastbound	Westbound
ADT (vehicles)	5,940	6,653
Total Counts (vehicles)	6,435	7,208
Posted Speed Limit	35 mph	35 mph
Mean Speed	39.5 mph	38.2 mph
85^{th} Percentile Speed	44.0 mph	43.0 mph
Percent of Vehicles Exceeding Speed Limit	81.0%	73.1%
Percent Exceeding Limit more than 10 mph	14.0%	9.5%

On Blake Lane, the posted speed for the study area is 35 mph. However, drivers frequently travel at speeds higher than the posted speed limit, as indicated by data collected in January 2021. At the data collection site, on average 81.0 percent and 73.1 percent drivers were driving over the speed limit in the eastbound and westbound directions, respectively. This has been also confirmed by speed data indicating that the 85^{th} percentile speed (speed that 85 percent of drivers are travelling at or below) is 44 mph in the eastbound direction and 43 mph in the westbound direction. The average speed was 39.5 mph and 38.2 mph in the eastbound and westbound directions, respectively. Maximum speeds recorded in the January 2021 data collection were 79 mph around 10:30 pm in the westbound direction and 64 mph at roughly 10 am in the eastbound direction. During the midday and nighttime hours, data indicates that individual drivers exceed the speed limit by more than 15 mph.

Although engineering countermeasures and road design can have an impact on the majority of driver speeds, there will be individuals with higher risk tolerance during hours when the road is underutilized. These individuals may speed due to drug and/or alcohol intoxication, overconfidence in their ability to navigate the roadway at high speeds, or young drivers with poor traffic safety judgment. Additionally, street racing has been a problem in parts of the County, which could contribute to excessive speeds along Blake Lane in the evening and overnight hours. Efforts to reduce these outliers require robust education and routine enforcement.

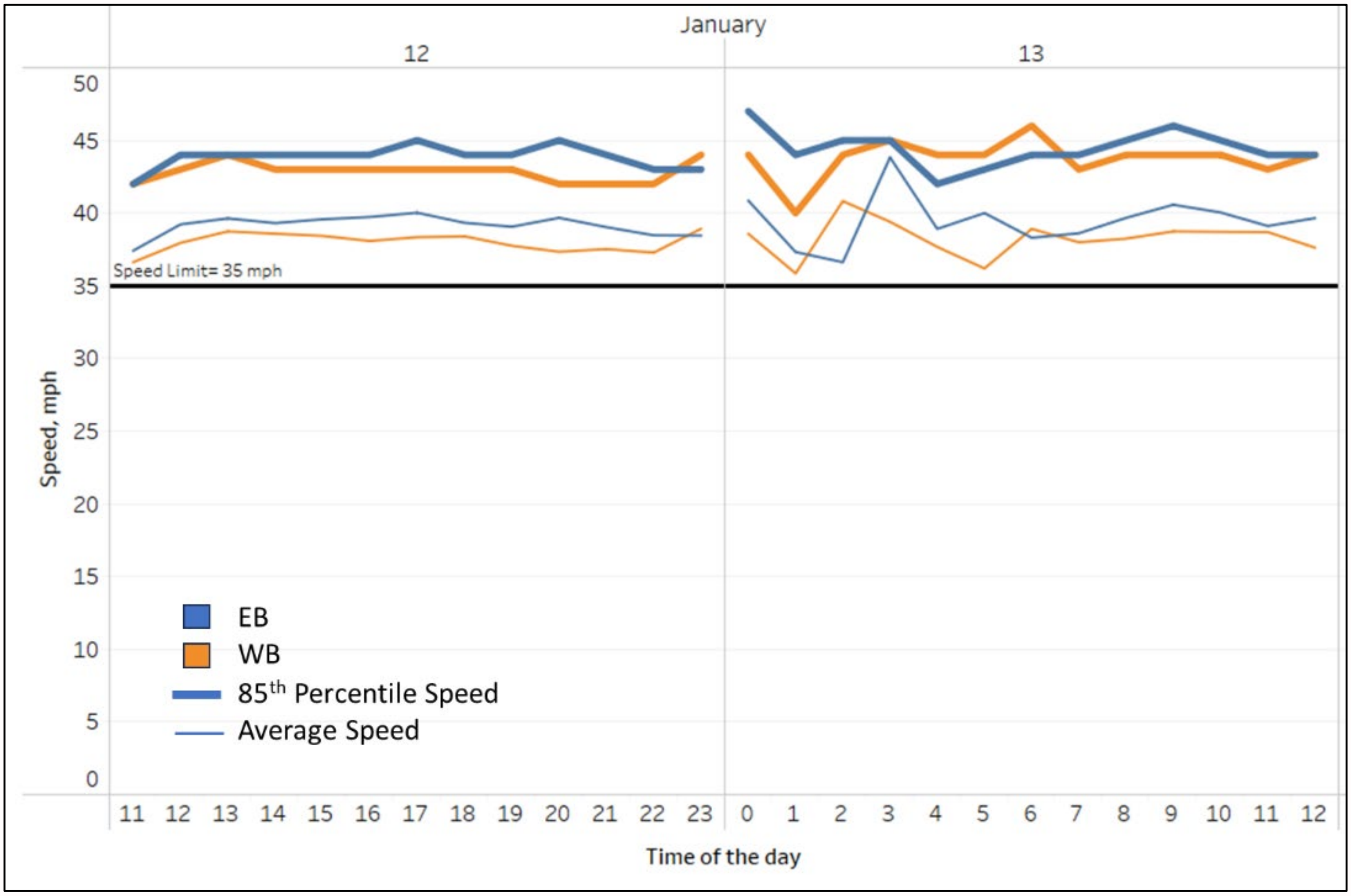

Figure 4. 85th percentile speeds by times of day.

Average and 85th percentile vehicular speeds on the corridor vary throughout the day; however, high average speeds of roughly 41 mph along the corridor were observed during morning peak hours, compared to an overall average speed of roughly 39 mph throughout the day. During this time, the general flow of traffic seemed to be traveling at consistently high speeds, versus midday and night hours when there was more variation among drivers. The consistently higher speed in the morning aligns with the time when many students are walking to Oakton High School and residents in the area are walking or biking for recreational or commuting purposes (7:30 to 8:30 am). This overlap of peak pedestrian and bicyclist activity and high speeds can introduce additional risk to all road users.

2.5. Planned and Recently Completed Projects/Development

The surrounding region was reviewed to identify planned improvements to the transportation system within or in close proximity to the Blake Lane study area. Planned improvements identified within the study area include improvements in bicyclist access to the Vienna Metro Station, the AT&T Campus Redevelopment, and Blake Lane and Sutton Road intersection improvements. The intersections of Blake Lane and Bushman

Drive, as well as Blake Lane and Bel Glade Street also have planned improvements to install rectangular rapid flashing beacons (RRFBs) to improve safety for pedestrians crossing the road. There are also several ongoing or completed projects, including the Oakton High School Zone speed cameras and a recent repaving of Blake Lane with lane narrowing extending through the entirety of the study area between Chain Bridge Road and Route 29, as well as high visibility crosswalk improvements at all crossings on Blake Lane and standard crosswalks on each side street approach to Blake Lane.

2.5.1. Vienna Metro Station Bicycle and Pedestrian Improvements in Fairfax County

This project will facilitate bicycle and pedestrian improvements around the Vienna Metro station. As part of this project, a shared-use path will be constructed along the west side of Blake Lane, extending from the 66 Parallel Trail to Sutton Road and continuing along the south side of Sutton Road to Country Creek Road. Intersection improvements at Blake Lane and Sutton Road include traffic signal modifications and eliminating the channelization for the right turn lane on the northbound Blake Lane approach. A new marked crosswalk with a median refuge island will be installed across Blake Lane, connecting the new shared-use paths. Construction for the final improvements is expected to begin in late 2024.

2.5.2. AT&T Site Redevelopment

A planning study is currently under development for the approximately 33-acre AT&T campus situated at the southeast corner of Jermantown Road and Chain Bridge Road. The current plan envisions redeveloping the commercial property into a mixed-use neighborhood consisting of 1,000 residential units and 100,000 to 120,000 square feet of retail space. The conceptual plan includes two new road connections to Jermantown Road, along with multimodal access and circulation. A draft comprehensive plan amendment is anticipated for spring 2024.

2.5.3. Sutton Road and Blake Lane Intersection Redesign

Sutton Road and Blake Lane is currently under redesign for a new crosswalk on the south side of the intersection across Blake Lane with refuge space, removal of the slip lane for the right-turn onto Sutton Road, and audible pedestrian push buttons. The expected start date for construction of these improvements is summer 2025.

2.5.4. Oakton High School Zone and Speed Cameras

Oakton High School was selected as one of eight locations for Fairfax County’s pilot demonstration of automated speed camera enforcement within a school zone. The speed camera will be in effect when the school zone hours are in effect and will ticket drivers traveling 10 or more miles per hour over the speed limit. The fines will escalate with vehicle speed, with a maximum of $100.

2.5.5. Rectangular Rapid Flashing Beacons (RRFBs)

Fairfax County DOT has approved funding for two RRFB locations on the corridor. These treatments are currently in design and may be installed with additional improvements such as new crosswalks, pedestrian curb ramps, and median refuge space, like the example in Figure 5. The two locations include:

- Blake Lane and Bushman Drive
- Blake Lane and Bel Glade Street

Figure 5: RRFB at Bluemont Way and Discovery Street in Reston, Virginia (Source: Fairfax County DOT).

2.5.6. Repaving and Marking Improvements

Blake Lane was recently repaved in Summer 2023, and existing lanes were reduced from 12-foot travel lanes to 11-foot travel lanes. This resulted in an additional four (4) feet of median area that could aid in the construction of pedestrian refuge islands. Furthermore, VDOT added new high visibility crosswalks on the side streets and converted existing standard crosswalks along the corridor to high visibility.

2.6. Crash Analysis

Contributing factors, crash “hotspots”, and observable crash patterns and trends for both motorized and non-motorized crashes were the focus of the RSA’s crash analysis. Between October 31st, 2017, and October 31st, 2022, 140 crashes occurred along the study area, including a fatal crash with multiple pedestrian fatalities. In total, there were 38 crashes resulting in death or injuries. The most frequently observed collision type during the study period was ‘angle’ crashes between at least two drivers (62 total), followed by rear end collisions between at least two drivers (37 total). The third most frequent collision type involved drivers departing the roadway and colliding with fixed objects (10 total). Figure 6 shows all crash locations (points) within the study corridor, with the corridor symbolized to show relative crash density weighted by the equivalent property damage only (EPDO) method. The EPDO method assigns higher values to more severe crashes, allowing for a comprehensive assessment of crash density and safety issues. Figure 7 shows the locations where pedestrians and bicyclists were struck within the study corridor.

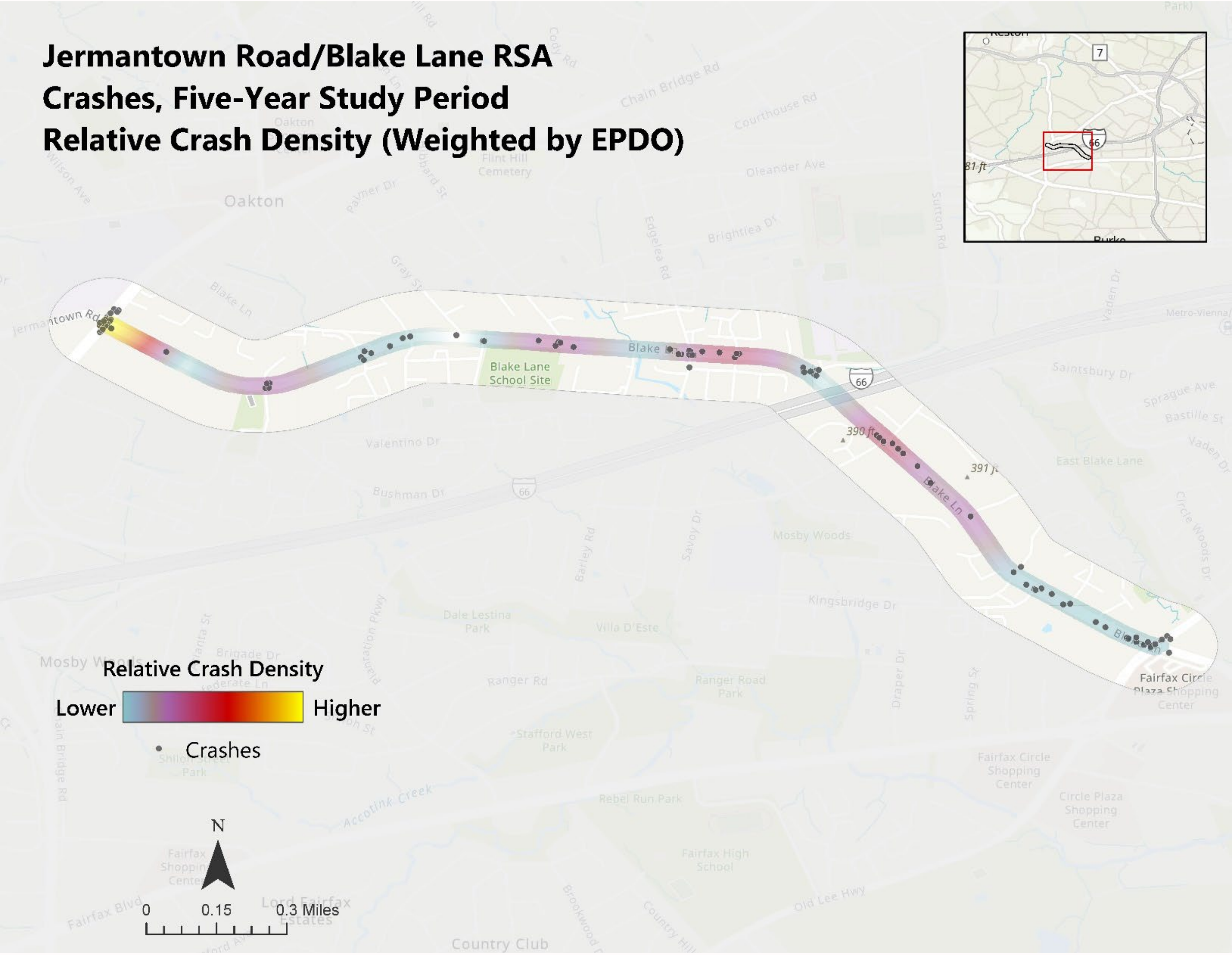

Figure 6. Relative crash density on Blake Lane, weighted by EPDO.

2.6.1. Vehicle-Pedestrian & Vehicle-Bicyclist Collisions

During the study period, there were six crashes in which vehicle drivers struck a pedestrian and three crashes in which a bicycle was struck by a driver or involved in the crash. Most pedestrian and bicyclist crashes occurred within the area of influence of an intersection, with the intersections with Chain Bridge Road (1 pedestrian and 1 bicyclist crash) and Five Oaks Road (2 pedestrian and 1 bicyclist crash). The Blake Lane and

Five Oaks Road intersection was the site of a crash which killed two pedestrians and injured a third. Two other incapacitating injuries involving a vehicle-pedestrian or vehicle-bicyclist collision were recorded along the corridor.

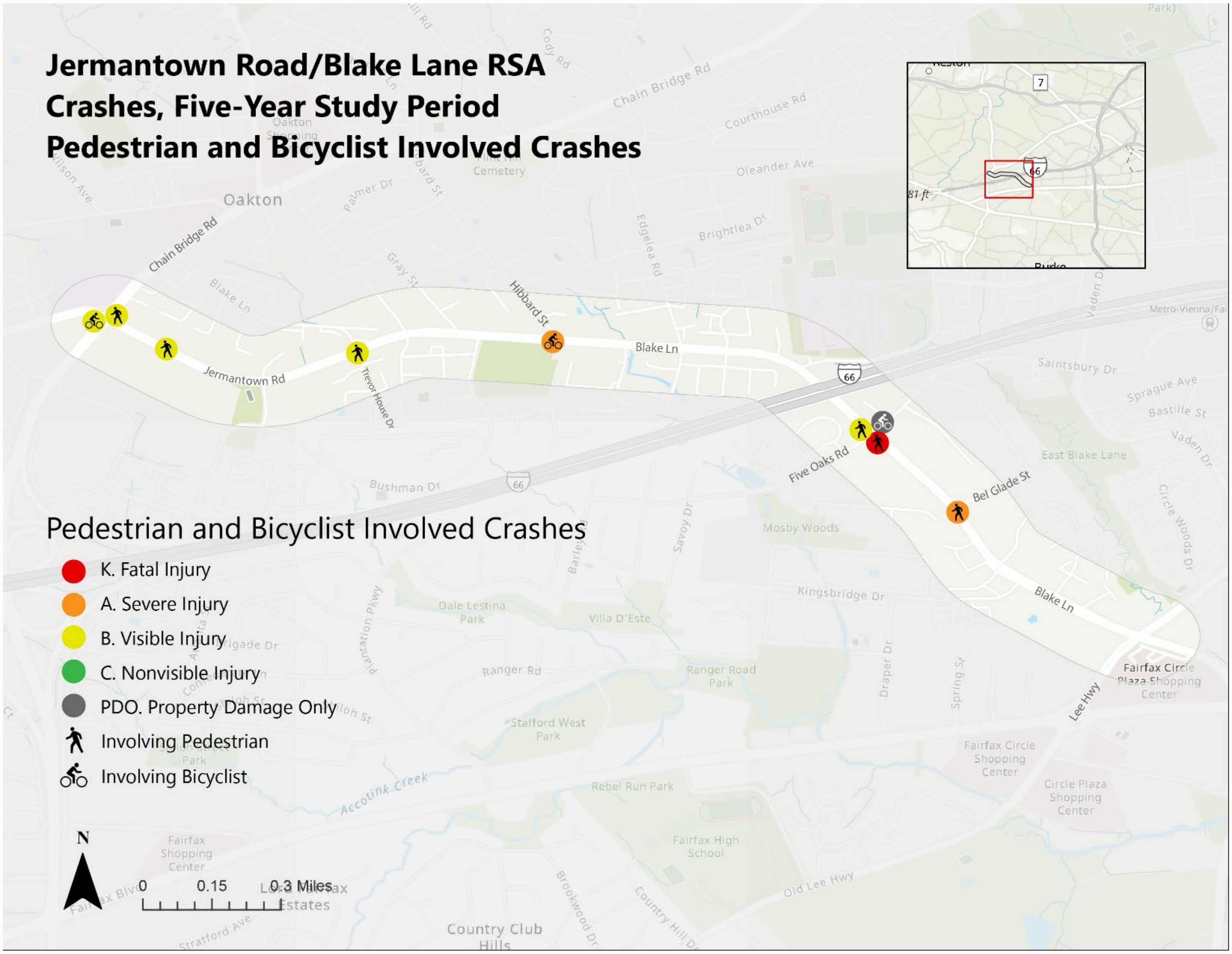

Figure 7. Blake Lane pedestrian and bicyclist involved crashes.

2.6.2. Corridor Hot Spots

Through the crash analysis, three 'hotspots' with higher concentrations of crashes or severe crashes were identified and presented in Table 4. The three hotspots included the intersection of Blake Lane and Five Oaks Road (13 crashes total, of those, there was 1 fatal crash and 4 injury crashes), Blake Lane between Edgelea Road/Platten Drive and Sugar Lane/Tipperary Pass (20 crashes, of those, there were 5 injury crashes), and Blake Lane between Lindenbrook Street and Blenheim Boulevard (36 crashes, of those, there were 5 injury crashes). The crashes within these hotspot locations accounted for just under half of the crashes for the entire study corridor.

Table 4. Corridor hot spots.

Hot Spot	Crashes
Blake Lane and Five Oaks Road	13 total crashes, 1 fatal crash, 4 injury crashes
Blake Lane from Edgelea Road / Platten Drive to Sugar Lane / Tipperary Pass	20 total crashes, 5 injury crashes
Blake Lane from Lindenbrook Street to Route 29	36 total crashes, 5 injury crashes

2.6.1. Blake Lane and Five Oaks Road

This location recorded 13 crashes total including 1 fatal and 4 injury crashes. The fatal crash at this intersection occurred when a northbound, left-turning vehicle was struck by a driver heading southbound after yielding to the pedestrians within the crosswalk on Blake Lane. The approaching vehicle then ricocheted off the turning vehicle onto the sidewalk, striking and killing two students and severely injuring another. According to the crash report, the southbound vehicle was speeding excessively, at an estimated 81 mph (Crash 12 in Figure 8).[6] Four additional injury crashes transpired at or near this intersection. Among them, one incident involved a pedestrian who was struck by a driver while crossing with the right-of-way signal (Crash 6 in Figure 8). A bicyclist-involved crash also occurred within this intersection when a driver passed a stopped school bus and struck a bicyclist who was crossing against the signal in the crosswalk (Crash 10 in Figure 8). Fortunately, the crash did not result in injury.

[6] NBC Washington Staff. *Driver, 18, Indicted in Crash That Killed 2 Oakton High School Students*. Published June 23, 2022 https://www.nbcwashington.com/news/local/northern-virginia/driver-18-indicted-in-crash-that-killed-2-oakton-high-school-students/3083850/

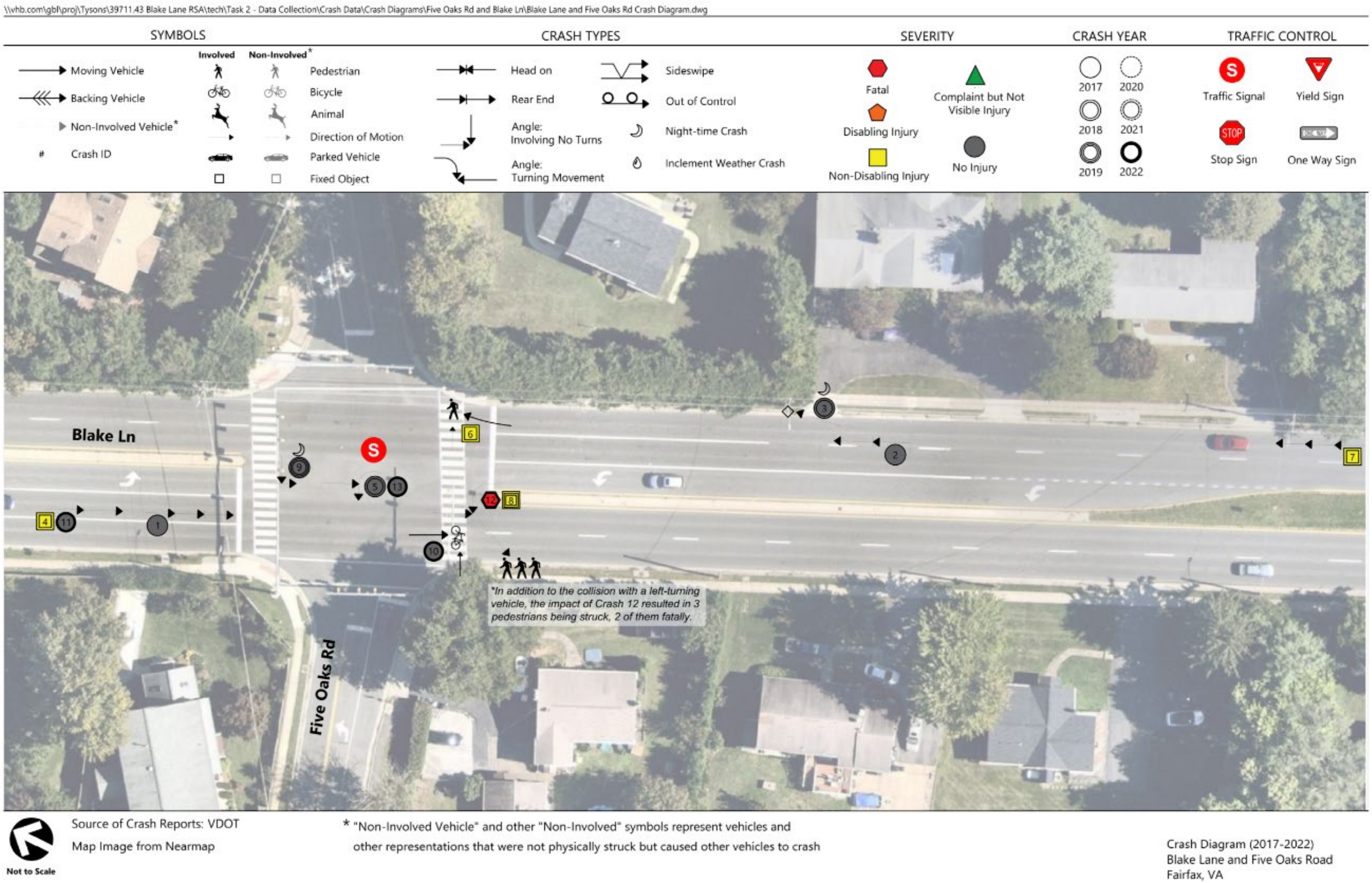

Figure 8. Crash diagram: Blake Lane and Five Oaks Road.

2.6.2. Blake Lane between Edgelea Road / Platten Drive and Sugar Lane / Tipperary Pass

The hotspot, as shown in Figure 9, consisted of two nearby intersections, Edgelea Road/Platten Drive and Tipperary Pass/Sugar Lane where 20 crashes, including 5 injury crashes occurred. A pattern of angle and rear end collisions was observed. For the angle collisions, particularly at the Edgelea Road/Platten Drive intersection, improper yielding or confusion due to the current traffic controls and intersection design seemed to be major factors. For the rear end collisions, the most predominant contributing factor recorded was vehicles slowing for various reasons, such as emergency vehicles, crossing pedestrians, or turning vehicles. There were no pedestrian or bicyclist crashes within this hotspot, however, the angle crash pattern was considered during the field review and is discussed in further detail in Section 3.

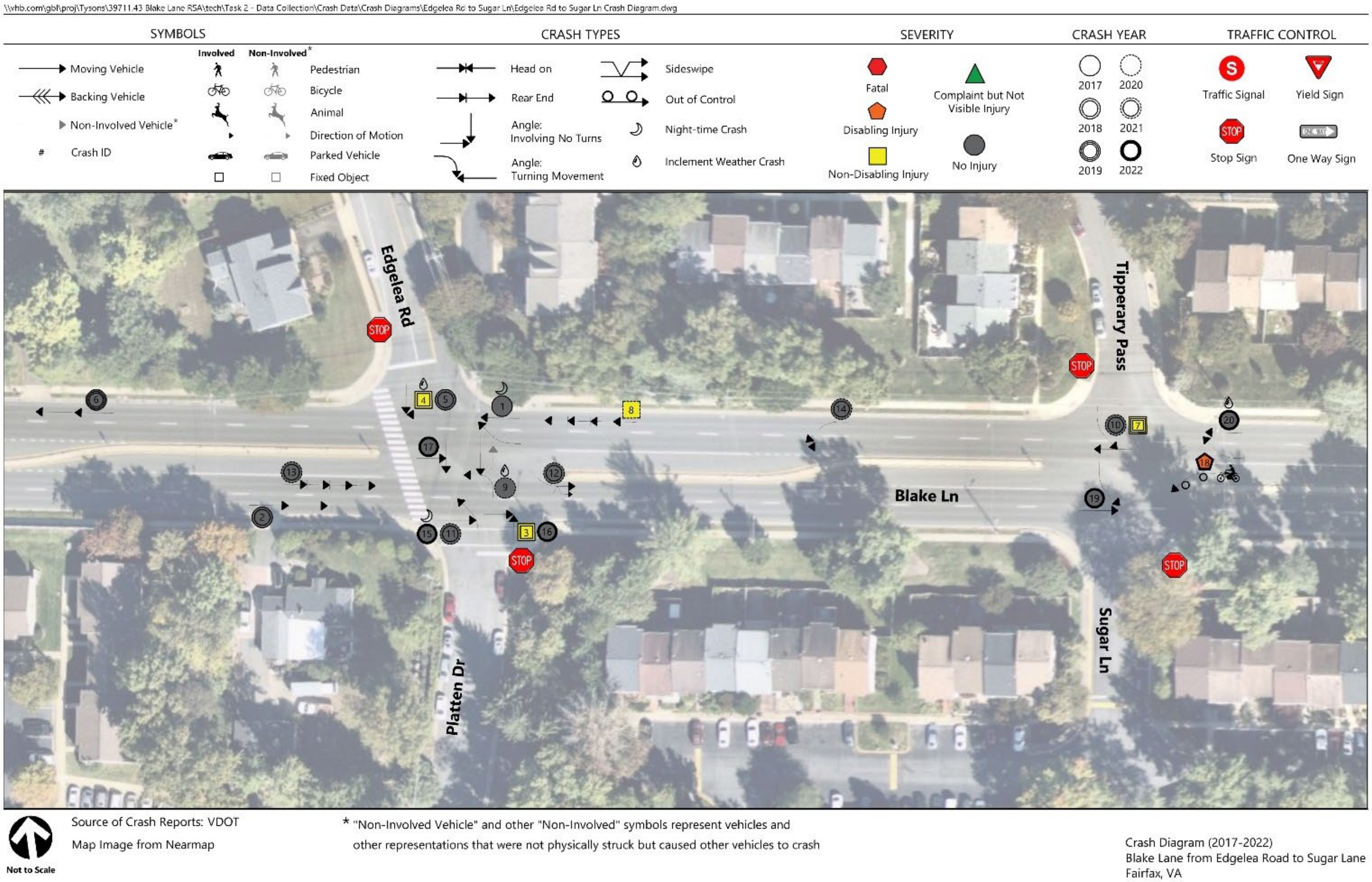

Figure 9. Crash diagram: Blake Lane between Edgelea Road / Platten Drive and Sugar Lane / Tipperary Pass.

2.6.3. Lindenbrook Street to Route 29

Between Lindenbrook Street and Route 29, 36 crashes occurred with 5 of those resulting in an injury. There is an observed pattern of red light running, especially vehicles traveling eastbound. Additionally, they most often occurred during off-peak, afternoon hours, with some others occurring in the morning.

Figure 10. Crash diagram: Lindenbrook Street to Route 29.

3. Identified Safety Concerns

The RSA team identified a variety of safety concerns throughout the corridor and at each intersection along the corridor. A high-level takeaway of primary concerns for each location are outlined in the Table 5 below. The table also features initial countermeasures that the project team will investigate for further feasibility.

Table 5. Identified safety concerns and countermeasures by location.

Location	Concern	Countermeasure(s) For Further Investigation
Corridor-wide	Higher vehicular speeds, particularly in the morning and afternoon peaks. *Higher speeds reduce drivers' ability to see and respond to other roadway users/roadway conditions. Higher speeds also result in more severe crashes.*	• Lane Narrowing • Curb Extensions • Refuge Islands
	Large turning radii that allow for high turning vehicle speed. *Corner radii are determined by design standards to accommodate certain vehicles, as well as consider an acceptable design speed given the type of roadway and width available for the turn. However, the corner radius indicates the comfortable allowable speed that passenger vehicle drivers can turn, which is faster the larger the radius is. Vehicle speed at the point of collision with a pedestrian influences the severity of the crash, so reducing the corner radius to lower the turning speed can lower the crash risk severity.*	• Reducing Corner Radii • Curb Extensions • Centerline Hardening
	Multiple threat for uncontrolled pedestrian and bicyclist crossing locations. *Multiple threat is when, on a multi-lane roadway, one driver stops for a crossing pedestrian but drivers in the other lane may not see/stop and could potentially result in a crash between the moving vehicle and pedestrian.*	• Turn Lane Reduction • Refuge Islands • RRFBs • Green Paint
	Limited sight distance for pedestrians and vehicles at intersections and driveways.	• Lane Width Reduction • Curb Extensions • Vegetation Trimming • Geometric Improvements

Location	Concern	Countermeasure(s) For Further Investigation
	Limited sight distance reduces drivers' ability to see oncoming vehicles and judge appropriate gaps to turn onto and off-of Blake Lane. This potential conflict can take the driver's attention away from crossing pedestrians. Additionally, vegetation, intersection skew, vertical and horizontal curves can pose visibility issues for pedestrians looking for vehicles prior to crossing. If pedestrians are unable to see approaching vehicles, drivers will also have challenges seeing crossing pedestrians.	• Access Management
	Wide pedestrian crossings across and along Blake Lane. *Longer crossings increase pedestrian crash risk with vehicular traffic and decrease pedestrian comfort, which could cause them to cross elsewhere (i.e., at undesirable locations).*	• Pedestrian Refuge Islands • Turn Lane Reduction • Curb Extensions
	Misalignment of some transit stops to marked pedestrian crosswalks. *Misalignment of the pedestrian crossings and transit stops can reduce pedestrian comfort by increasing the walking distance and can ultimately result in pedestrians crossing outside of marked crosswalks.*	• Transit Stop Balancing • Moving Existing Crosswalks/Installing New Crosswalks
	Difficult to see pedestrians in dark conditions. *Driver's may not be able to see/respond to crossing pedestrians. Similarly, limited lighting can reduce transit driver's ability to see pedestrians and may pass them without stopping.*	• Pedestrian Scale Lighting
	Conflicts between turning vehicles and pedestrians. *Crashes and near misses between turning vehicles and pedestrians were noted in the data and during the field review. Limiting the potential conflicts for drivers, prioritizing pedestrians, and reducing the turning vehicle speeds can aid in improving crossing safety.*	• Leading Pedestrian Interval • Flashing Yellow Arrow • Reduced Corner Radii • Installing Crosswalks on Side Streets and Major Driveways
	Many approaches on the corridor are missing stop lines and/or crosswalks.	• Corridor Repaving

Location	Concern	Countermeasure(s) For Further Investigation
	Pavement markings such as stop lines and crosswalks provide driver and pedestrian guidance on where drivers are to stop prior to the intersection as well as where pedestrians are likely to be crossing.	
	Many sidewalks along the corridor are uneven, cracked, or in poor condition. *Sidewalks along Blake Lane should be reviewed from a maintenance perspective for accessibility/walkability. Sidewalk improvements could also be prioritized based on pedestrian usage, condition, and ease of implementation.*	• Sidewalk Maintenance and Improvements
Blake Lane and Kingsbridge Drive	North side of intersection across Blake Lane does not have a crosswalk. *Pedestrians traveling across the street to the corner without a crosswalk present will need to cross the minor street twice and major street once, significantly extending pedestrian walk time. Alternatively, pedestrians may opt to cross where the crossing is not marked to save travel time, thus increasing the pedestrian crash risk.*	• New Crosswalk • Leading Pedestrian Interval
	Sidewalk along frontage road is uncomfortable due to potential for traffic on either side of the sidewalk. It is also narrow and uneven. Signal equipment is within pedestrian path on the sidewalk. *Sidewalk facilities that are narrow, uncomfortable, or have obstructions increase pedestrian crash risk. Signal equipment in a narrow walking path can pose an obstacle for pedestrians with mobility devices, carts, or strollers. This may force them into walking in the roadway. Uncomfortable sidewalks may also lead to pedestrians walking in roadway space, such as access roads.*	• Right-of-Way Acquisition • Access Management • Enhance pedestrian facilities to widen the sidewalk and provide a buffer between vehicular travel lanes.
	Span wire signal poles should be replaced with mast arm.	• Right-of-Way Acquisition

Location	Concern	Countermeasure(s) For Further Investigation
	Placing signal heads on mast arms instead of span wire would allow for better signal visibility. This could be especially beneficial given the horizontal curve when heading southeast on Blake Lane, which also has challenges with sun glare.	
	Signal visibility is reduced during certain times of day due to sun glare. *Driver's ability to perceive and react to changes in the intersection control and conflicts with other vehicles and pedestrians can be greatly diminished with sun glare.*	• Dynamic All Red Extension • Additional southbound, near-side signal head on signal pole.
Blake Lane between Lindenbrook Street and Route 29	Observed pedestrians crossing midblock (no crosswalk). *Pedestrians may be crossing midblock due to a lack of nearby crosswalks or when boarding or alighting a bus. The next closest crosswalk south of Kingsbridge Drive is over 1,100 feet away. At a standard walking pace, the travel time to get to the other side of Blake Lane could be more than 5 minutes, without accounting for time waiting at the signal.*	• Access Management • Geometric Improvements • Pedestrian Refuge • New Crosswalk
	Sidewalks are narrow and immediately adjacent to vehicular travel lanes on both sides of Blake Lane. *While there are pedestrian facilities, they are uncomfortable and may not be accessible. By blending into the surrounding environment of pavement and concrete, they blend into the environment and make pedestrians less visible.*	• Enhance pedestrian facilities to widen the sidewalk and provide a buffer between vehicular travel lanes.
Blake Lane & Bel Glade Street	Consider shifting the crosswalk to opposite side to allow for median refuge. *The current crosswalk at Bel Glade Street is across 5 lanes with a narrow strip of median. By moving the crosswalk to the south side of the intersection, only 4 lanes would require crossing and there is a wide median that could be used as a pedestrian refuge island. This reduces pedestrian exposure and allows for a two-stage crossing as needed.*	• Turn Lane Reduction • Pedestrian Refuge • New Crosswalk

Location	Concern	Countermeasure(s) For Further Investigation
Blake Lane & Five Oaks Road	Pedestrian recall phase currently allows for more than one recall during a signal phase. *Having multiple pedestrian recalls can be confusing for pedestrians, especially when pushing the button for a second time when the walk time cannot be accommodated within the same cycle length. This may also be confusing for turning drivers that are not expecting an additional walk phase.*	• Investigate Signal Timing • Leading Pedestrian Interval
	Concerns with crashes caused by turning vehicles at the intersection. *Turning vehicles have been an issue at the intersection, as indicated by past crash history. An investigation into the contributing factors of previous crashes may indicate challenges in drivers finding gaps to turn during a permissive green phase, or high turning speeds that pose a risk of serious injury to pedestrians.*	• Centerline Hardening • Investigate Signal Timing
Blake Lane & Sutton Road	Limited sight distance due to foliage and horizontal curve for southbound vehicles on Blake Lane. *Eastbound Blake Lane drivers may have limited visibility of the intersection of Sutton Road, which could result in challenges seeing the signal and seeing pedestrians crossing eastbound towards the high school. This is a safety concern because drivers may not stop with enough time to provide adequate distance between their vehicle, other vehicles, or the crosswalk. This could result in rear end crashes or collisions with pedestrians.*	• Vegetation Trimming
	Large numbers of pedestrians waiting to cross from southern side and conflicting with right-turns from Sutton Road. *The adjacent high school to this intersection generates heavy right and left-turning vehicular volumes from Sutton Road during afternoon dismissal, as well as significant pedestrian volumes crossing Blake Lane in the marked crosswalk. The pedestrian facilities are also*	• Investigate Signal Timing • Leading Pedestrian Interval

Location	Concern	Countermeasure(s) For Further Investigation
	limited, so many students fill the corner and surrounding sidewalk waiting to cross Blake Lane.	
	Major queuing due to drop-offs downstream at Oakton High School. *The arrival time prior to Oakton High School's first bell results in significant queuing for vehicles turning left from southeastbound Blake Lane onto Sutton Road. This queuing backs up into the left-through travel lane, impacting intersection operations during the morning peak hour.*	• Investigate Signal Timing
Blake Lane & Sugar Lane / Tipperary Pass	Vehicles approaching from side streets have limited sight distance due to foliage and existing geometry. *The site conditions currently prohibit drivers from being able to see downstream, resulting in the need to pull up closer or into the path of the pedestrian crossing. The combination of visibility challenges due to geometry and vegetation infringing in the right-of-way along with elevated driver speeds in the eastbound Blake Lane direction result in safety concerns for both vehicles and pedestrians. Safety concerns include an elevated risk of angle crashes involving vehicles turning onto Blake Lane, as well as turning vehicle-pedestrian collisions due to drivers focus on finding an acceptable gap to enter Blake Lane.*	• Lane Width Reduction • Vegetation Trimming • Geometric Improvements
	No crosswalks across Blake Lane at this intersection. *There are no crosswalks on Blake Lane between Sutton Road and Edgelea Road / Platten Drive (approximately 1,100'). However, there are transit stops present, meaning that pedestrians may have a desire to cross Blake Lane when boarding or alighting from a bus.*	• New Crosswalk
Blake Lane & Platten Drive / Edgelea Road	Vehicles approaching from side streets have limited sight distance due to foliage and existing intersection geometry.	• Lane Width Reduction • Curb Extensions • Vegetation Trimming • Geometric Improvements

Location	Concern	Countermeasure(s) For Further Investigation
	The site conditions currently prohibit drivers from being able to see downstream, resulting in the need to pull up closer or often into the path of the pedestrian crossing. The combination of visibility challenges due to geometry and vegetation infringing in the right-of-way along with elevated driver speeds in the eastbound Blake Lane direction result in safety concerns for both vehicles and pedestrians. Safety concerns include an elevated risk of angle crashes involving vehicles turning onto Blake Lane, as well as turning vehicle-pedestrian collisions due to drivers' attention to finding a gap to enter Blake Lane.	• Access Management
	Pedestrians caught in the middle of crosswalk. *Pedestrians crossing Blake Lane at Edgelea Road / Platten Drive may have unique challenges given the complexity of the intersection. Drivers traveling eastbound on Blake Lane are likely traveling at higher rates of speed than the westbound direction, which is coming from a signal and horizontal curve. Also, vehicles coming from the side street are aggressive in finding a gap to enter Blake Lane, meaning that they may not yield to pedestrians in the crosswalk.*	• Geometric Improvements • Access Management • Pedestrian Refuge
	No crosswalks on east side of the intersection. *Pedestrians traveling across the street to the corner without a crosswalk present will either need to cross the minor street twice and major street once, significantly extending pedestrian walk time. Alternatively, pedestrians may opt to cross where the crossing is not marked to save travel time, thus increasing the pedestrian crash risk.*	• Pedestrian Refuge • New Crosswalk • Corridor Repaving
	Cross County Trail connects with new I-66 Parallel Trail at this intersection. *With the opening of the new I-66 Parallel Trail, many pedestrians and bicyclists may be connecting to from the Cross County Trail on Blake Lane via Platten Drive. Platten Drive is a low-volume local road, which may make it desirable for bicyclists coming from the neighborhood*	• Green Paint and Shared Lane Markings (Sharrows)

Location	Concern	Countermeasure(s) For Further Investigation
	north of Blake Lane. Increasing driver awareness through signage and supplementary pavement markings can help indicate that the intersection is a frequent crossing location for a variety of multimodal road users.	
Blake Lane & Cyrandall Valley Road	Vehicles approaching from side streets have limited sight distance due to foliage and existing geometry. *The site conditions currently prohibit drivers from being able to see downstream, resulting in the need to pull up closer or into the path of the pedestrian crossing. The combination of visibility challenges due to geometry and vegetation infringing in the right-of-way along with elevated driver speeds in the eastbound Blake Lane direction result in safety concerns for both vehicles and pedestrians. Safety concerns include an elevated risk of angle crashes involving vehicles turning onto Blake Lane, as well as turning vehicle-pedestrian collisions due to drivers' attention to finding a gap to enter Blake Lane.*	• Lane Width Reduction • Vegetation Trimming • Geometric Improvements
Blake Lane & Hibbard Street	Highly difficult for eastbound and westbound vehicles to see pedestrians crossing at the crosswalk due to vertical curve. *Blake Lane in this portion of the corridor features a vertical curve, with the crosswalk at Hibbard Street at the crest. This makes it challenging for drivers to see the crosswalk markings on both approaches.*	• Relocate or New Crosswalk • Pedestrian Refuge
	Straightness of the road may increase speed, along with heading downhill eastbound. *Between Gray Street and Sugar Lane, Blake Lane does not have horizontal deflection. Drivers in the eastbound direction continue straight on a relatively grade, until reaching Hibbard Street, which then continues downhill at roughly a 3 percent grade until Edgelea Road / Platten Drive.*	• Lane Width Reduction
	Closely spaced transit stops between Palmer Street and Bushman Drive.	• Transit Stop Rebalancing

Location	Concern	Countermeasure(s) For Further Investigation
	Coordinating transit stops with suitable crosswalk locations is one way to reduce pedestrian crash risk by better designating frequent crossing locations. This may require looking at current transit stops and identifying ways to consolidate stop locations to only where pedestrian crossings are well-marked and highly visible.	
Blake Lane & Bushman Drive	Left-turning vehicles blocking visibility of those turning right, particularly due to sight distance issues. *When the Bushman Drive approach serves as a right and left-turn lane, vehicles turning left prohibit drivers from being able to see downstream. Not only do both left and right-turning vehicles pull up into the crosswalk, but right-turning vehicles still have trouble seeing downstream on eastbound Blake Lane. The current Bushman Drive approach configuration and elevated driver speeds in the eastbound Blake Lane direction result in safety concerns for both vehicles and pedestrians. Safety concerns include an elevated risk of angle and rear end crashes involving vehicles turning onto Blake Lane, as well as turning vehicle-pedestrian collisions due to drivers' attention to finding a gap to enter Blake Lane.*	• Lane Width Reduction • Curb Extensions • Vegetation Trimming • Geometric Improvements
	Vehicles driving over bike lane. *Vehicles infringing on the bike lane pose a risk to bicyclists or micromobility users riding in the lanes, who might not expect a vehicle to enter the facility. Additionally, drivers may not expect or see a bicyclist or micromobility user approaching alongside in the bike lane, thus increasing the risk of a sideswipe crash.*	• Green Paint on Intersection Approach • Buffer with Pavement Markings
	Cross County Trail connects with new I-66 Parallel Trail at this intersection. *With the opening of the new I-66 Parallel Trail, many pedestrians and bicyclists may be connecting to from the Cross County Trail on Blake Lane via bike facilities already on Bushman Drive. Bushman Drive currently has a bike*	• Green paint and Bike Lane Extension Markings

Location	Concern	Countermeasure(s) For Further Investigation
	lane in the northbound direction and shared lane markings in the southbound. Increasing driver awareness through signage and supplementary pavement markings can help indicate that the intersection is a frequent crossing location for a variety of multimodal road users.	
Blake Lane & Windwood Farms Drive / Palmer Street	Wide driveways allow for high-speed turns. *Similar to a large corner radius, a wide approach or driveway allows for vehicles to turn off of Blake Lane at higher speeds. This is due to the additional space that vehicles have to turn wider onto the driveway or side street.*	• Curb Extensions
	Potentially unnecessary right-turn lane eastbound. *Turn lanes are frequently added when turning volumes are high to reduce the risk of rear end crashes as well as ease impacts from vehicles slowing to turn on vehicles continuing through on the roadway. However, removing turn lanes can help to slow down turning drivers as well as traffic traveling through, and regain roadway space to reduce the pedestrian crossing distance.*	• Turn Lane Reduction
Blake Lane & Trevor House Drive	No crosswalk on west side of intersection. *Pedestrians traveling across the street to the corner without a crosswalk present will need to cross the minor street twice and major street once, significantly extending pedestrian walk time. Alternatively, pedestrians may opt to cross where the crossing is not marked to save travel time, thus increasing the pedestrian crash risk.*	• New Crosswalk
	Pedestrians not pushing the button for walk signal because it is "out of the way". *The pedestrian push button on the northwest corner of the intersection is far from the curb ramps where pedestrians would be waiting for the walk phase. Pedestrians may not see the push button in the current location, especially visually impaired pedestrians that may experience*	• Relocate pedestrian push button

Location	Concern	Countermeasure(s) For Further Investigation
	challenges with expectations of where to expect the push button.	
Blake Lane & Borge Street	Vegetation blocking pedestrian warning signs. *Trees and bushes that block pedestrian warning signs prevent drivers from advanced awareness of crossing locations. Informing driver expectations helps reduce the reaction time required for the vehicle to stop for pedestrians using the crosswalk.*	• Vegetation Trimming
	Cross County Trail connects with new I-66 Parallel Trail at this intersection. *With the opening of the new I-66 Parallel Trail, many pedestrians and bicyclists may be connecting to from the Cross County Trail on Blake Lane via bike lanes in both directions on Borge Street. Increasing driver awareness through signage and supplementary pavement markings can help indicate that the intersection is a frequent crossing location for a variety of multimodal road users.*	• Green Paint and Bike Lane Extension Markings
Blake Lane & Chain Bridge Road	Preliminary plans are in place to redevelop the AT&T campus in the southeast quadrant of this intersection. *The RSA Project Team will look for any existing plans on the redevelopment and seek to identify opportunities for pedestrian and bicyclist improvements.*	• Review Plans • Identify Opportunities for Ped/Bike Enhancement

4. Alternatives Analysis

The Alternatives Analysis in the following section evaluates a variety of potential safety enhancements to compare options, better understand potential trade-offs, and to aid with determining treatments to advance into engineering assessments. The alternatives analysis also includes the following quantified measures of effectiveness to aid in evaluating alternatives, including:

- Expected crash reduction
- Pedestrian comfort
- Enhanced multimodal connectivity
- Speed reduction

Safety improvement countermeasures outlined in this memorandum may not all be feasible. However, the additional engineering assessments conducted in Section 4 investigate five of these alternatives further.

4.1. Potential Demonstrations

There are multiple treatments outlined in the following two sections that could be implemented as demonstrations as needed. For example, alternative intersection designs or access management could initially be tested with temporary materials. This would allow VDOT and FCDOT to test the locations and design, gather public feedback on the treatment, and implement improvements quickly while permanent treatments are seeking funding and/or being designed. The following are two initial temporary treatments for consideration.

4.1.1. Temporary Curb Extensions (Curb Hardening)

Curb extensions (or neckdowns, bump outs) are a commonly used traffic calming countermeasure and can be used on roadways with on-street parking or additional, unneeded pavement width. Benefits of curb extensions can include:

Reducing a corner radius that is larger than the required inner turn radius of the specified design vehicle and narrowing of curb-to-curb width of a roadway.

- Tightening turning radius can have beneficial traffic calming effects by slowing turning speeds. A recent study found that pedestrian crash medication factors increase with increased turning radius.[7]
- Reducing the curb-to-curb width helps reduce pedestrian exposure to vehicles by shortening the crossing.

[7] Fitzpatrick, K., Avelar, R., Pratt, M., Das, S., Lord, D. "Crash Modification Factor for Corner Radius, Right-Turn Speed, and Prediction of Pedestrian Crashes at Signalized Intersections." Report No. FHWA-HRT-21-106. Federal Highway Administration. (2022).

- Curb extensions at uncontrolled locations can help reduce vehicle speeds by visually narrowing the street.
- Increasing the visibility of pedestrians at crossings.
- Maintaining intersection clearance by prohibiting standing or parking, which can be critical to ensuring adequate sight lines for drivers.

These treatments can be installed with more permanent materials, such as concrete curbing, or with materials that are less expensive and faster to install, such as with pavement markings and a raised elements like temporary curbing Figure 11 shows a curb extension that is created with lower-cost, faster installation materials.

Potential drawbacks of curb extensions include turning restrictions for large vehicles, such as trucks or buses. Additionally, vehicles slowing down to turn right without adequate advance notice may lead to an increase in rear end crashes. Lastly, coordination with VDOT on snow removal and curb extension material maintenance would be needed, as temporary curbing could be removed prior to significant snow events for plowing.

Temporary curb extensions with flexible delineators can increase the need for maintenance, especially in areas with heavy foliage. Street sweepers and snow removal can be a challenge with the vertical elements. Additionally, while the vertical element prevents vehicles from simply driving over the marked gore area, this can result in the vertical elements being hit by turning vehicles. Permanent concrete curb extensions may require costly changes to stormwater drainage if not designed with an open channel that allows water to flow to existing drainage structures.

The following locations have been identified as candidates for curb extensions based on the intersection skew, existing turning radius, and curb-to-curb width of the side street. Locations include:

- Blake Lane and Bushman Drive
- Blake Lane and Borge Street
- Blake Lane and Palmer Street
- Blake Lane and Gray Street
- Blake Lane and Hibbard Street
- Blake Lane and Edgelea Road
- Blake Lane and Tipperary Pass

Proposed concepts for temporary curb extensions at these seven intersections are provided later in this document in Sections 5.4 and 5.5.

Figure 11. Temporary curb extension with curb hardening (Source: Richard Drdul).

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.1.2. Temporary Centerline Hardening

Centerline hardening, or left-turn hardening, can be used to slow down left-turning vehicles by forcing them to turn with a smaller, slower turning angle instead of taking a sweeping, faster turn over the crosswalk (as shown in Figure 12). Studies have shown that this treatment may provide up to a 70 percent reduction in pedestrian-vehicle crashes and 7 percent reduction in left-turning vehicle speeds.[8]

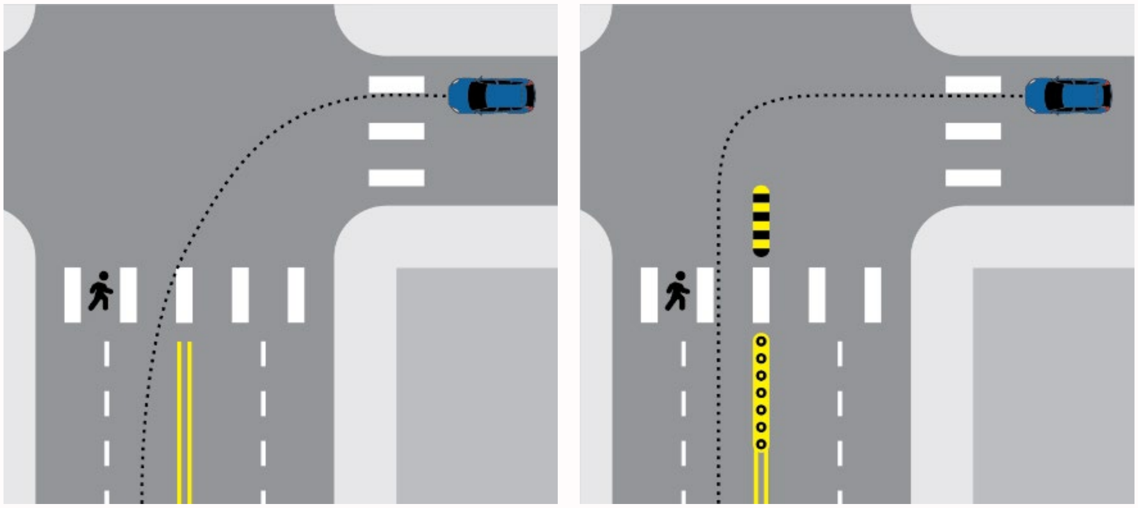

Figure 12. Centerline hardening treatment concept (Source: Insurance Institute for Highway Safety).

A secondary effect of the centerline hardening treatment could include speed reduction for right-turning vehicles as well. When a vehicle is not present at the stop line in the opposing direction, a right-turning vehicle is able to easily make a wide and fast turn over the centerline of the receiving roadway. When a hardened centerline is present, the vehicle's turning path is constrained, and the driver may be more likely to slow down for the right-turn to avoid crossing over the treatment. It should be noted that implementation of this treatment would not include moving the crosswalk so that it is offset from the intersection, as that would impact drivers' ability to see crossing pedestrians.

There are potential maintenance and crash concerns with this treatment. Given the types of materials used for this treatment, and placement in the roadway, damage to the treatment may require frequent maintenance. Additionally, in locations where vehicles may have difficulty making left-turns, such as on higher-speed or higher-volume roadways with small and infrequent gaps in on-coming traffic, this treatment could further expose the driver to conflicts with on-coming vehicles. At unsignalized intersections, or signalized intersections with permissive left-turns, an assessment of geometry for all turning movements

[8] Hu, W. and Cicchino, B. "The effects of left-turn traffic-calming treatments on conflicts and speeds in Washington, DC." Journal of Safety Research, Volume 75, Pages 233-240. (2020).

would need to be performed to make sure that the raised elements would not impede drivers such that it would increase overall severe crash risk within the intersection. Additionally, combined with other potential safety enhancements designed to improve turning vehicle safety (such as flashing yellow arrow) and reduction in speeds (such as lane narrowing), increased crash risk is minimized.

Based on crash history and pedestrian crash risk factors, the following intersections may be suitable for further examination of centerline hardening treatments:

- Five Oaks Road approaches to Blake Lane
- Edgelea Road approach to Blake Lane
- Platten Drive approach to Blake Lane
- Southbound Palmer Street approach to Blake Lane
- Northbound Borge Street approach to Blake Lane

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2. Potential Corridor Treatments

The corridor is generally four lanes, with two in each direction and numerous right and left-turn lanes. There are long stretches of corridor without controlled crossings. The corridor has a high amount of pedestrian activity, particularly during the mornings with students walking to school and on the weekends. Pedestrian and bicyclist activity is expected to increase with the new connections between Blake Lane and the new I-66 Parallel Trail opened on Sunday, May 22, 2023. During morning and evening peak periods speeds appear to be higher, increasing the crash risk and severity for all roadway users, particularly non-motorized roadway users. The following are treatments that could help to change the look and feel of the corridor by reducing speeds, increasing driver expectation of pedestrians and bicyclists, providing consistency in design and safety treatment application, and improving safety for all roadway users.

4.2.1. Reduction of Unwarranted Left and Right-Turn Lanes

By reducing right and left-turn lanes that are not warranted by the VDOT Road Design Manual, Appendix F, additional roadway space can be reallocated for pedestrian use or geometric realignment. Although turn lanes often have a favorable crash reduction factor for motorists (particularly for rear end crashes), they increase the roadway width for pedestrian crossings and introduce and additional conflict points between pedestrians and turning vehicles. They also allow for through traveling drivers to remain unaffected by those turning, allowing drivers to maintain the free-flow speed of the roadway, even at intersections where pedestrians may be crossing. Reducing speeds at intersections where pedestrians are crossing is particularly important given the effects of speed on injury severity for vulnerable road users. Reducing turn lanes where turning volumes are low would provide space for median refuges. The elimination of left-turn lanes may also be paired with a turn restriction to reduce the risk of rear end crashes. There are several locations along the corridor where there are few turns throughout the day that currently have turn lanes. Investigation into each of these locations should be done to determine the feasibility of the turn lane removal and benefits for each road user.

Several of these locations may be good candidates for new or relocated crosswalks with a median refuge. Locations where left-turn and right-turn volumes may fall under the warrant threshold for turn lanes and turn tapers could include:

- Northbound Left-Turn onto Cedar Grove Drive
- Westbound Left-Turn onto Platten Drive
- Westbound Left-Turn onto Sugar Lane
- Westbound Left-Turn into Townhomes at Hibbard Street
- Eastbound Right-Turn onto Windwood Farms Drive
- Eastbound Left-Turn onto Borge Street

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

4.2.2. Pedestrian Refuge Islands / New Crosswalks

Pedestrian refuge islands (Figure 13) can lead to a 26 percent reduction in all crashes and a 32 percent reduction in vehicle-pedestrian crashes.[9] Refuge islands can be particularly effective on multilane arterials with high vehicular volume and speeds 35 mph and greater. For this reason, Blake Lane is well suited for this treatment, as it allows for two-stage crossings and enhances driver visibility of crossing pedestrians at uncontrolled locations.

[9] Zegeer, C., Lyon, C., Srinivasan, R., Persaud, B., Lan, B., Smith, S., Carter, D., Thirsk, N. J., Zegeer, J., Ferguson, E., Van Houten, R., & Sundstrom, C. "Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments." Transportation Research Record, 2636(1), 1–8. (2017).

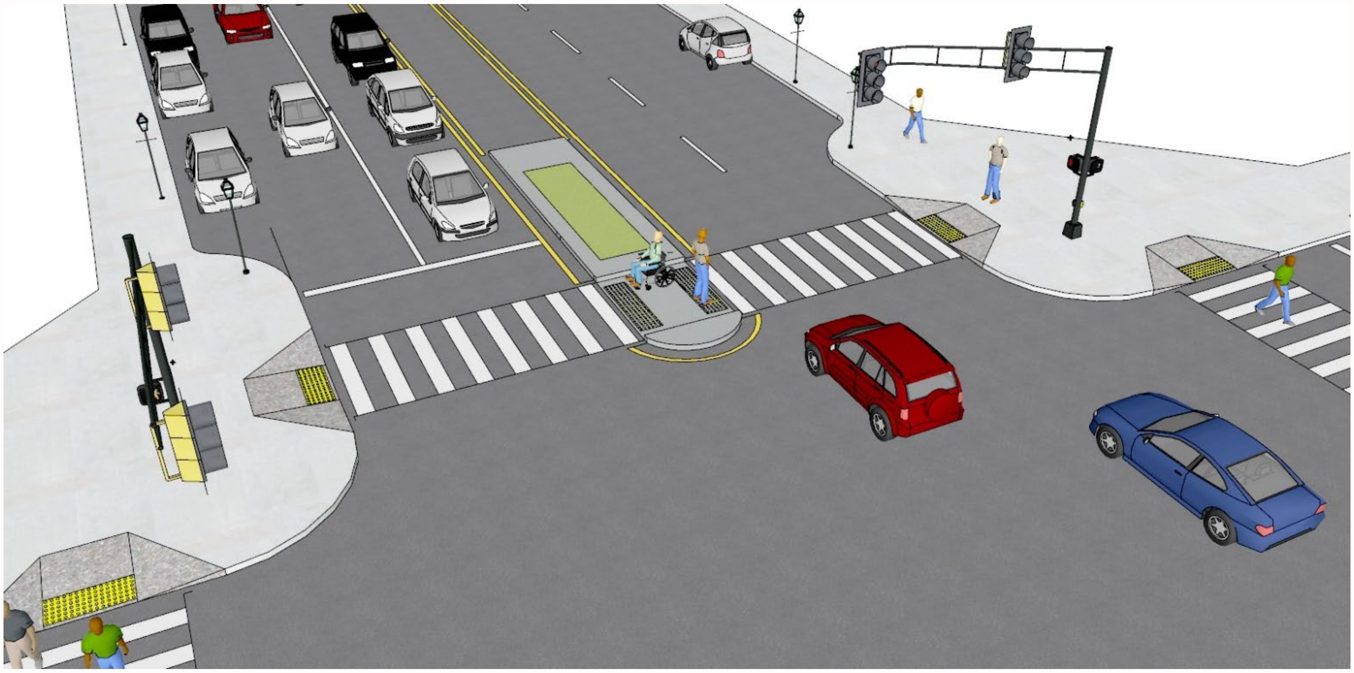

Figure 13. Pedestrian refuge island concept on four-lane roadway (Source: VDOT).

There are several locations that could accommodate a pedestrian refuge island. The new cross-section, with its additional median width, may then be suitable for a new/relocated crosswalk. This could mean relocating a crosswalk from one side of an intersection to another and enhancing it with the pedestrian refuge island or installing a new crosswalk with a median refuge island. Two candidate locations, including Blake Lane / Bushman Drive and Blake Lane / Bel Glade Street, for pedestrian refuge islands are currently under design and both will also include Rectangular Rapid Flashing Beacons (RRFBs). There are also several intersections along the corridor that have existing medians wide enough to extend for a pedestrian refuge island. In Figure 14, two pedestrians crossing at Borge Street run across between vehicle gaps. Borge Street is an example of where an 8-foot median is present that could potentially be extended to provide a pedestrian refuge.

Figure 14. Pedestrians crossing Blake Lane at Borge Street.

Potential pedestrian refuge island locations with new/relocated crosswalks could include:

- [Relocated or Additional] South Crosswalk at Bel Glade Street
- [Relocated] East Crosswalk at Edgelea Road / Platten Drive (pending intersection treatment)
- [Relocated] East Crosswalk Hibbard Street
- [New] West Crosswalk at Bushman Drive

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

4.2.3. Green Paint and Trail Crossing Signage

There are several intersections along the corridor where bicyclists may be connecting between the I-66 Parallel Trail and the Gerry Connolly Cross County Trail. At these connections, using green paint and trail crossing signs to designate crossing points can help raise driver awareness of the presence of bicyclists. These treatments would be particularly beneficial at intersections and driveways. This treatment has shown to increase driver yielding to bicyclists and reduce conflicts between turning vehicles and bicyclists[10].

[10] National Academies of Sciences, Engineering, and Medicine. "Guidance to Improve Pedestrian and Bicyclist Safety at Intersections." NCHRP Research Report 926. The National Academies Press. (2020).

Green paint can be applied within the bike lane on approaches to Blake Lane (such as Borge Street and Bushman Drive) and within intersections where the existing bike lane connects with another bicyclist facility, such as the Gerry Connolly Cross County Trail. Intersection green paint would consist of hatched markings aligned with the most common path of bicyclists, which often runs parallel to marked crosswalks. This treatment would visually separate pedestrian and bicyclist spaces, as well as provide wayfinding for the I-66 Parallel Trail and Gerry Connolly Cross County Trail connection points. The green paint could also visually narrow the roadway for drivers, which could encourage slower speeds and increase general expectancy of pedestrians and bicyclists. An example of the use of green paint is shown in Figure 15.

Potential treatment locations all have bicycle lanes present on the side street approach that connect with the Cross County Trail. Intersections with potential for green paint installations include:

- Jermantown Road and Borge Street
- Blake Lane and Bushman Drive
- Blake Lane and Platten Drive (with new bicyclist markings on Platten Drive)

Figure 15. Green paint for bicycle lane extension (Source: City of Richmond).

Green paint does require frequent maintenance when located in the path of vehicular travel. Coordination with maintenance will be needed to maintain visibility.

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2.4. Leading Pedestrian Interval (LPIs)

A Leading Pedestrian Interval (LPI) is a signal timing mechanism that begins the pedestrian phase three (3) to seven (7) seconds earlier than the parallel vehicular phase. This treatment allows waiting pedestrians to begin walking first, approaching the center of the crosswalk before vehicles begin to turn. Ultimately it helps drivers to see and yield to pedestrians in the crosswalk. While LPIs are a pedestrian safety treatment, they have been shown to reduce all crashes as much as 13 percent and reduce vehicle-pedestrian crashes as much as 19 percent at treated intersections.[11]

Other benefits include:

- Increased likelihood of drivers yielding to pedestrians in crosswalk
- Increased visibility of pedestrians in crosswalk at start of green phase
- Enhanced safety for slower pedestrians that may need additional crossing time

In the VDOT Northern Virginia District, LPI installations typically are four (4) to seven (7) seconds but may be extended depending on site conditions (VDOT Northern Region, Traffic Operations Practice: Pedestrian Accommodations at Traffic Signals). They can be particularly beneficial when installed at T-intersections where pedestrians conflict with turning vehicles from the stem of the T (minor street approach), at 4-leg intersections where opposing traffic is low and left-turn movements are high, or any signalized intersection with higher risks for turning vehicle-pedestrian crashes. The installation of LPIs can degrade the operational performance of the intersection and increase vehicular delay.

Potential candidates for an LPI installation include the following signalized intersections:

- Jermantown Road and Trevor House Drive
- Blake Lane and Sutton Road (pending intersection redesign)
- Blake Lane and Five Oaks Road
- Blake Lane and Kingsbridge Drive

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2.5. Pedestrian Recall

Pedestrian recall is a signal timing feature that entails activating the pedestrian phase for every signal cycle. This means that each time the concurrent vehicular phase is given the right-of-way, the adjacent crosswalk (non-conflicting) will automatically have a walk indication. Pedestrian recall is often deactivated at actuated signals, or signals with adjustable timing based on demand, because the walk phase for the crosswalk across the major road can often be longer than the timing needed for the side street phases. By having the pedestrian recall turned off, extra green time not needed for the side streets can be added to the major road green time.

[11] Goughnour, E., D. Carter, C. Lyon, B. Persaud, B. Lan, P. Chun, I. Hamilton, and K. Signor. "Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety." Report No. FHWA-HRT-18-044. Federal Highway Administration. (2018).

Since the Blake Lane corridor has significant pedestrian activity, it may be beneficial to investigate the need for pedestrian recall at signalized intersections. This signal timing mechanism could also be programmed during peak pedestrian activity so that vehicle delay can be reduced during off-peak hours (when pedestrians are less frequent).

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2.6. Flashing Yellow Arrow for Left-Turning Vehicles

Flashing yellow arrows are frequently used to indicate to drivers when they can make a permissive left-turn. In these instances, a left-turning vehicle must yield to oncoming traffic. When installed at an urban intersection with supplemental traffic signs, flashing left-turn arrows have a crash reduction factor of 14 percent for left-turn crashes and 10 percent for all crashes.[12]

Flashing yellow arrows can also be used to separate the left-turn phase and pedestrian phase through signal timing. This can be carried out through the use of a red arrow for left turns when the concurrent pedestrian walk phase is active. The arrow could then flip back to flashing yellow upon completion of the walk phase. The same timing mechanism can also be used for a flashing yellow right-turn arrow as well.

Signalized intersections where a flashing left arrow may be suitable for Blake Lane or side streets include:

- Jermantown Road and Trevor House Drive
- Blake Lane and Sutton Road
- Blake Lane and Kingsbridge Drive

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2.7. No Turn On Red

Implementing a No Turn On Red restriction at intersections can greatly improve safety and predictability for all road users. This can be achieved either through signage or through the use of a red arrow signal indication for right-turning vehicles. Additionally, the red arrow signal indication could be used when the adjacent vehicles are proceeding straight through the intersection on a green signal to separate the pedestrian phase from the right-turn phase. The red arrow signal indication for right-turns would then serve as an effective No Right-Turn On Red restriction by separating the pedestrian phase and right-turn phase. This measure helps to minimize conflicts between vehicles and pedestrians by creating a more consistent and predictable crossing experience. When vehicles are prohibited from turning right on red, pedestrians can cross with greater confidence and less risk. However, it is important to note that at some intersections, it

[12] Schattler, K., Gulla, C., Wallenfang, T., Burdett, B., Lund, J. "Safety effects of traffic signing for left turn flashing yellow arrow signals". Accident Analysis and Prevention, Vol. 75, pp. 252-263. (2015).

may not be immediately feasible to implement the No Turn on Red restriction until additional geometric or signal timing adjustments are implemented.

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.2.8. Transit Stop Optimizing

Blake Lane features several different transit routes along the corridor; with a varying proximity to marked crosswalks. Figure 16 illustrates some of the closely spaced transit stops and their proximity/distance from a marked crosswalk.

Figure 16. Closely spaced transit stops and crosswalk locations on Jermantown Road/Blake Lane.

Transit ridership varies significantly between stops and there are several that are closely spaced to one another or not located near a marked pedestrian crossing. Transit stops are pedestrian generators and by placing stops away from marked crossing locations, drivers may not expect to encounter a crossing pedestrian. Optimizing the transit stops may result in the reduction or relocation of transit stops and would allow the remaining transit stops, and their neighboring marked crosswalks, to be enhanced. Additionally, the relocation of transit stops could address challenges with sight lines between oncoming vehicular traffic and alighting passengers that may by trying to cross the roadway. Transit stops should also be easily accessible to all road users and located appropriately near those that are using transit. This RSA has made recommendations about transit stop placement based on desirable crossing locations, geometric and safety factors, and ridership; however, community input and engagement are also essential to optimizing transit stops effectively when removing or relocating transit stops.

Based on the engineering assessments, the RSA team provided recommendations regarding transit stop optimizing to support pedestrian safety. Details on transit stop optimization are provided later in this document in Section 5.3.

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

4.2.9. Speed Management

Speed plays a critical role in traffic operation, road safety, and the environmental impact of transportation systems. Despite the use of speed limits, there is a consistent concern nationally that there is an observed difference between the posted speed limits and the actual operating speeds on the roads. The National Cooperative Highway Research Program (NCHRP) Report 504 highlighted that on non-freeway facilities in suburban/urban areas, merely 23 to 64 percent of drivers adhere to or stay below the posted speed limits.[13] Following the pandemic, speeding has remained an issue, with more drivers traveling 10 mph over the speed limit becoming the social norm according to a new Insurance Institute for Highway Safety study.[14]

Higher speeds reduce drivers' ability to see and respond to other roadway users/roadway conditions. High vehicle speeds can also lead to severe crashes, especially when higher than the posted or design speed. The length of turn lanes, placement of warning signs, determination of yellow and red signal phases, and many other roadway elements rely on speed in the design. When operating speeds exceed the design speeds, it puts roadway users at higher risk of crashes. This is primarily because of the stopping sight distance required by drivers to react to a change in the roadway.

Driver speeds also have a significant impact on vulnerable road user safety. Research has shown that the risk of a pedestrian fatality is not linear, but that the fatality risk doubles between drivers traveling at 32 mph versus 42 mph. This is one reason why arterials with speed limits greater than or equal to 45 mph are currently experiencing significant increases in pedestrian fatalities. The general acceptance of driving 10 mph over the speed limit on roads greater than 45 mph means that pedestrian fatality risk is nearly 90 percent. Speed data collected on Blake Lane showed significantly higher operating speed. For details on the specific speeding concerns of the corridor, refer to Section 2.4.

What is known is that speeding is currently a national issue – and a hard problem to solve. Driver, vehicle, roadway, and environment characteristics are all factors that influence driver behavior, including driver speeds. This complexity of these factors and variation in vehicle characteristics (model, year, performance, size, etc.) and driver attribute (age, gender, risk tolerance, visual skills, etc.) make speeding a challenging

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[13] Fitzpatrick, K., National Cooperative Highway Research Program, & National Research Council (U.S.) (Eds.). Design speed, operating speed, and posted speed practices. Transportation Research Board, National Research Council. 2003.
[14] Insurance Institute for Highway Safety. "Pandemic lockdowns made rush-hour speeding, risky driving the new normal". 2022. https://www.iihs.org/news/detail/pandemic-lockdowns-made-rush-hour-speeding-risky-driving-the-new-normal

problem. Additionally, physical features on and alongside the roadway, as well as context, also impact speed selection for driver. For this reason, speed must be approached from the following perspectives:

- Vehicle Characteristics: Continue improving vehicle technology. Rapid advancements in vehicle technology, including autonomous vehicles, will change how roads are designed.
- Driver Characteristics: Education and community engagement on the risks of driving at high speeds, particularly within driver education classes.
- Roadway and Traffic: Roadway modification to include multimodal elements and other contextual features to influence driver perception and behavior.
- Enforcement: Routine speed enforcement on Blake Lane, including through automated traffic enforcement.

As the speeding problem is multifaceted, there is no single answer, rather a holistic solution requires a layered approach, including countermeasures related to engineering, enforcement, and community engagement/education. Detailed speed assessment including speeding-related concerns on Blake Lane and recommendations are provided later in this document in Section 5.2.

Implementation Timeframe: Short/Intermediate Term
Approximate Implementation Cost: Low-High

4.2.10. Reduced Conflict Corridor

A variety of innovative intersection designs can be considered to improve safety and efficiency by reducing the number of conflict points at select intersections along the Blake Lane corridor. The number of conflict points at an intersection, or locations where vehicle-to-vehicle and vehicle-to-pedestrian travel paths intersect, is an important metric to analyze as a reduction of conflict points correlates with a reduction of crashes.

The VDOT Junction Screening Tool (VJuST)[15] is used by transportation professionals to determine which 13 available innovative intersection designs and seven available interchange designs might be appropriate at a specific location. For example, where possible based on the VJuST analysis and site-specific features, a Restricted Crossing U-Turn (RCUT) design can reduce the conflict points of a traditional four-leg intersection from 32 to 18. Each innovative intersection design has guidance on where it can be considered along Blake Lane, such as appropriate geometric features and turning movement volumes relative to an intersection approach. The benefits that these designs can provide, in addition to a reduction of crashes, include increasing vehicle throughput or progression and decreasing vehicle delay due to limiting intersection movements and reducing the number of signal phases. Similarly, applying such treatments at various

[15] Virginia Department of Transportation. "Innovative Intersections and Interchanges." https://virginiadot.org/info/innovative_intersections_and_interchanges/virginia_icap.asp

intersections along the Blake Lane corridor has the potential to support the speed management strategy outlined in Section 5.9 as the traffic signals in the corridor can be better coordinated.

The majority of the innovative intersection designs from VJuST are appropriate for signalized intersections. Therefore, considering these treatments may require traffic signal warrant studies or other analyses to support the design. Lastly, the implementation cost of multiple innovative intersection treatments along Blake Lane to reduce conflict points can be high.

Implementation Timeframe: Intermediate/Long Term
Approximate Implementation Cost: Medium-High

4.2.11. Road Diet

A Road Diet typically involves converting an existing four-lane undivided roadway segment to a three-lane roadway segment consisting of two through lanes and one center two-way left-turn lane (TWLTL) but can also include any roadway redesign that reduces the overall number of vehicular travel lanes[16]. The average annual daily traffic (AADT) for the corridor ranges from roughly 17,000 to 20,000 vehicles per day (vpd). According to VDOT road diet guidance, a roadway may be a good candidate for a 4 to 3 lane reconfiguration if the AADT is less than 16,000 vpd, has long spacing between signals, minimal driveways, and a presence of rear end or speed-related crashes.[17] However, this guidance is typically used for short-term implementation road diets, such as through uniform pavement markings and signage upgrades. Additionally, peak hour volumes on Blake Lane are above 900 vehicles per hour, meaning that road diet feasibility under a quick and short-term implementation is less likely, per FHWA guidance.[18]Blake Lane's geometric features make it a good candidate for a road diet through longer term recommendations, supplemented by additional improvements along the corridor, as the AADT for Blake Lane exceeds the 16,000 vpd threshold.

Road diet feasibility has been evaluated using factors such as speed, level of service (LOS), average daily traffic (ADT), peak hour volume, and turning volumes. Details on the road diet assessment on Blake Lane including prior research on road diet, road diet feasibility on Blake Lane, and road diet options are discussed in Section 5.1.

Implementation Timeframe: Intermediate/Long Term
Approximate Implementation Cost: Medium/High

[16] Federal Highway Administration. "Road Diets (Roadway Configuration)". Federal Highway Administration. Washington, D.C. 2021. https://highways.dot.gov/safety/proven-safety-countermeasures/road-diets-roadway-configuration
[17] Virginia Department of Transportation. "Roadway Reconfiguration Guidance." https://virginiadot.org/programs/resources/bike/23671-VDOT_Road_Diet_Brochure.pdf
[18] Knapp, K., Chandler, B., Atkinson, J., Welch, T., Rigdon, H., Retting. R, Meekins, S., Widstrand, E., Porter, R. "Road Diet Informational Guide." Report No. FHWA-SA-14-028. Federal Highway Administration. (2014).

4.2.12. Vegetation Trimming

There are several locations along the corridor where shrubs, branches, and other vegetation infringing on sight lines between drivers on side streets and Blake Lane, as well as pedestrians crossing side streets. Most of the vegetation is on private property; however, VDOT is allowed to trim vegetation that overlaps with the public right-of-way. Any vegetation obstructing sight lines located on private property must be removed or trimmed at the discretion of the owner. For this reason, it is encouraged that the community raise awareness on the challenges created for drivers and pedestrians when shrubs, trees, and bushes block sight lines on side street approaches.

4.3. Potential Site-Specific Treatments

4.3.1. Blake Lane and Edgelea Road / Platten Drive

The intersection of Blake Lane and Edgelea Road / Platten Drive has experienced a pattern of angle crashes in recent years, particularly involving drivers turning left from Platten Drive onto Blake Lane, as well as pedestrian crossing concerns. Figure 17 shows a vehicle turning left from Platten Drive onto westbound Blake Lane not yielding right-of-way to the vehicle turning left from Blake Lane onto Edgelea Road.

Blake Lane also features transit stops on the east side of the intersection, as well as stops at the intersections of Cyrandall Valley Road (to the west) and Oakton Crest Place (to the east). There are also sight distance issues for both the Platten Drive and Edgelea Road approaches to Blake Lane due to intersection geometry and infringing vegetation, which may be a contributing factor to the angle crash pattern.

Figure 17. Vehicles simultaneously attempting to turn left from Platten Drive onto Blake Lane and from Blake Lane onto Edgelea Road.

4.3.1.1. Alternative Intersection Design/Access Management

Because of the challenges with sight distance and the existing roadway geometry, an alternative intersection design or access management may help reduce crashes and improve intersection safety. One type of alternative intersection is a Restricted Crossing U-Turn (RCUT), which has been shown to reduce all crashes by 20 percent.[19] An RCUT also greatly reduces the number of conflict points when compared to a traditional intersection (32 conflict points to 18 with RCUT design). Figure 18 shows the RCUT design and associated conflict points.

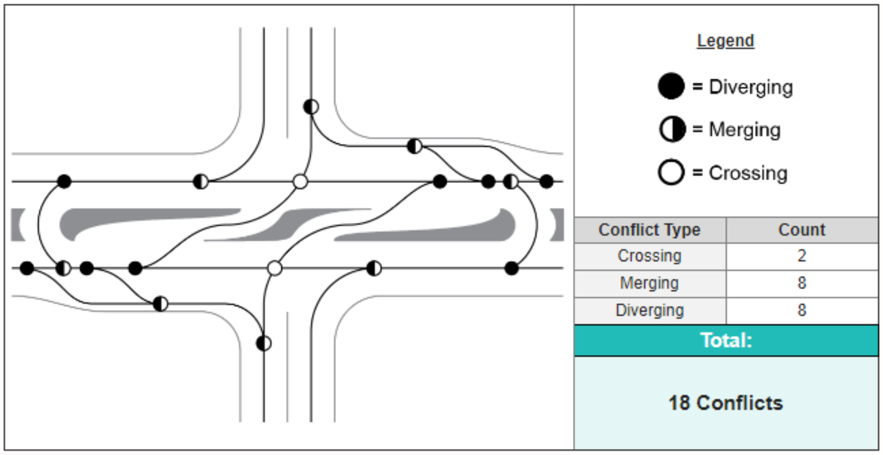

Figure 18. RCUT Intersection Design and Conflict Points (Source: VDOT).

According to traffic counts, Platten Drive has a limited number of left-turning vehicles but that movement results in the majority of the crashes, indicating that it is a high-risk movement. However, Edgelea Road has a high number of vehicles turning left onto and off of Blake Lane. Given the high volume, it may be beneficial to keep this movement. Both redesign and access management would find the greatest safety benefit from eliminating left-turns from Platten Drive and through movements across the intersection between Edgelea Road and Platten Drive. Vehicles that would otherwise turn left onto off of Platten Drive could then utilize the intersections to the east (Sugar Lane/Tipperary Pass) and west (Cyrandall Valley Road) to make a U-turn. Given the high volumes, and relatively lower crash rate, maintaining lefts in and out of Edgelea Road may be desirable. With these concepts in mind, Figure 19 provides an illustration of what that type of an alternative intersection design/access management option.

[19] Sun, X., and Rahman, S. "Investigating Safety Impact of Center Line Rumble Strips, Lane Conversion, Roundabout and J-Turn Features on Louisiana Highways" Report No: FHWA/LA.18/597. Louisiana Department of Transportation and Development. Baton Rouge, Louisiana. (2019).

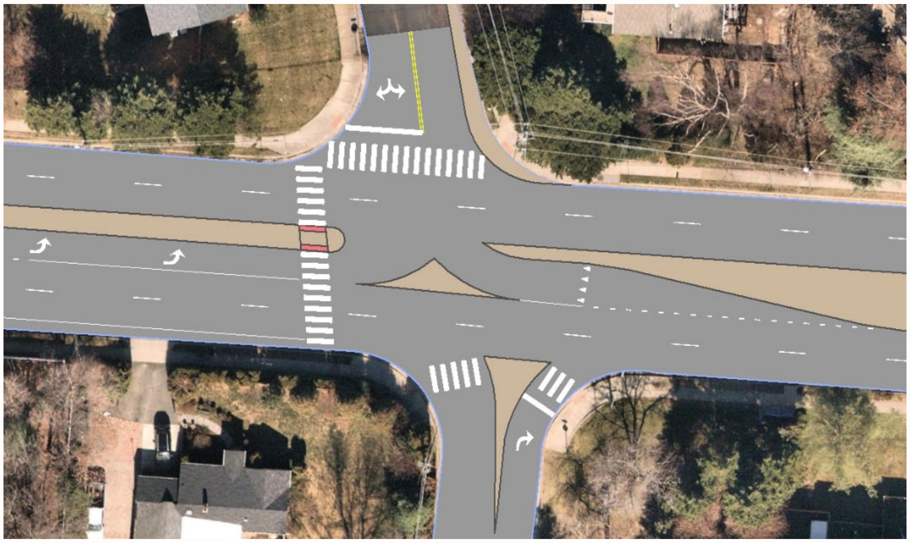

Figure 19. Potential geometric design concept at Blake Lane and Edgelea Road / Platten Drive (Illustration Purposes Only).

Both an RCUT and the potential concept in the image above have benefits for all road users. Both reduce the number of vehicle-vehicle conflict points, as well as reduce turning vehicle and pedestrian conflicts. When drivers are able to focus less on the potential conflicts with other vehicles, they have a greater ability to react to pedestrians that may be crossing in their path. Additionally, these geometric improvements have better sight lines for drivers and pedestrians using the intersection. They can also provide physical medians for pedestrians, as well as serve as traffic calming measures through lane narrowing, new curb lines, and enhanced awareness of the intersection.

Implementation Timeframe: Long Term
Approximate Implementation Cost: High

4.3.1.2. Modified Intersection Control

As noted in 4.3.1.1, the intersection of Blake Lane and Edgelea Road / Platten Drive has experienced a pattern of angle crashes in recent years, particularly involving drivers turning left from Platten Drive onto Blake Lane. Another option to the alternative intersection design/access management could be to convert the intersection from two-way stop control to signal controlled. Signal control of this intersection could help to separate and provide dedicated crossing time to certain traffic movements, including what could be increased pedestrian and bicyclist volumes from the new I-66 Parallel Trail connection. Traffic signal control could also help drivers traveling southbound to be more prepared and approach the traffic signal at Sutton Road at slower speeds, as there is a long stretch with no traffic signals. Currently, the nearest signal-controlled intersection to the north/west is located at the intersection of Blake Lane and Jermantown Road, approximately 0.8 miles away.

However, upon review of existing turning movement counts collected in October 2023, minor road volumes from Edgelea Road / Platten Drive throughout the course of the day are not typical of what would be required for a traffic signal per National and State guidance. In addition to vehicular volumes, additional considerations such as crash history, pedestrian safety, and other potential safety impacts must also be reviewed when evaluating an intersection for a traffic signal.

In the 2009 version of the Manual on Uniform Traffic Control Devices (MUTCD), the crash history requirement for this intersection was five (5) crashes in a single year that could potentially be *correctable by a traffic signal* (left-turn, angle crashes).[20] This arbitrary crash warrant had been in the MUTCD since the original release in 1935. In 2017, the MUTCD issued an Interim Approval (IA-19) for alternative signal warrants relating to the crash history driven by research documented in NCHRP Report 07-19, which VDOT has since adopted as the crash warrant for signalization through IIM-387.[21] Research used to develop the new crash warrants incorporate geometric features of the intersection, AADT, and speed, as well a single year and three-year crash history. Crash thresholds for an urban four-leg intersection are listed below:

- Five (5) angle or pedestrian crashes in a single year; OR
- Three (3) fatal/injury angle or pedestrian crashes in a single year; OR
- Six (6) angle or pedestrian crashes in three years; OR
- Four (4) fatal/injury angle or pedestrian crashes in three years.

The intersection of Blake Lane and Edgelea Road / Platten Drive does not meet any of the required crash thresholds for signalization per IA-19, as only as many as three total angle crashes occurred in a single year during 2018 and 2022. In 2018, there were two non-disabling injury angle crashes and one property damage only angle crash, while 2022 had three property damage only angle crashes. There were also no reported pedestrian crashes at this intersection during the study period.

This is essential to note as research behind the warrant indicates that improper signalization of a multilane roadway may not result in safety benefits. Additionally, the installation of traffic signals has a well-documented data-driven history of an increase in rear end crashes, despite the potential reduction in angle crashes.[22] Because of the diversity in risk tolerance of drivers on Blake Lane, particularly among less experienced high school drivers, the risk of a severe crash involving a driver not expecting to stop for a red light may result in a rear end crash, whereas the same driver may opt to run the red light, which can result in a severe angle crash.

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[20] Federal Highway Administration. *Manual on Uniform Traffic Control Devices*. Section 4C.08. Federal Highway Administration, Washington, D.C. 2009.
[21] Virginia Department of Transportation. *IIM TE-387 Signal Justification Reports (SJRs) For New and Reconstructed Signals*. Virginia Department of Transportation. 2019
[22] National Academies of Sciences, Engineering, and Medicine. *Accident Modification Factors for Traffic Engineering and ITS Improvements*. Washington, DC: The National Academies Press. 2008.

Ultimately, unwarranted traffic signals not only have impacts to operations, but they can result in an increase in crash rate and lead to driver disobedience with the signal.[23] Studies have also shown that the removal of unwarranted signals can lead to a decrease in all crashes (24 percent) and a significant decrease in severe injury crashes (53 percent).[24] Another study conducted by the University of Kentucky showed that total crashes increased at intersections where an unwarranted traffic signal was installed by 28.3 percent.[25] The same study also found that total crashes decreased by 42.9 percent when the study intersection met the criteria for crash warrant, but total crashes at intersections meeting non-crash warrant criteria (such as traffic volume) increased by 11.5 percent. While research into the effects of unwarranted traffic signals is limited, transportation agencies across the country have been investigating the impacts of removing unwarranted signals for safety. For this reason, justification of a traffic signal is an in-depth review of all intersection characteristics and must consider the effect on all road users and potential safety impacts, in addition to MUTCD signal warrant criteria. A signal at the intersection of Blake Lane and Edgelea Road / Platten Drive is not currently justified given the crash history, traffic volumes, and site conditions.

Implementation Timeframe: Long Term
Approximate Implementation Cost: High

4.3.2. Blake Lane and Sutton Road

The adjacent high school to this intersection generates heavy right (415 right-turns onto Blake Lane) and left-turning vehicular volumes (235 left-turns onto Blake Lane) from Sutton Road during afternoon dismissal, as well as significant pedestrian volumes crossing Blake Lane in the marked crosswalk. Recognizing the need for an additional pedestrian crossing, the intersection is currently under redesign (refer to subsection 7.4 for more details). Currently, the traffic signal is equipped with push buttons to trigger the walk phase across Blake Lane, but the concurrent walk phase is significantly less than the green time allocated for right and left turns from Sutton Road. This is a heavily used crosswalk and pedestrian demand is constant just before and after school (Figure 20). The pedestrian facilities are also limited, so many students fill the corner and surrounding sidewalk waiting to cross Blake Lane. Table 6 shows how these traffic volumes fluctuate during the day:

[23] National Academies of Sciences, Engineering, and Medicine. *A Guide for Reducing Collisions at Signalized Intersections*. Washington, DC: The National Academies Press. 2004.
[24] National Academies of Sciences, Engineering, and Medicine. *Accident Modification Factors for Traffic Engineering and ITS Improvements*.
[25] Agent, K.R. and Green, E.R. *Crash history after installation of traffic signals: warranted vs. unwarranted*" University of Kentucky Transportation Research Center. 2008.

Table 6. Fluctuations in traffic volume during different times of the day at Blake Lane and Sutton Road.

	Eastbound Blake Lane		Westbound Blake Lane	Southbound Sutton Road	West Leg Peds
AM	Thru	Left	Thru	Right	
7:00 - 7:15	119	45	57	8	1
7:15 - 7:30	129	59	72	14	4
7:30 - 7:45	169	131	100	40	5
7:45 - 8:00	207	138	121	73	51
8:00 - 8:15	252	65	119	98	91
8:15 - 8:30	199	42	140	36	5
PM					
2:30 - 2:45	126	37	134	24	4
2:45 - 3:00	114	26	153	53	34
3:00 - 3:15	124	25	136	162	86
3:15 - 3:30	130	23	176	60	15
3:30 - 3:45	115	37	188	62	10
3:45 - 4:00	120	32	175	66	1
4:00 - 4:15	136	57	162	96	9
4:15 - 4:30	165	39	135	77	2
4:30 - 4:45	142	31	155	72	5
4:45 - 5:00	160	37	183	76	1
5:00 - 5:15	152	24	171	62	6
5:15 - 5:30	171	44	220	83	3
5:30 - 5:45	157	37	228	92	7
5:45 - 6:00	176	60	259	76	4
6:00 - 6:15	170	55	222	90	4
6:15 - 6:30	156	66	185	81	1
6:30 - 6:45	155	41	168	68	1
6:45 - 7:00	126	41	148	66	1

Peak 15-minutes before Oakton High School first bell

Peak 15-minutes after Oakton High School last bell

As expected, the time segments with the most conflicting vehicle movements with pedestrians are before the school day (8:00 am - 8:15 am) and immediately after the school day (3:00 pm - 3:15 pm).

Similarly, the north leg crosswalk of the Sutton Road intersection should be reviewed closely for future improvements, as there are high numbers of conflicting westbound vehicles entering the slip lane with pedestrians. Table 7 below shows the north leg pedestrian volumes along with all conflicting movements.

Table 7. Volumes of pedestrians and associated conflicting movements at the north leg crosswalk of the Sutton Road intersection.

	Eastbound Blake Lane	Westbound Blake Lane		Southbound Blake Lane		North Leg Peds
AM	Left	Thru	Right	Left	Right	
7:00 - 7:15	45	57	22	16	8	1
7:15 - 7:30	59	72	38	22	14	4
7:30 - 7:45	131	100	39	34	40	0
7:45 - 8:00	138	121	58	50	73	16
8:00 - 8:15	65	119	34	77	98	37
8:15 - 8:30	42	140	34	46	36	0
PM						
2:30 - 2:45	37	134	28	26	24	1
2:45 - 3:00	26	153	29	19	53	6
3:00 - 3:15	25	136	20	62	162	19
3:15 - 3:30	23	176	37	40	60	4
3:30 - 3:45	37	188	38	41	62	2
3:45 - 4:00	32	175	46	57	66	2
4:00 - 4:15	57	162	26	49	96	2
4:15 - 4:30	39	135	29	44	77	6
4:30 - 4:45	31	155	36	43	72	2
4:45 - 5:00	37	183	33	47	76	5
5:00 - 5:15	24	171	44	44	62	1
5:15 - 5:30	44	220	39	40	83	2
5:30 - 5:45	37	228	31	53	92	2
5:45 - 6:00	60	259	38	43	76	0
6:00 - 6:15	55	222	40	44	90	1
6:15 - 6:30	66	185	36	30	81	1
6:30 - 6:45	41	168	26	35	68	0
6:45 - 7:00	41	148	36	37	66	0

Peak 15-minutes before Oakton High School first bell

Peak 15-minutes after Oakton High School last bell

It appears that eastbound left-turns into the north leg crosswalk are more common than westbound right-turns through the slip lane, so both of these movements require attention when addressing pedestrian safety in the north crosswalk. In general, the rest of the corridor has heavy traffic on the major approach of Blake Lane, with limited left and right-turning traffic from the minor approaches, and limited peak hours pedestrian crossing volumes on Blake Lane, with the exception of the Sutton Road intersection.

Figure 20. Students crossing Blake Lane at Sutton Road.

4.3.2.1. Pretimed Signal Timing

Currently, the intersection is part of an actuated-coordinated signal system on Blake Lane during off-peak hours. This means that the signal is connected to a larger network of signals, and its timing is typically based on the busiest intersection in the corridor. However, during peak hours (school arrival and dismissal), the intersection operates as a freestanding actuated signal. This means the signal phasing changes based on the number of vehicles at each approach of the intersection, rather than being coordinated with a master signal along the corridor. When operating as an actuated signal, even if the push button is pressed during the concurrent phase, the signal cannot extend the walk phase across Blake Lane to match the entire green time. This is due to the unpredictability of how long the Sutton Road phase will remain green, as timing for each phase varies based on vehicular demand. As a result, pedestrians often have to wait in queues on the corner and sidewalk before they can cross.

To combat this challenge, the signal could be switched to pre-timed phasing during peak pedestrian times before and after school. Given the heavy right and left-turn volumes from Sutton Road during the afternoon dismissal, it is likely that most signal cycles are already maximizing the green time for the Sutton Road movements. Similarly, during morning arrival, there are heavy right and left-turning volumes onto Sutton Road, as seen in Figure 21, with extensive queues for the eastbound left-turn from Blake Lane. This modification could allow pedestrians to have a walk phase that matches the Sutton Road green time and allow for permissive right-turns during the green phase for Blake Lane. As with any change to traffic signal timing, additional analysis would be required to determine feasibility.

Figure 21. Queues generated by vehicles turning left into Oakton High School during morning arrival.

Although this modification would lengthen pedestrian walk time, it could lead to longer wait times for the walk indication. For example, if a pedestrian presses the push button during a green indication for Sutton Road, the walk indication would not activate during the same cycle because the required walk time would exceed the remaining duration of the green phase. This issue arises if there is no pedestrian recall feature, which means that pedestrians must press the push button to activate the walk signal.

4.3.2.2. Pedestrian Recall

Another option for extending the pedestrian phase could include adding a pedestrian recall for a period of time leading up to school arrival and after school dismissal. This would mean that each signal cycle would automatically actuate the pedestrian phase across Blake Lane for the set walk time. This walk time could be extended, as ultimately the Sutton Road green phase would not end until the set pedestrian walk time (including walk and flashing don't walk) is fulfilled. However, this pedestrian recall would not require pedestrians to press the push button to activate the walk phase, which may cause confusion or expectation among pedestrians during hours of the day that do not have a pedestrian recall.

4.3.2.3. Flashing Yellow Arrow for Right-Turning Vehicles

A treatment that could potentially be applied to the Sutton Road right-turn onto Blake Lane is a flashing yellow arrow for right-turns from Sutton Road. Flashing yellow arrows are frequently used to indicate permissive left scenarios in which a left-turning vehicle must yield to oncoming traffic. However, a flashing yellow arrow can also be applied to right-turning vehicles that must yield to pedestrians. With this treatment, the right-turn would be required to stop with a red arrow indication while pedestrians in the Blake Lane crosswalk had the walk indication. The signal for the right-turn would then become a flashing yellow arrow indication once the flashing "don't walk" interval begins. If the pedestrian signal is not actuated for the Blake Lane crossing, then the right-turn would have a green arrow indication during the green phase for Sutton Road. Further analysis is needed to determine if a flashing yellow arrow treatment is appropriate for the intersection of Blake Lane and Sutton Road.

Figure 22. Flashing yellow right arrow at Atlantic Avenue and Flatbush Avenue in New York City (Source: Google Maps).

4.3.2.4. Separated Pedestrian and Right-Turn Phases

Another option for signal timing at the intersection is to include an overlap phase for the southbound right-turn from Sutton Road onto Blake Lane that would separate the vehicular movements from the pedestrian movements in the crosswalk. This would allow for southbound left-turns from Sutton Road to have a green indication, while the right-turns would have a red indication during the walk phase. This is similar to the concept of the flashing yellow right arrow but would not allow for right-turning vehicles to proceed until given a green right arrow indication. This treatment would also require traffic analysis, especially given the heavy right movement during school dismissal.

4.3.2.5. All Pedestrian Phase or LPI for Blake Lane Phase

Another potential phasing change for Sutton Road and Blake Lane could include an all-pedestrian phase or an LPI for the Blake Lane phase (effective for crosswalk on Sutton Road). An all-pedestrian phase can provide an advantage to pedestrians looking to cross multiple approaches to the intersection, as well as eliminate conflict points between pedestrians and vehicles during the walk phase. However, this all-pedestrian phase comes at a cost of delay to all users, including pedestrians. In the single cycle length, pedestrians would only be provided a single phase to cross, which could leave them waiting for most of the cycle. It also increases vehicle delay, as an all-pedestrian phase requires all traffic to be stopped. The exclusive pedestrian walk phase would also be longer than a standard walk phase, requiring vehicles to be stopped longer than time needed for a traditional crossing.

If an all-pedestrian phase is not feasible, then an LPI for the Blake Lane phase/Sutton Road crossing could potentially be implemented. The benefits of LPIs are discussed extensively in Section 4.2.4 of this memorandum. While LPIs for the major road phase are not common in the region, recognition of the balance between operations and pedestrian safety is essential for all road users on Blake Lane.

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.3.3. Blake Lane and Kingsbridge Drive

The intersection of Blake Lane and Kingsbridge Drive has unique geometry with stop-controlled approaches from the Blake Lane access road, which utilize the signalized Kingsbridge Drive approach. This intersection also connects Blake Lane to Fairfax Boulevard via Draper Drive and Kingsbridge Drive. The Kingsbridge Drive approach is posted at 25 mph while Blake Lane is posted at 35 mph. The signal timing of this intersection features a 3.3 second yellow signal timing and an all-red signal timing of 3.8 seconds for the Kingsbridge Drive phase. The Blake Lane signal phase includes a yellow time of 4.1 seconds and all-red time of 2.0 s.

While reviewing crash data, a safety concern at the intersection of Blake Lane and Kingsbridge Drive was identified due to a pattern of red-light running (RLR) on the southeastbound approach. In the field, it was noted that the lack of mast arms, as well as the positioning of the signal heads relative to the horizon, could pose a challenge for visibility. High visibility backplates have already been installed, but there have been recent RLR crashes.

The project team also looked at the time of day for the RLR crashes and found that many occurred during mid-morning to midday hours. This approach that is most often involved with red light violations is also oriented towards the sun's position for the morning hours, which may be contributing to sun glare for drivers approaching the intersection. Using resources online also revealed that the sun's position is commonly aligned with the southeastbound approach of Blake Lane at Kingsbridge Drive.[26] The intersection will need to be studied further during the engineering assessments to establish the reason for RLR behavior. Several potential countermeasures to address the RLR crashes and sun glare concerns are discussed below.

4.3.3.1. Innovative Technology for Red Light Running

One potential countermeasure for crashes resulting from RLR could include dynamic red-light extension (RLE) technology.[27] This technology works by intercepting the approaching vehicle speed and distance from the signal during the yellow phase. It then determines if the vehicle will have enough time to stop prior to

[26] Sun Position Calculator. https://www.suncalc.org/#/38.869,-77.277,17/2019.10.23/08:00/1/3
[27] Hurwitz, D., Abadi, M., McCrea, S., Quayle, S., and Marnell, P. "Smart Red Clearance Extensions to Reduce Red-Light Running Crashes." Report No. FHWA-OR-RD-16-10. Federal Highway Administration. (2016).

the end of the all-red phase. If the vehicle is likely to enter the intersection during the right-of-way change, then the all-red clearance interval is extended to avoid RLR conflicts.[28] A recent analysis conducted by North Carolina DOT found that results following implementation of a Dynamic All Red Extension (DARE) showed a 35 percent reduction in RLR crashes for multilane arterials at intersections with two-lane roadways.[29]

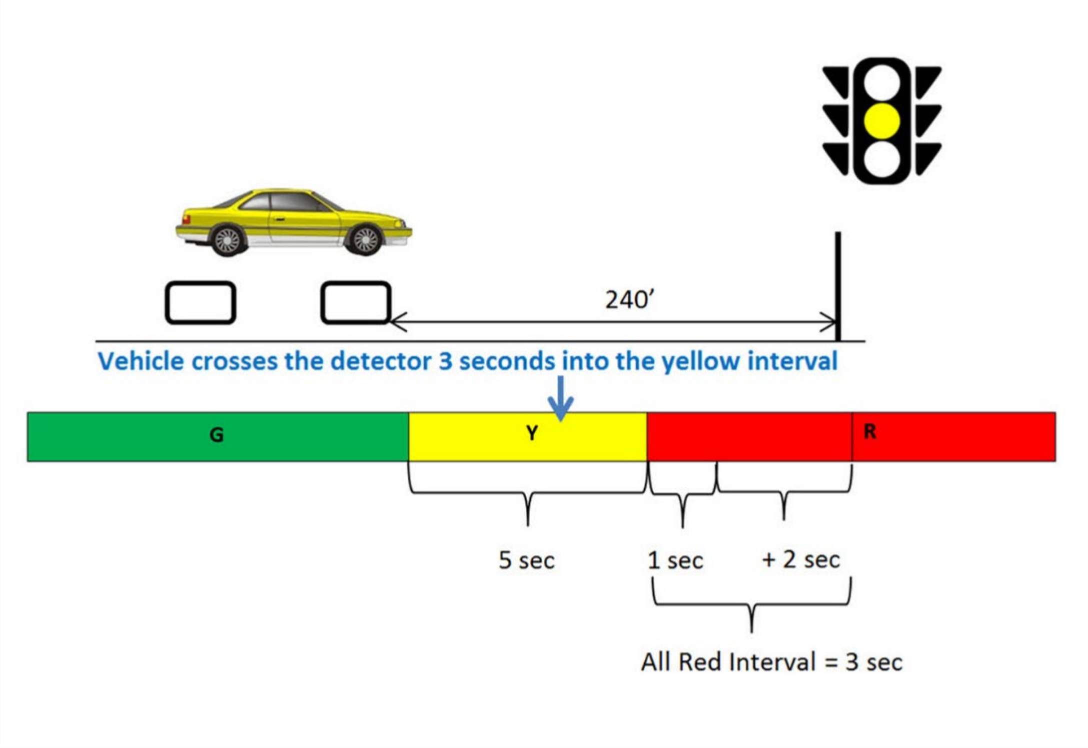

Figure 23. Demonstration of the DARE technology (Source: NCDOT).

The intersection of Blake Lane and Kingsbridge Drive has challenges with respect to signal placement and visibility. Unfortunately, right-of-way limitations prevent relocation of signal equipment to better driver visibility in the southbound direction. Alternatively, RLE technology could help mitigate the angle crashes occurring as a result of RLR.

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

4.3.3.2. Supplemental Nearside Signal Head

Another treatment that could be applied includes an additional signal head located on the west-curb upright. This could allow southbound drivers to see the signal sooner as they come around the horizontal

[28] Simpson, C., Harrison, M., and Troy, S. "Implementation of a Dynamic All-Red Extension at Signalized Intersections in North Carolina: Evaluation of Driver Adaptation and Operational Performance." Transportation Research Record. 2624,19–27. (2017).
[29] Simpson, C. "Dynamic All-Red Extension: An Innovative Safety Countermeasure to Treat Red Light Running Crashes." Transportation Research Record. 2677(2), 753–762. (2023).

curve at Lindenbrook Street. Given the different perspective, the signal head may be more visible in the background, possibly during times with sun glare. Figure 24 shows the sun position above signal in the morning peak hour in May.

Figure 24. Sun position above the southeastbound approach of the Blake Lane traffic signal at Kingsbridge Drive.

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

4.3.3.3. Wider High Visibility Backplates

Although existing high visibility backplates are present, there is an opportunity to enhance the two signal heads for the southeastbound direction with wider backplates. For both the supplemental signal head and the wider backplates, an evaluation of the signal structures, including span wire loading and forces on the upright would need to be completed.

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.3.3.4. Intersection Ahead Warning Sign

An intersection warning sign (W2-1) on the southeast bound approach could also be placed as an additional treatment in advance of the intersection (Figure 25). If the red-light running persists after installation of the warning sign and addition of other intersection treatments, dynamically activated warning beacons could be added to the warning sign to alert drivers when the signal is red.

Figure 25. Intersection warning sign, MUTCD sign code W2-1 (Source: FHWA).

Implementation Timeframe: Short Term
Approximate Implementation Cost: Low

4.3.3.5. Upgrade Signal Structure and Relocate from Sidewalk

For a long-term improvement, the span wire signal poles could be replaced with mast arms. This would require right-of-way acquisition, as there is currently not enough space for this signal equipment in the existing right-of-way. Additionally, this would allow for the signal controller to be relocated from the sidewalk to a location out of the pedestrian path.

Implementation Timeframe: Long Term
Approximate Implementation Cost: High

4.3.4. Blake Lane between Kingsbridge Drive and Route 29

Kingsbridge Drive to Route 29 currently has many access points, but no crosswalks across Blake Lane between Kingsbridge Drive and Route 29, despite the presence of heavily used transit stops. This portion of the corridor currently features access roads on either side of Blake Lane that connect to the townhomes on both sides, but only provides a narrow potion of sidewalk. The sidewalk in this part of the corridor is commonly 5-foot wide with a 2-foot grass buffer, though it also can be 6- to 8-feet wide without any landscape buffer. As a result, many pedestrians were observed walking in the access road.

There is currently only one crosswalk across Blake Lane at Kingsbridge Drive, with the next closest to the southeast located 1150 feet away at Route 29. Between the two crosswalks, there are transit stops in both directions located near Blake Lane Loop / Sutherland Hill Court, as shown in Figure 26.

Figure 26. Opportunities for access management to reduce turn lanes (Source: NearMap).

To improve pedestrian connections across Blake Lane, especially to and from transit, there is an opportunity to close access points to Sutherland Hill Court and Blake Lane Loop, or potentially close the center median on Blake Lane and make both intersecting roads right-in-right-out onto Blake Lane. A right-in-right-out configuration would also require an evaluation of the displaced left turns, likely to result in U-turns at the intersections of Blake Lane and Kingsbridge Drive and Route 29. Additionally, the transit stops could be relocated with the addition of a new pedestrian crossing with enhancements according to guidance from VDOT IIM 384.1.[30] Given the current the roadway configuration, volume, and speed limit, a PHB would be the recommended pedestrian countermeasure for crossing Blake Lane, according to VDOT IIM 384.1. This PHB would also likely require coordinated signal timing between the intersections of Kingsbridge Drive and Route 29.

With the additional space from the unneeded turn lanes resulting from the closure, bus bulbouts and/or pedestrian refuge space could be potentially added to the 70 feet of curb-to-curb width. The addition of the marked crosswalk with a PHB would also require vehicles to stop for pedestrians that activate the walk phase. This safety improvement would significantly reduce the spacing between crosswalks on Blake Lane in this portion of the corridor where transit usage is higher and medium-density housing is predominant. By reducing the crosswalk spacing between Sutherland Hill Court and Route 29 to roughly 500 feet, safety countermeasures such as pedestrian fencing within the median could be installed to discourage crossings in

[30] Virginia Department of Transportation. *IIM TE-384.1 Pedestrian Crossing Accommodations at Unsignalized Locations*. Virginia Department of Transportation. 2022

front of the 7-Eleven. The two crosswalks would be placed roughly 250 feet from the 7-Eleven, meaning that people on the north side of Blake Lane could easily access either of the crosswalks at Sutherland Hill Court or Route 29. This crossing could also serve pedestrians now crossing nearby at Mission Square Drive (Figure 27), which is roughly 250 feet away as well.

Figure 27. Pedestrian crossing Blake Lane near Mission Square Drive.

Implementation Timeframe: Long Term
Approximate Implementation Cost: High

4.3.5. Blake Lane and Hibbard Street

Blake Lane and Hibbard Street experienced a serious injury crash involving a bicyclist in 2021. The original recommendations from VDOT included the implementation of an RCUT intersection design. The intersection did not meet MUTCD signal warrants nor VDOT guidelines for installation per traffic data collected November 2021.

As this intersection has challenges with crosswalk visibility due to the vertical curve, driver compliance with yielding/stopping for pedestrians, and a wide cross-section, additional countermeasures may be needed to improve safety of pedestrian crossings. One option discussed in the previous section includes removing the left-turn lane into the townhomes across from the Hibbard Road approach. Removing this turn lane would allow for a pedestrian crossing with reduced exposure, as they would only be required to cross two travel lanes at once without physical separation from vehicles. This would also be recommended with the removal of the crossing on the west side of the intersection, as the removal of the eastbound left-turn lane is not feasible with the current volumes. The new crossing could also be supplemented by an additional enhancement such as a RRFB or potentially a pedestrian hybrid beacon, depending on the roadway configuration at the time of installation.

Implementation Timeframe: Intermediate Term
Approximate Implementation Cost: Medium

5. Engineering Assessments

The purpose of the engineering assessments is to support consideration of potential safety improvement countermeasures. These assessments were conducted to determine if such treatments could be carried forward into implementation or should be studied further for feasibility. Engineering Assessments were conducted for:

- Road Diet Feasibility
- Speeding on Blake Lane
- Transit Stop Optimization
- Blake Lane and Bushman Drive Geometric Improvements
- Temporary Curb Extensions

5.1. Road Diet

5.1.1. Research on Road Diet Feasibility

A Road Diet typically involves converting an existing four-lane undivided roadway segment to a three-lane roadway segment consisting of two through lanes and one center two-way left-turn lane (TWLTL) but can also include any roadway redesign that reduces the overall number of vehicular travel lanes.[31] The FHWA Road Diet Informational Guide outlined a variety of potential objectives for a study corridor including improving safety and reducing speeds. [32] Road diets have documented safety benefits, including the ability to reduce rear end, left turn, and angle crashes and a 19 to 47 percent reduction in total crashes.[33] Other primary benefits of road diets include the opportunity to reduce the crossing distance for pedestrians, the ability to create space for other treatments (e.g., refuge islands, bike lanes, parking), and can serve as a speed management strategy. This additional cross-section width gained through a road diet can be used to create a Complete Street, which is a roadway that provides "safe and adequate accommodation of all users of the transportation system, including pedestrians, bicyclists, public transportation users, children, older individuals, individuals with disabilities, motorists, and freight vehicles."[34] Complete Streets can also have economic benefits, as safe and accessible facilities can encourage people to patronize businesses and utilize community amenities.[35] Ultimately, the safety,

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[31] Federal Highway Administration. "Road Diets (Roadway Configuration)". Federal Highway Administration. Washington, D.C. 2021. https://highways.dot.gov/safety/proven-safety-countermeasures/road-diets-roadway-configuration

[32] Knapp, Keith, Brian Chandler, Jennifer Atkinson, Thomas Welch, Heather Rigdon, Richard Retting, Stacey Meekins, Eric Widstrand, and Richard J. Porter. "Road diet informational guide". No. FHWA-SA-14-028. United States. Federal Highway Administration. Office of Safety, 2014.

[33] Knapp et al. "Road diet informational guide". No. FHWA-SA-14-028. 2014.

[34] Smart Growth America. "Complete Streets policies nationwide." 2023. https://smartgrowthamerica.org/program/national-complete-streets-coalition/policy-atlas/

[35] A Complete Street is planned, designed, operated, and maintained to enable safe, convenient, and comfortable travel and access for users "of all ages and abilities" regardless of their mode of transportation.

multimodal, and equitable benefits of a Complete Street can be accomplished through the implementation of a road diet.

Once the objectives of a corridor study are identified, road diet feasibility can be evaluated using factors such as speed, level of service (LOS), average daily traffic (ADT), peak hour volume, and turning volumes[36]. The extant body of literature assessing the operational and safety impacts of road diets has also documented ADT ranges before road diet implementation. This information provided valuable insights on traffic volume ranges for the identification of roadway segments suitable for conversion.

5.1.1.1. Traffic Volume Considerations

An FHWA study evaluating the safety effects of road diets included 15 sites from Iowa on U.S. or State routes passing through small urban towns, where average annual daily traffic (AADT) ranged from 4,854 to 11,846 vehicles per day (vpd) before road diet implementation.[37] The study included another 30 sites from California and Washington on suburban corridors where AADT ranged from 5,500 to 24,000 vpd before implementation. However, the study noted that, for segments with AADTs exceeding 20,000 vpd, there is an increased probability of traffic congestion reaching a level where traffic may be diverted to alternative routes. A study in Minnesota included seven sites in urban areas where AADT ranged from 8,900 to 17,400 vpd and the study recommended road diets to be considered only if the projected ADT of the roadway segment is less than 17,500 vpd.[38] A study by Lyles et al. in Michigan included 24 sites in different areas (e.g., residential, industrial, mixed-use, high-crash, high driveway density) that had AADT ranges from 3,510 to 17,020 vpd.[39] The study suggested that road diet conversions experienced significant delays when ADT exceeded 10,000 vpd and, critically, when peak-hour volumes surpassed 1,000 vpd. A study in Kentucky included four sites with AADT ranging from 7,400 to 16,150 vpd and using traffic simulations recommended that road diet could work up to an AADT of 23,000 vpd. The study also recommended considering side street volumes when road diet is considered.[40] Knapp et al. documented applications of road diets on segments with an AADT of up to 24,000 vpd.[41] A study in Florida by Abdel Aty et al. considered 122 road diet segments (approximately 50 miles) on urban arterials with AADT ranging from 2,000 to 28,500 vpd.[42] Sun and Rahman conducted a study in Louisiana and included four road diet sites with before period AADT

[36] Knapp et al. “Road diet informational guide”. No. FHWA-SA-14-028. 2014.
[37] Huang, Herman F., J. Richard Stewart, and Charles V. Zegeer. "Evaluation of lane reduction “road diet” measures on crashes and injuries." Transportation Research Record 1784, no. 1 (2002): 80-90.
[38] Noyce, David A., Vijay Talada, and Tim J. Gates. "Safety and Operational Characteristics of Two-Way Left-Turn Lanes." 2006.
[39] Lyles, Richard W., M. Abrar Siddiqui, William C. Taylor, Bilal Z. Malik, Gregory Siviy, and Tyler Haan. “Safety and operational analysis of 4-lane to 3-lane conversions (road diets) in Michigan.” No. RC-1555. Michigan. Dept. of Transportation, 2012.
[40] Stamatiadis, Nikiforos, and Adam Kirk. "Guidelines for road diet conversions." 2014.
[41] Knapp, Keith K., Karen L. Giese, and Woochul Lee. "Urban Four-Lane Undivided to Three-Lane Roadway Conversion Guidelines." In Proceedings of the 2003 Mid-Continent Transportation Research Symposium. 2003.
[42] Abdel-Aty, Mohamed A., Chris Lee, Juneyoung Park, Jung-Han Wang, Muamer Abuzwidah, and Saif Al-Arifi. Validation and application of highway safety manual (part D) in Florida. No. BDK78-977-14. Florida. Dept. of Transportation, 2014.

between 8,333 and 13,900 vpd.[43] A recent study in Virginia evaluated 36 segments and 39 intersections where road diets were installed and the before-period AADT ranged from 2,654 to 16,988 vpd.[44] Another recent study in Rhode Island considered 11 road diet sites where AADT ranged between 3,390 to 22,500 vpd.[45] Table 8 presents a summary of the ADT/AADT ranges for the sites where road diets were implemented.

Table 8. Review of road diet studies and associated ADT/AADT ranges.

Study	State	Number of Sites	Area Type	ADT/AADT Range (vpd)
FHWA	IA	15	Urban	4,854-11,846
FHWA	CA, WA	30	Suburban	5,500-24,000
Noyce et al.	MN	7	Urban	8,900-17,400
Lyles et al.	MI	24	Mixed	3,510-17,020
Stamatiadis et al.	KN	4	Urban	7,400-16,150
Knapp et al.	MO, MN, IA, CA, WA	21	Mixed	8,400-24,000
Abdel Aty et al.	FL	122	Urban	2,000-28,500
Sun and Rahman	LA	4	Urban	8,333-13,900
Lim et al.	VA	36	Urban/Suburban	2,654-16,988
Zhou et al.	RI	11	Urban/Rural	3,390-22,500

While AADT plays a pivotal role in determining the feasibility and success of road diet conversions, there is not one recommended value in the existing literature. **The literature reflects that AADT ranges for road diet conversions vary based on location and context.** While some studies recommend considering road diets for segments with projected ADTs below 17,500, others suggest that conversions may lead to significant delays when ADTs exceed 10,000, especially when peak-hour volumes surpass 1,000. There's consensus that AADT levels exceeding 20,000 pose a higher risk of congestion, potentially diverting traffic to alternative routes.

5.1.1.2. Peak Hour and Lane Breakdown Considerations

The existing literature offers limited details on peak-hour traffic volume when assessing the feasibility of road diets. Peak hour traffic volumes are assumed to be 8 to 12 percent of the ADT to make feasibility

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[43] Sun, Xiaoduan, and M. Ashifur Rahman. Investigating Safety Impact of Center Line Rumble Strips, Lane Conversion, Roundabout, and J-turn Features on Louisiana Highways. No. FHWA/LA. 18/597. Louisiana Transportation Research Center, 2019.
[44] Lim, Linda, and Michael D. Fontaine. "Development of road diet segment and intersection crash modification factors." Transportation research record 2676, no. 5. 2022.
[45] Zhou, Yuying, Scott Himes, Thanh Le, Jeff Gooch, Kayla Northup, and Peter Pavao. "Safety effectiveness of the road diet treatment in Rhode Island." Transportation research record 2676, no. 7. 2022.

decisions.[46] Iowa guidelines for road diets assume a 50/50 directional split and 10 percent of the ADT during the peak hour. The guideline suggests road diets to be probably feasible at or below 750 vehicles per hour per direction (vphpd), considered cautiously between 750 – 875 vphpd and less likely feasible for peak hour volume above 875 vphpd.[47] A case study in San Jose, California reported a road diet implementation on a road that had an AM peak hour volume of 1,392 and PM peak hour volume of 1,246.[48] FHWA Road Diet Informational Guide included a case study from Chicago which reported a peak hour volume of 1,000 to consider road diet before it is required to modify signal and turning movements. [49] **The current studies on road diet do not break down the traffic volume by lanes while evaluating road diet feasibility, instead assume traffic flows approximately evenly in both directions and distributes uniformly across all four lanes.**

5.1.1.3. Case Studies

The FHWA article "Going on A Road Diet" reported a few case studies on road diets across different cities in the United States.[50] For road diet implementation, the Seattle Department of Transportation (DOT) considers several traffic operation-, mobility-, and safety-related variables. The variables include traffic volume (less than 25,000 vpd), number of collisions, speed, number of lanes, freight usage, bus stops and routing, travel time, and accessibility. The article also discussed a few other case studies in different cities and reported the ADT range considered before implementing a road diet. Road diets were implemented in Athens, GA on an arterial roadway segment with an ADT of 20,000 vpd, on an arterial in Vancouver, WA with an ADT of 17,000 vpd, and in Clear Lake, IA on an urban segment with an ADT of 12,000 vpd. The FHWA Road Diet Informational Guide also included several case studies and reported road diet considerations.[51] Chicago DOT puts the main emphasis on the number of crashes for road diet consideration, followed by traffic volume, and considers roadways with ADT up to 18,000 vpd for implementation. Michigan DOT considers traffic volume, turning volume, level of service, and crash data analysis as part of road diet feasibility determination. Genesee County Metropolitan Planning Commission (GCMPC) in Michigan considers the level of service, lane width, driveway count, and crash types to prioritize road diet locations. In terms of ADT, GCMPS considers a road diet to be feasible when ADT is less than 10,000 vpd, potentially feasible when ADT is between 10,000 vpd and 20,000 vpd, and likely not feasible when ADT is greater than 20,000 vpd. FHWA Guide on Road Diet Case studies

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[46] Knapp et al. "Road diet informational guide". No. FHWA-SA-14-028. 2014.
[47] Knapp, Keith K., Karen L. Giese, and Woochul Lee. "Urban Four-Lane Undivided to Three-Lane Roadway Conversion Guidelines." 2003.
[48] Nixon, Hilary, Asha Weinstein Agrawal, and Cameron Simons. "Designing road diet evaluations: Lessons learned from San Jose's Lincoln Avenue road diet." 2017.
[49] Knapp et al. "Road diet informational guide". No. FHWA-SA-14-028. 2014.
[50] Tan, Carol H. "Going on a road diet." Public roads 75, no. 2. 2011.
[51] Knapp et al. "Road diet informational guide". No. FHWA-SA-14-028. 2014.

aggregated 24 example case studies from 12 agencies across the USA.[52] ADT in this report ranges from 2,000 vpd to 23,000 vpd.

5.1.1.4. NCHRP Report 1036: Roadway Cross Section Reallocation (2022)

NCHRP recently released a new report on how to select cross section alternatives for a roadway undergoing redesign.[53] As part of this study, a screening tool was created that considers roadway characteristics, project goals, and community needs. This tool does not conduct a full traffic analysis as part of the potential cross section development, and does not require turning movement counts, or need traffic volumes by time of day. Rather, it takes the AADT, roadway classification, land use context, and other characteristics to project hourly volumes based on averages of roadways with similar characteristics. As a result, the tool can use the AADT to estimate peak hour volumes. The key inputs for Blake Lane into this tool are included in Table 9 below:

Table 9. NCHRP 1036 cross section reallocation tool inputs.

Project Details	
Type of project: Can you move curb lines?	No
The curb-to-curb distance in feet:	70
The available right-of-way in feet:	92
What is the existing land use context?	Suburban
What is the planned land use context?	Suburban
What is the roadway's primary intended function?	Distributor
The road directionality:	two-way
Number of lanes per direction:	2
Presence of a median:	Yes
Width of the median:	18
Presence of a TWLTL:	No
Width of the TWLTL:	0
Is this a freight corridor?	No
Is there heavy bus lane use on this corridor?	Yes
What is the controlling downstream intersection type?	Signal
Existing Conditions & Data	
What is the posted speed limit?	35
What is the 85th percentile speed? (If known)	43-44

[52] Federal Highway Administration. “FHWA Road Diet Case Studies”. No. FHWA-SA-15-052. United States. Federal Highway Administration. Office of Safety, 2015.
[53] Brewer, Marcus A., Srinivas Geedipally, Michael P. Pratt, and Karen Dixon. Guidelines for Optimizing Roadway Cross-Section on Texas Highways. No. FHWA/TX-23/0-7136-R1. Texas A&M Transportation Institute, 2023.

What is the average daily traffic?*	20,000
Is on-street parking present on the east/north side?	N
Is on-street parking present on the west/south side?	N

The output of the tool is a proposed cross section design and high-level potential impacts to operations. Following the addition of the Blake Lane characteristics, **the tool proposed a cross section design that included one moving lane in each direction and buffered bike lanes along the curb to replace one of the existing travel lanes in each direction.** The projected operation impacts at 20,000 vpd suggest that 2 hours of the day may experience capacity constraints, but that the safety, social, and multimodal benefits of the road diet outweigh the operational impacts. A summary of the impacts of a lane reduction and addition of dedicated bike lanes was provided through this tool. The results of the impact screening are outlined in Table 10 below.

Table 10. Impacts of road diet/cross section redesign (from NCHRP 1036 Tool Output).

Measure	Impact of adding bike lanes	Impact of removing travel lanes
Safety	**High Positive effect:** Added exclusive biking space leads to increased comfort of bicyclists, leading to increased use and expectation of bicyclist presence and behavior. *The Caltrans Local Roadway Safety Manual cites a 55% CMF for addition of separated bike lanes and 65% CMF for painted bike lanes.*	**Near Term: High Positive effect:** Even if it contributes to congestion, queueing at slower speeds would reduce severity of crashes. There would be shorter crossing distances and reduced crossing crash exposure for pedestrians. If it results in addition of a TWLT, the HSM provides a 0.71 CMF for conversion from a four-lane road (two through lanes each direction) to a three-lane road with TWLTL. May increase propensity for double parking. **Long Term: Medium Compound Positive effect:** Potentially inducing triple divergence in the long term and reducing ADT--the most closely associated factor with crash risk.
Economic	**Medium Positive effect:** Increase in modal accessibility impacts local businesses and individuals' travel costs and options	**Near Term: Medium Adverse effect:** Reduced automotive capacity, more delay, higher cost of goods movement and lower mobility. **Near Term: Positive effect:** Opportunity for placemaking. **Long Term: Low Positive effect:** Potential for pass-by trips increased with mode shift from reduced vehicle travel lanes
Environmental		

Measure	Impact of adding bike lanes	Impact of removing travel lanes
	Medium Positive effect: Reduced driving causing reduced emissions .	**Near Term**: **Medium Adverse effect:** Reduction in local air quality effects related to number of stops, stop-and-go traffic, idling (vehicles occupy smaller area for longer period of time). **Long Term: Medium Positive effect:** Reduced long-term demand for driving and developments associated with driving (pavement, smaller parking lots, less runoff, lower emissions). This probably swamps the short-term adverse effect in the long run. Short-term adverse effects mitigated with change in fleet characteristics (EVs). **Long Term: Medium Adverse effect**: If buses share a travel lane, congestion can decrease reliability and travel times, thereby decreasing the viability of and attractiveness of transit, reducing the likelihood for mode shift to transit.
Social	**High Positive effect:** increased access to physical activity, increased incentive for local trips, causing community building, and decreased direct exposure to emissions. Increases ability for some communities (zero- or low-car households, younger/older populations, disabled populations, underserved communities, etc.) to reach the goods and services they need.	**Medium Positive effect:** Helps with placemaking: street crossings are shorter, vehicle speeds and volumes are likely lower, leading to improved health outcomes over time. This impact is reduced if transit shares the lane and is significantly affected by congestion.
Mode Shift	**High Positive effect:** May increase viability of biking for transportation, thereby increasing ridership.	**High Positive effect:** If removing a lane increases motorist travel times, this significantly increases the likelihood of travelers switching to different modes. This impact is reduced if transit shares the lane and is also affected by the congestion.

The output of the tool is a high-level summary of the effects, including the potential benefits and adverse impacts. **Although the results show that capacity could be exceeded during two peak hours, this**

engineering assessment further investigates the impacts with specific temporal traffic volume data by roadway segments with lower volumes and higher vehicle speeds on Blake Lane.

5.1.2. Blake Lane Road Diet Application

5.1.2.1. Methodology

According to VDOT road diet guidance, a roadway may be a good candidate for a 4 to 3-lane reconfiguration (two through lanes and one TWLTL) if the AADT is less than 16,000 vpd, has long spacing between signals, minimal driveways, and a presence of rear end or speed-related crashes.[54] However, this guidance is typically used for short-term implementation of road diets, including those implemented through pavement markings and signage upgrades during repaving. Additionally, volumes on Blake Lane can exceed 1,100 vehicles in the eastbound direction in the morning peak hour, which is above the recommended threshold of 900 vehicles per hour per lane per FHWA guidance.[55]

Blake Lane's geometric features make it a good candidate for a road diet with turn lanes. For the purposes of this planning-level screening, the corridor was screened for a road diet between Trevor House Drive and Sutton Road which features long portions of the road without traffic controls and is the center of corridor speeding concerns. Due to potential impacts from the redevelopment of the AT&T site to the west and heavy turns onto eastbound Blake Lane from Sutton Road, the middle portion of the corridor was prioritized in this analysis.

The first step of this capacity analysis is to determine how much vehicular volume a travel lane on Blake Lane can accommodate. An intersection-level analysis was not included in this feasibility review, as many existing features such as turn lanes, signal timing, and traffic controls can be maintained with a road diet. However, a road diet will require a lane reduction within each segment, which is the focus of this analysis. This analysis also does not review projected future traffic volumes for the corridor, and only that of existing data collected October 2023.

When adjusting for heavy vehicle volume, driver characteristics, and flow characteristics using the 2010 Highway Capacity Manual (HCM) and FHWA's Procedures for Estimating Highway Capacity, the maximum capacity for each lane during peak hours is projected to be roughly 1,300 to 1,400 vehicles per hour under existing conditions, varying by segment on the corridor.[56,57] The base capacity of a multilane roadway is highly dependent on the free flow speed of vehicles using the road. The average speed can

[54] Virginia Department of Transportation. "Roadway Reconfiguration Guidance." https://virginiadot.org/programs/resources/bike/23671-VDOT_Road_Diet_Brochure.pdf
[55] Knapp, K., Chandler, B., Atkinson, J., Welch, T., Rigdon, H., Retting. R, Meekins, S., Widstrand, E., Porter, R. "Road Diet Informational Guide." Report No. FHWA-SA-14-028. Federal Highway Administration. 2014.
[56] Transportation Research Board. *Highway capacity manual 2010. Volumes 1-4: (Fifth edition.)*. Washington, DC: The National Academies Press. 2010.
[57] Federal Highway Administration. "Highway Performance Monitoring System Field Manual, Appendix N: Procedures for Estimating Highway Capacity". Federal Highway Administration https://www.fhwa.dot.gov/ohim/hpmsmanl/appn.cfm

be used as the free flow speed, which has been collected at 40 mph. The formula to determine the base capacity in passenger cars per hour per lane (pcphpl) of a multilane facility is shown below:

$$BaseCap = 1{,}000 + 20FFS;\ for\ FFS \leq 60$$

$$BaseCap = 2{,}200;\ for\ FFS > 60$$

Where:

FFS = free flow speed (miles per hour)

The base capacity can then be used to find the peak capacity that a multilane roadway can accommodate. This peak capacity number is the product of roadway characteristics such as the presence of heavy vehicles, the familiarity of drivers with the route, and the peak hour factor, which represents the distribution of traffic during the peak hour based on the busiest 15 minutes.

$$Peak\ Capacity = BaseCap \times N \times PHF \times f_{HV} \times f_p$$

Where:

Peak Capacity = maximum volume in vehicles per hour (vehicles per hour)
BaseCap = capacity adjusted for Free Flow Speed (pcphpl)
PHF = peak hour factor
N = number of lanes
f_{HV} = adjustment factor for heavy vehicles
f_P = adjustment factor for typical driver populations

For two-lane roadways (single lane in each direction), the 2010 HCM estimates a base capacity of 1,700 pcphpl. Since this capacity does not use FFS as a factor in determining capacity, which takes lane width into consideration through effects on speed, an adjustment factor has been used in the calculated capacity for each segment:

$$Peak\ Capacity = 1{,}700 \times PHF \times f_{HV} \times f_p \times f_{LW}$$

Where:

Peak Capacity = maximum volume in vehicles per hour (vehicles per hour)
PHF = peak hour factor
f_{HV} = adjustment factor for heavy vehicles
f_P = adjustment factor for typical driver populations
f_{LW} = adjustment factor for lane width

Using this methodology, it is also likely more conservative in the estimates of the level of service, as the volume-to-capacity ratio is greatly influenced by the PHF. As this corridor experiences significant school-related traffic during the morning peak hour, the peak capacity calculated using the PHF may not be represented realistically when in undersaturated conditions. For this analysis, the variables used in determining capacity on a segment level of the corridor are included in Table 11 below.

Table 11. Variables used in segment capacity analysis on Blake Lane.

Variables Influencing Lane Capacity	Value
Free Flow Speed (FFS)	40 mph
Heavy Vehicle Factor (f_{HV})	No Trucks (1)
Driver Population Factor (f_P)	Commuter Traffic (0.975)
Lane Width Adjustment Factor (f_{LW})	11' (0.967)
Base Capacity (BaseCap)	1,800 pcphpl (multilane), 1,700 pcphpl (single lane)
Number of Lanes (N)	2 (existing), 1 (road diet)
Peak Hour Factor (PHF)	*Calculated by segment*

The access point adjustment factor was not used for the single-lane capacity calculations as turn lanes are present along the corridor and are likely to reduce interruptions in traffic exiting Blake Lane significantly. Additionally, the single-lane base capacity does not include considerations for a divided roadway, two-way left turn lanes, intersection turn lanes, shoulders, or wide cross-sections, all of which can improve traffic operations. For this reason, the level of service estimates for a single lane along the corridor are conservative.

The peak capacity was then calculated for each of the segments along the corridor between Trevor House Drive and Sutton Road. This portion of the corridor was selected for a review of road diet feasibility due to the potential for lower volumes than the east side of Blake Lane (east of Sutton Road), as well as the speeding concerns in this portion of the corridor. From the volumes taken on Wednesday, October 25, 2023, the calculated peak capacity could be used to the projected volume-to-capacity (V/C) and level of service (LOS) by segment on the corridor.

Traditional LOS estimates are typically calculated using vehicle density (vehicles per mile). However, this planning-level estimate used the V/C ratio ranges in Table 12.

Table 12. Range of V/C ratios for approximating Level of Service.

LOS	V/C Ratio
A	0 – 0.6
B	0.6 – 0.7
C	0.7 – 0.8
D	0.8 – 0.9
E	0.9 – 1.0
F	> 1.0

5.1.2.2. Results

The analysis of the morning (7:30-8:30 am) and evening (5:15-6:15 pm) peak hours revealed that the roadway does not currently have capacity challenges with two lanes in each direction. However, reducing to one lane will result in a reduction in the LOS in the eastbound direction during the morning peak hour. The morning peak hour also aligns closely with the first bell for Oakton High School at 8:10 am. As a result, Blake Lane experiences congestion from drop-off activity, particularly between Hibbard Street and Sutton Road in the eastbound direction.

This significant influx of vehicles on Blake Lane from 7:30 to 8:15 am results in a lower PHF (0.75 to 0.81) than what is typically used for an urban/suburban area traffic analysis (0.92). This decrease in the PHF results in a reduction in the maximum capacity calculated using the aforementioned equations. Table 13. Table 14, Table 15, and Table 16 outline the projected capacity impacts for each Blake Lane segment reviewed.

Table 13. AM peak hour volumes and Level of Service for westbound Blake Lane.

AM Peak Hour Capacity on Blake Lane Segments (Westbound)							
		Sutton Road to Edgelea Road / Platten Drive	Edgelea Road / Platten Drive to Hibbard Street	Hibbard Street to Bushman Drive	Bushman Drive to Gray Street	Gray Street to Trevor House Drive	Trevor House Drive to Borge Street
Segment Inputs	Peak Hour Volume (veh)	729	687	650	595	618	498
	Peak 15-Minute Volume (veh)	218	230	210	197	194	163
	Peak Hour Factor (PHF)	0.84	0.75	0.77	0.76	0.80	0.76
Multilane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1549	1383	1433	1399	1475	1415
	V/C Ratio (Existing)	0.24	0.25	0.23	0.21	0.21	0.18
	Level of Service (Existing)	**A**	**A**	**A**	**A**	**A**	**A**
Single Lane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1339	1196	1240	1210	1276	1224
	V/C Ratio (1-lane)	0.54	0.57	0.52	0.49	0.48	0.41
	Level of Service (1-lane)	**A**	**A**	**A**	**A**	**A**	**A**

Table 14. AM peak hour volumes and Level of Service for eastbound Blake Lane.

AM Peak Hour Capacity on Blake Lane Segments (Eastbound)							
		Trevor House Drive to Gray Street	Gray Street to Bushman Drive	Bushman Drive to Hibbard Street	Hibbard Street to Edgelea Road / Platten Drive	Edgelea Road / Platten Drive to Sutton Road	Sutton Road to Five Oaks Road
Segment Inputs	Peak Hour Volume (veh)	904	950	1100	1087	1145	1034
	Peak 15-Minute Volume (veh)	303	317	342	362	354	329
	Peak Hour Factor (PHF)	0.75	0.75	0.80	0.75	0.81	0.79
Multilane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1382	1388	1490	1391	1498	1456
	V/C Ratio (Existing)	0.33	0.34	0.37	0.39	0.38	0.36
	Level of Service (Existing)	**A**	**A**	**A**	**A**	**A**	**A**
Single Lane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1195	1200	1288	1203	1296	1259
	V/C Ratio (1-lane)	0.76	0.79	0.85	0.90	0.88	0.82
	Level of Service (1-lane)	**C**	**C**	**D**	**E**	**D**	**D**

Table 15. PM peak hour volumes and Level of Service for westbound Blake Lane.

PM Peak Hour Capacity on Blake Lane Segments (Westbound)							
		Sutton Road to Edgelea Road / Platten Drive	Edgelea Road / Platten Drive to Hibbard Street	Hibbard Street to Bushman Drive	Bushman Drive to Gray Street	Gray Street to Trevor House Drive	Trevor House Drive to Borge Street
Segment Inputs	Peak Hour Volume (veh)	1271	1140	1076	920	911	770
	Peak 15-Minute Volume (veh)	335	294	281	244	231	198
	Peak Hour Factor (PHF)	0.95	0.97	0.96	0.94	0.99	0.97
Multilane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1757	1796	1773	1746	1826	1801
	V/C Ratio (Existing)	0.36	0.32	0.30	0.26	0.25	0.21
	Level of Service (Existing)	**A**	**A**	**A**	**A**	**A**	**A**
Single Lane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1339	1196	1240	1210	1276	1224
	V/C Ratio (1-lane)	0.95	0.95	0.87	0.76	0.71	0.63
	Adjusted Peak Capacity (veh/hr/ln)	**C**	**C**	**C**	**C**	**C**	**B**

Table 16. PM peak hour volumes and Level of Service for eastbound Blake Lane.

PM Peak Hour Capacity on Blake Lane Segments (Eastbound)							
		Trevor House Drive to Gray Street	Gray Street to Bushman Drive	Bushman Drive to Hibbard Street	Hibbard Street to Edgelea Road / Platten Drive	Edgelea Road / Platten Drive to Sutton Road	Sutton Road to Five Oaks Road
Segment Inputs	Peak Hour Volume (veh)	770	775	835	835	840	854
	Peak 15-Minute Volume (veh)	211	220	232	229	228	219
	Peak Hour Factor (PHF)	0.91	0.88	0.90	0.91	0.92	0.97
Multilane Capacity	Adjusted Peak Capacity (veh/hr/lane)	1690	1631	1667	1689	1706	1806
	V/C Ratio (Existing)	0.23	0.24	0.25	0.25	0.25	0.24
	Level of Service (Existing)	**A**	**A**	**A**	**A**	**A**	**A**
Single Lane Capacity	Adjusted Peak Capacity (veh/hr/ln)	1462	1411	1442	1461	1476	1562
	V/C Ratio (1-lane)	0.53	0.55	0.58	0.57	0.57	0.55
	Adjusted Peak Capacity (veh/hr/ln)	**A**	**A**	**A**	**A**	**A**	**A**

5.1.2.3. Potential Multimodal Shift

While there are limited resources available to quantify the potential for people to shift from motorized vehicles to walking and biking with a road diet implementation, this assessment reviews pedestrian and vehicular travel patterns to Oakton High School in the morning peak hour, as it is currently the most congested period.

When considering these potential impacts on mode choice, the broader school assignment area must be reviewed. One significant note is that the majority of the roughly 2,600 students who attend Oakton High School are located west of Chain Bridge Road, as shown in Figure 28. The main routes for people dropping students off at the high school from neighborhoods west of the study area include Jermantown Road from west of Chain Bridge Road, Blake Lane west of the Trevor House Drive intersection, Hibbard Street, and Edgelea Road. Oakton High School may also be accessed from Sutton Road via Chain Bridge Road. **Because the overall area that Oakton High serves is well over a mile from the school, a minimal reduction in drop-off related vehicle trips on eastbound Blake Lane during the morning peak hour is expected.**

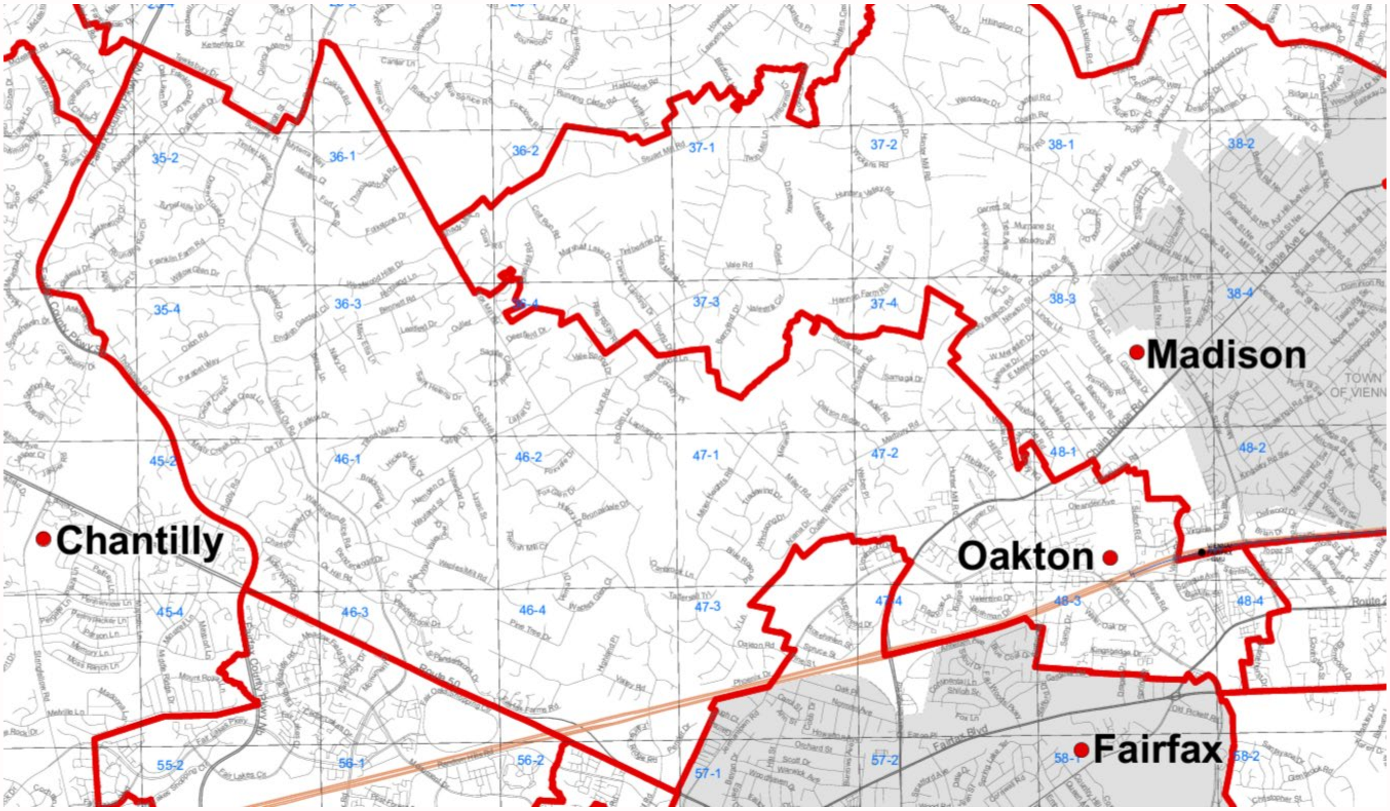

Figure 28. Oakton High School assignment boundaries.

However, pedestrian count data during the school arrival times (7:30-8:15 am) on the west side of the corridor indicates that more students may be walking home following school dismissal than those walking to school in the morning. This could be a result of parents and guardians traveling to the Vienna Metro Station or east on Blake Lane for commutes to work that see a drop-off opportunity along their existing route. Those same students may also be walking home in the afternoon if their parent or guardian is unavailable to pick them up before the end of their workday. In this scenario, the possibility of parents and guardians shifting to non-vehicle modes of travel for commuting could result in more students walking to school during the morning peak hour. Furthermore, the pedestrian count data was collected following the opening of the I-66 trail between Blake Lane and Bushman Drive. Students that live on neighborhoods on or near Bushman Drive may also be utilizing the trail as a more direct route between home and school, which would only be reflected in the pedestrian volume crossing Blake Lane at Sutton Road.

Overall, 171 of the 221 right turning vehicles onto eastbound Blake Lane between Trevor House Drive and Sutton Road occurred during the 45 minutes before the first bell at 8:10 am. These right turns are directly from the neighborhoods south of Blake Lane, meaning that these trips have the greatest opportunity for a reduction in vehicular volume on Blake Lane. If 30 to 40 percent of vehicle trips to Oakton High School or beyond to the Vienna Metro Station from neighborhoods south of Blake Lane shifted to walking or biking, there could be a potential reduction of 60 to 90 vehicles on eastbound Blake Lane during the morning peak hour. This would result in a minor reduction in the V/C ratio on the segments of eastbound Blake Lane between Hibbard Street and Sutton Road.

Blake Lane traffic volumes outside of the morning and afternoon peak hours currently operate at a high level of service (LOS A or B), which would only be minimally impacted by reducing Blake Lane between Trevor House Drive and Sutton Road. For this reason, the peak hours were examined in this engineering assessment.

5.1.3. Road Diet Options

The extensive safety and multimodal benefits that a Complete Street implemented through a road diet offers could outweigh the moderately minor impacts on traffic operations. The original Alternatives Analysis memo outlined several potential cross-sections that could be considered with additional space that could be allocated to pedestrian and bicyclist improvements. The following road diet options were either posed as potential options in the RSA Alternatives Analysis, or were further refined following the segment capacity analysis conducted as part of this engineering assessment on Blake Lane:

1. **Segment-Specific Road Diet with Shared Transit-Bike Lane** – This option would include a conversion of the far-right general purpose curb lane in both directions into a shared transit-bike lane and right-turn only lane on each intersection approach. The far-right curb lane can serve as an exclusive transit-bike lane through red paint, in-lane pavement word messaging (such as "BUS ONLY") and signage. With this option, vertical elements could be used to reinforce separation. On approaches to intersections, the shared transit-bike lane could be used as a right-turn only lane.

   With this option, the transit and bus separation from general vehicle traffic could enhance transit operations and create a multimodal shift to transit or biking. Another advantage of this option is that it could be implemented more readily than a full cross-section redesign with separated bike lanes and curb extensions. Such a treatment could be installed as a pilot demonstration for the use of a shared transit-bike lane or use of red paint. A disadvantage of this option would be possible driver non-compliance, which would require enforcement to reduce vehicle use of the shared transit-bike lane. Additionally, this option does not allow for roadway modifications to the cross-section to include expanded pedestrian and bicyclist-only infrastructure, as the far-right curb lane in both directions would also serve transit vehicles and right-turning vehicles. This option could be implemented during certain times of day, but that is not recommended as that would eliminate the ability to use red paint, which would reduce the visual narrowing of the roadway, and would contribute to concerns related to driver non-compliance. Without enhancements such as red paint or vertical elements to designate the exclusive shared transit-bike lane, the roadway context may be perceived similarly to the current conditions, which could diminish the safety benefits.

2. **Segment-Specific Road Diet with Separated Bike Lanes** – This option would include reducing the travel lanes to one lane in each direction at certain lower-volume segments along the Blake Lane

corridor. In general, the center-most travel lanes in each direction would be maintained and the outer general purpose curb lanes in each direction would be converted into separated bike lanes. At the outer edges of the road diet, merging and shifting tapers would be introduced to widen the corridor back to the existing four-lane facility or narrow the corridor to the proposed narrowed two-lane facility. Implementation of this road diet option could be accomplished through upgraded pavement markings and signage, modifications to curb and gutter, and changes to the median.

Unlike the shared transit-bike lane option, this cross-section would feature separated bike lanes, which is an "exclusive facility for bicyclists that is located within or directly adjacent to the roadway and that is physically separated from motor vehicle traffic with a vertical element".[58] A significant advantage of this road diet concept is the maintained cross-section on parts of the corridor where traffic volumes are significant, but additional roadway space for pedestrians, bicyclists, and potential for dedicated space for transit stops on segments of the corridor where safety and speed concerns are the highest. On the segments with road diet implementation, there is the potential to realize the full safety benefits of a road diet, due to the changes in available operating space for motorized vehicles. It also allows for additional roadway space to adjust intersection geometry that can reduce pedestrian crossing width and improve sight lines. A potential disadvantage of this option is the potential for additional sideswipe crashes at points of the lane reduction and costly improvements.

3. **Entire Corridor Residential Boulevard Streetscape Road Diet** – Reducing the travel lanes to one lane in each direction throughout *the entire* Blake Lane corridor through permanent roadway curb and alignment improvements. This is similar to the segment-specific road diet described previously but would be implemented throughout the entire corridor and given the comprehensive corridor changes, would include more robust streetscaping considerations. In this option, the far-right curb lane in each direction can be repurposed to include a dedicated bike lane and wider sidewalks, or shared-use path with a buffer space adjacent to the travel lane. Such buffer space and medians could include Landscaping, such as street trees or shrubs. *This road diet option was not reviewed in this assessment due to the challenges with implementing a road diet on high traffic volume portions of the corridor (east of Sutton Road and west of Borge Street) discussed in the methodology section of this report.*

Following a corridor traffic analysis that conducts an in-depth review of the traffic volume data, future trip generators, and school travel patterns, a segment-specific road diet between Borge Street and Sutton Road could be a potential alternative for future study. The following subsections outline additional considerations for the segment-specific road diet design between Borge Street and Sutton Road

[58] VDOT. "Appendix A(1): VDOT Complete Streets: Bicycle & Pedestrian, Bus Stop Design & Parking Guidelines." Virginia Department of Transportation. Richmond, VA. 2023.

for each segment along Blake Lane. Full concept development during future design will require integration of these challenges and needs.

5.1.4. Considerations by Roadway Segment and Treatment Type

5.1.4.1. Typical Cross Section

With a segment-specific road diet implementation, the typical cross-section on Blake Lane between Borge Street and Sutton Road could include one through lane and a separated bike lane in each direction, or a shared transit-bike lane. Existing left turn lanes at intersections could be maintained. This would allow through traffic to continue uninterrupted on Blake Lane while still providing sufficient width for median refuge islands and bike or shared transit-bike facilities. For the segment-specific road diet with the shared transit-bike lane, the far-right general-purpose curb lane in both directions could be converted into a shared transit-bike lane and a right-turn-only lane at each intersection approach. Examples of what typical 70-foot cross sections with separated bike or shared transit-bike lanes could look like are illustrated in Figure 29.

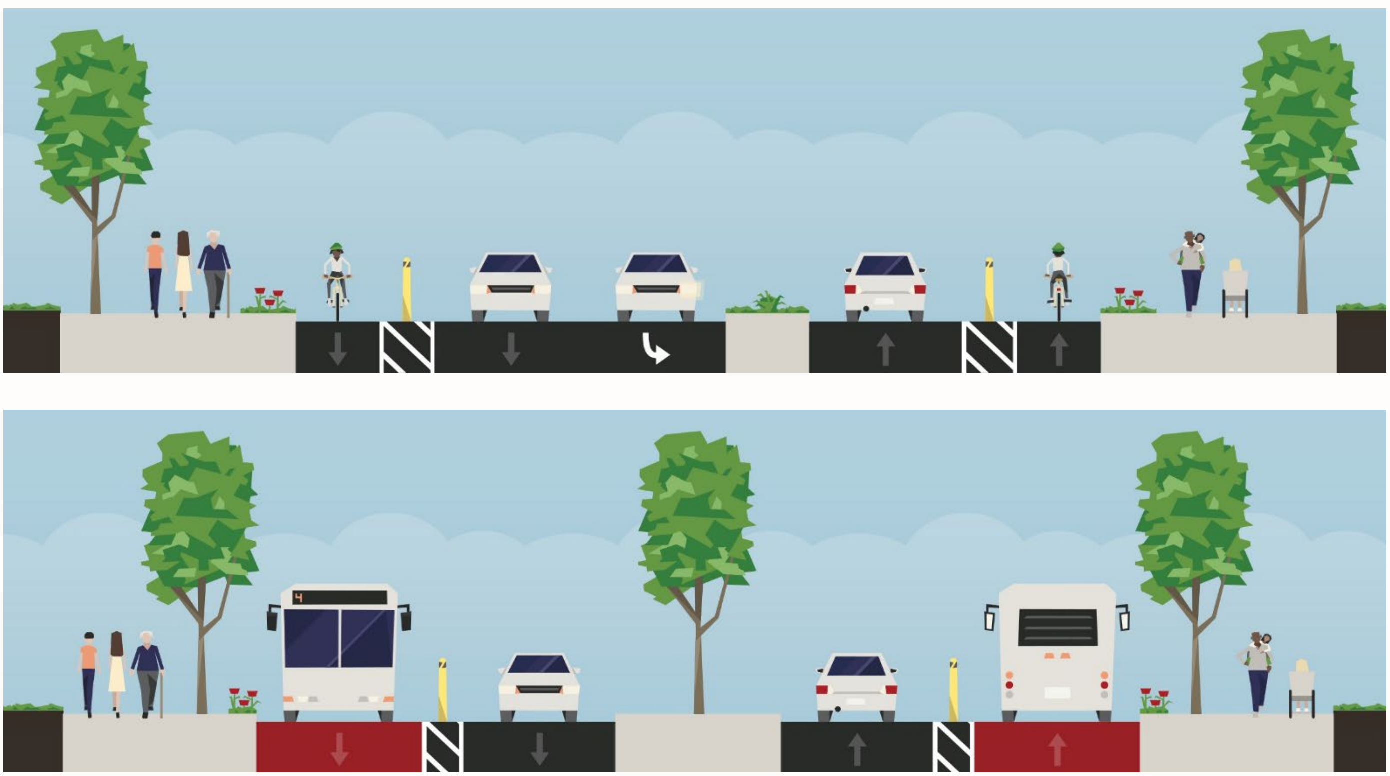

Figure 29. Potential segment-specific road diets along Blake Lane.

West of Borge Street – this portion of the corridor is adjacent to the upcoming redevelopment of the AT&T site bounded by Chain Bridge Road to the west, White Granite Drive to the south, and Flag Pole

Lane to the east. As part of the redevelopment, the developer has proposed shared-use paths along Jermantown Road between Chain Bridge Road and Borge Street. The new traffic signal at the existing AT&T driveway should include crosswalks on all legs of the intersection, as transit stops located in both directions will generate additional crossings. The transition for eastbound Jermantown Road from two to one lane could be done with a lane-drop (add right turn only lane for eastbound approach to Borge Street) or a merge downstream of the Borge Street intersection.

Borge Street to Trevor House Drive – To connect to the proposed shared-use path along Jermantown Road, adjacent to the new development, the intersection of Borge Street can serve as a transition point between separated bike lanes on Blake Lane / Jermantown Road or the shared transit-bike lane. The transition area could include elements of a protected intersection, such as physical separation of bike facilities and travel lanes, as well as smaller corner radii to slow turning vehicle speeds and provide drivers with additional time to react to crossing bicyclists.

Trevor House Drive to Palmer Street / Windwood Drive - Continue separated bike lanes or shared transit-bike lane in both east and westbound directions of Blake Lane. Investigate the removal of the right turn lane into Windwood Drive to reduce overall cross-section width, depending on the concept selection (separated bike lane versus shared transit-bike lane with right-turn only space).

Palmer Street / Windwood Drive to Gray Street / Bushman Drive – Continue separated bike lanes or shared transit-bike lane in both east and westbound directions of Blake Lane.

Gray Street / Bushman Drive to Hibbard Street – Continue separated bike lanes or shared transit-bike lane in both east and westbound directions of Blake Lane. Additionally, the new crosswalk proposed at Bushman Drive could be supplemented with a Rectangular Rapid Flashing Beacon (RRFB). Otherwise, if a road diet is not implemented at this location, guidance from VDOT IIM 384.1 indicates for roadways with ADTs greater than 15,000 vpd, speed limits greater than or equal to 35 mph, and divided roadways with four (4) or more travel lanes a Pedestrian Hybrid Beacon (PHB) is the preferred alternative.

Hibbard Street to Edgelea Road / Platten Drive – Continue separated bike lanes or shared transit-bike lane in both east and westbound directions of Blake Lane. This segment of the corridor is the beginning of eastbound Blake Lane congestion during the Oakton High School arrival time. At the intersection of Edgelea Road / Platten Drive, special consideration on the balance of multimodal needs, school pick-up/drop-off activity, and traffic congestion could feed into a redesign of the intersection to address safety needs.

Edgelea Road / Platten Drive to Sutton Road – This segment will require transitioning two westbound travel lanes to one on Blake Lane west of the Sutton Road intersection. This portion of the corridor experiences significant left turn queueing during the morning peak hour as a result of Oakton High School student drop-offs. The queuing impacts should be further investigated to determine the transition point for eastbound Blake Lane from one to two lanes to maintain through traffic when eastbound left turns exceed the turn lane capacity, as well as the potential for lengthening the left turn lane. Furthermore, the east and westbound bike lanes or shared transit-bike lanes will need to transition to connecting facilities, such as the I-66 trail (located on the south side of the Blake Lane and Sutton Road intersection).

Other potential opportunities for enhancements could include dedicated parking for the school as many drivers are currently parking their vehicles on the northbound shoulder of Sutton Road. This space along Sutton Road could then be reallocated to provide bike lanes in the northbound direction, connecting Oakton High School to the cycle track on Country Creek Road (connecting to the Vienna Metro station). Blake Lane and Sutton Road would serve as a critical connection for bicyclists commuting to and from Blake Lane, the I-66 trail, and beyond, creating the need for enhanced bicyclist infrastructure at the intersection.

East of Sutton Road – Blake Lane between Sutton Road and Route 29 has many challenges including limited right-of-way for pedestrian infrastructure, additional conflicts created by service roads, a relatively high density of access points. These challenges limit options for low- and medium-cost improvements to pedestrian and bicyclist infrastructure. Blake Lane east of Sutton Road also has high traffic volumes due to significant southbound left turning movements from Sutton Road and westbound right turning movements onto Sutton Road. While the segment between Sutton Road and Five Oaks Road is carrying similar traffic volumes to segments west of Sutton Road, the traffic signal likely cannot accommodate the high volumes of vehicles continuing through on Blake Lane at Sutton Road with only one through lane. As a result, the segments of Blake Lane east of Sutton Road require two general purpose lanes to effectively serve traffic demand. Long-term options could include: the removal of the median; reducing the pavement width of the roadway to accommodate wider sidewalks and/or a shared-use path; closing access points to Blake Lane; and enhancing pedestrian crossings with pedestrian refuge islands and/or RRFBs or PHBs (particularly at Bel Glade Street and Kingsbridge Drive).

5.1.5. Implementation of the Road Diet

Implementation of a segment-specific road diet with separated bicyclist facilities on Blake Lane between Borge Street and Sutton Road is a long-term improvement that would require substantial funding to include separated bike lanes, new and enhanced pedestrian crosswalks, transit stop improvements, curb extensions/protected intersection features, turn lane improvements, and median modifications. Alternatively, implementation of a segment-specific road diet with exclusive shared transit-bike lanes that allow for right-turn only space at intersections could be installed with pavement markings, signage, and other temporary materials through a pilot demonstration. This planning-level existing conditions review of segment capacity was conducted as part of this RSA and is the first step towards implementation. Next steps would include preliminary engineering with additional traffic analysis that considers projected growth in traffic volume along the corridor and impacts on intersection operations.

While a long-term vision for the corridor may include permanent roadway curb and alignment improvements, potential sidewalk widening, landscaping, and dedicated bike facilities, a pilot demonstration or short-term implementation with pavement markings could be used to demonstrate the impact of a road diet on Blake Lane. Removing the far-right lane through pavement markings and/or buffered bike lanes could be installed while the corridor seeks funding and full design. The use of pavement markings alone could result in miss-use of the reallocated lane for pick-up and drop-off activity for Oakton High School, unless designated pick-up and drop-off space is created on Blake Lane. Long-term improvements proposed for the corridor are costly, which means that a full overhaul of the corridor would require a minimum of 5 to 10 years for planning, design, funding approval, and construction.

5.2. Speed Assessment

5.2.1. Defining Speed and Safety Impacts

Speed plays a critical role in traffic operation, road safety, and the environmental impact of transportation systems. Per the Federal Highway Administration (FHWA), the posted speed limit is defined as “the maximum lawful vehicle speed for a particular location as displayed on a regulatory sign”.[59] Despite the use of speed limits, there is a consistent concern nationally that posted speed limits may be too high and/or the speed differential between the posted speed limits and the actual operating speeds is too great. FHWA has noted that on some roadways, the current methodology for speed limit setting may not be conducive to safe roadway operations and established with the human tolerance for injury in mind. [60] Operating speed, which is defined as “the speeds at which vehicles are observed operating during free flow” is commonly measured using the 85th percentile speed. [61] Since the COVID-19 pandemic when traffic volumes were significantly reduced, driver speeds nationally increased. Following the pandemic, speeding has remained an issue, with more drivers traveling over the speed limit becoming common according to a new Insurance Institute for Highway Safety study that found that more than 50 percent of Virginia drivers traveled more than 10 mph over the speed limit during Spring 2020.[62] Federal data collected in 2021 and 2022 show

[59] Donnell, E. T., Hines, S. C., Mahoney, K. M., Porter, R. J., & McGee, H., Speed Concepts: Informational Guide—Safety (FHWA-SA-10-001). Federal Highway Administration. 2009.
[60] Kumfer, W, Martin, L., Turner, S., Broshears, L. Safe System Approach for Speed Management (FHWA-SA-23-002). Federal Highway Administration. 2023.
[61] Donnell, E. T., Hines, S. C., Mahoney, K. M., Porter, R. J., & McGee, H. Speed Concepts: Informational Guide—Safety (FHWA-SA-10-001). Federal Highway Administration. 2009.
[62] Insurance Institute for Highway Safety. “Pandemic lockdowns made rush-hour speeding, risky driving the new normal”. 2022. https://www.iihs.org/news/detail/pandemic-lockdowns-made-rush-hour-speeding-risky-driving-the-new-normal

similar trends indicating high driver speeds. As a result, speed-related crashes are at an all-time high in the U.S., with nearly one-third of fatalities involving speed in 2021.[63]

Both higher speeds and a large speed differential can lead to increases in crashes. Speed differential is important because posted speed limits can provide a sense of consistency for other roadway users. They use this to determine if certain maneuvers, such as to enter or cross a roadway, turn left off a bi-directional roadway, or to change lanes/overtake a vehicle, are feasible. For each of these types of maneuvers, roadway users have to determine if there is a sufficient gap in on-coming traffic using both the speed and distance of the approaching vehicle. A larger variation in speeds can reduce driver's ability to successfully judge the gap in traffic, ultimately leading to an increase in crashes.[64]

Many roadway elements, including the length of turn lanes, placement of warning signs, determination of yellow and red signal phases, and have speed as a factor in design. When operating speeds exceed the design speeds, it impacts drivers' ability to use those facilities as designed and ultimately leads to a higher risk of crashes. This is primarily because of the stopping sight distance required by drivers to react to a change in the roadway.[64] The faster a driver travels, the more time and distance they need to slow down or stop. This can lead to an increase in rear end crashes for undersized turn lanes, turning vehicle crashes at intersections with insufficient sight distance or smaller turning radii to accommodate the operating speeds, or more frequent red light running crashes at signalized intersections. Because roadway features such as sign placement, turn lane length, intersection geometry, and signal timing are all designed with speed as a factor, ensuring that vehicles are operating at or near the speed limit is essential to safety.

Driver speeds also have a significant impact on vulnerable road user safety. Research has shown that the risk of a pedestrian fatality is not linear, but that the fatality risk doubles between drivers traveling at 32 mph versus 42 mph, as shown in Figure 30. This is important to note as arterials with speed limits greater than or equal to 45 mph are currently experiencing significant increases in pedestrian fatalities. In the case of Blake Lane, drivers traveling 10 mph or more over the 35 mph speed limit can lead to a pedestrian fatality risk of roughly 55 percent.

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[63] National Highway Transportation Safety Administration. "Almost One-Third of Traffic Fatalities Are Speed-Related Crashes" NHTSA. Washington, D.C. 2023. https://www.nhtsa.gov/press-releases/speed-campaign-speeding-fatalities-14-year-high
[64] "Institute for Road Safety Research. SWOV Fact Sheet: The relation between speed and crashes. Leidschendam, the Netherlands. 2012.

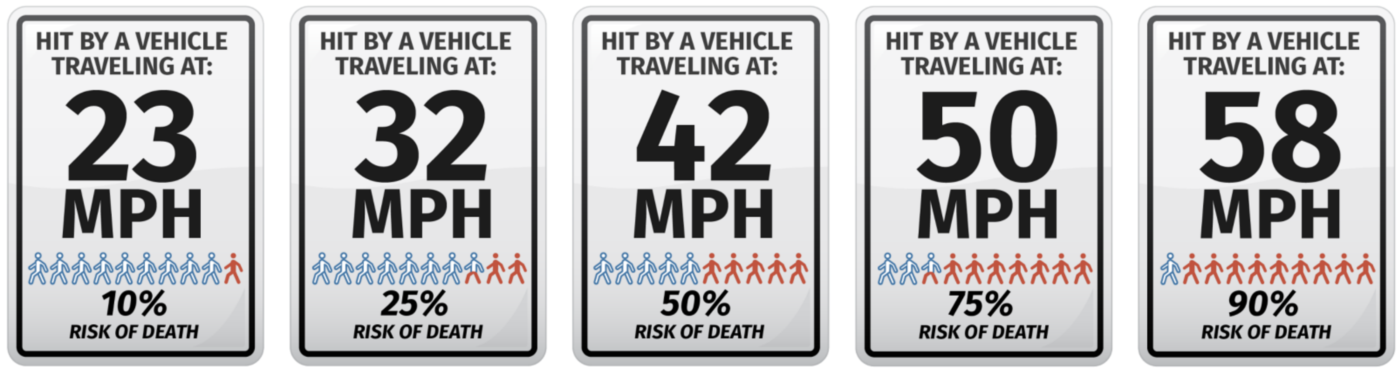

Figure 30. Risk of pedestrian fatality by vehicle speed (Source: FHWA).

Higher operating speed is particularly concerning for vulnerable road users including pedestrians and bicyclists. It increases both the probability of a pedestrian being struck by a car and sustaining a higher injury severity as the crash results in a greater impact.[65] A detailed study using pedestrian-involved crash data from 1994 to1998 in the US revealed a higher likelihood of severe injury and fatality with increasing operating speeds.[66] The study indicates that when a pedestrian is struck, the likelihood of a severe injury reaches 10 percent at an impact speed of 17.1 mph, 25 percent at 24.9 mph, 50 percent at 33.0 mph, 75 percent at 40.8 mph, and 90 percent at 48.1 mph. These risk levels exhibit variations depending on the pedestrian's age, with older pedestrians experiencing higher injury severity at lower speeds compared to younger pedestrians. Another study also reported that the average risk of death for a pedestrian is 10 percent when the speed is 23 mph, but increases to 50 percent when the speed is 42 mph.[67]

5.2.1.1. Why do people speed?

Driver, vehicle, roadway, and environmental characteristics are all factors that influence driver behavior, including driver speeds. The complexity of these factors and variation in vehicle characteristics (model, year, performance, size, etc.) and driver attributes (age, gender, risk tolerance, visual skills, etc.) make speeding a challenging problem. Additionally, physical features of the roadway and environment also impact speed selection for drivers. Figure 31 shows the variety of factors that influence driver speed, which impacts the overall safety performance of the roadway.

[65] Goughnour, Elissa, Kara Peach, Michael Dunn, Meghan Mitman, and Dan Gelinne. Primer on Safe System Approach for Pedestrians and Bicyclists. No. FHWA-SA-21-065. United States. Federal Highway Administration. Office of Safety. 2021.
[66] Tefft, B. C. Impact speed and a pedestrian's risk of severe injury or death. Accident Analysis & Prevention, 50, 871-878. 2013. https://doi.org/10.1016/j.aap.2012.07.022
[67] Xu, G., Zineddin, A., Atkins, R., and Abe, S. Speed Management is Key to Road Safety. Federal Highway Administration (FHWA-HRT-22-002). 2022.

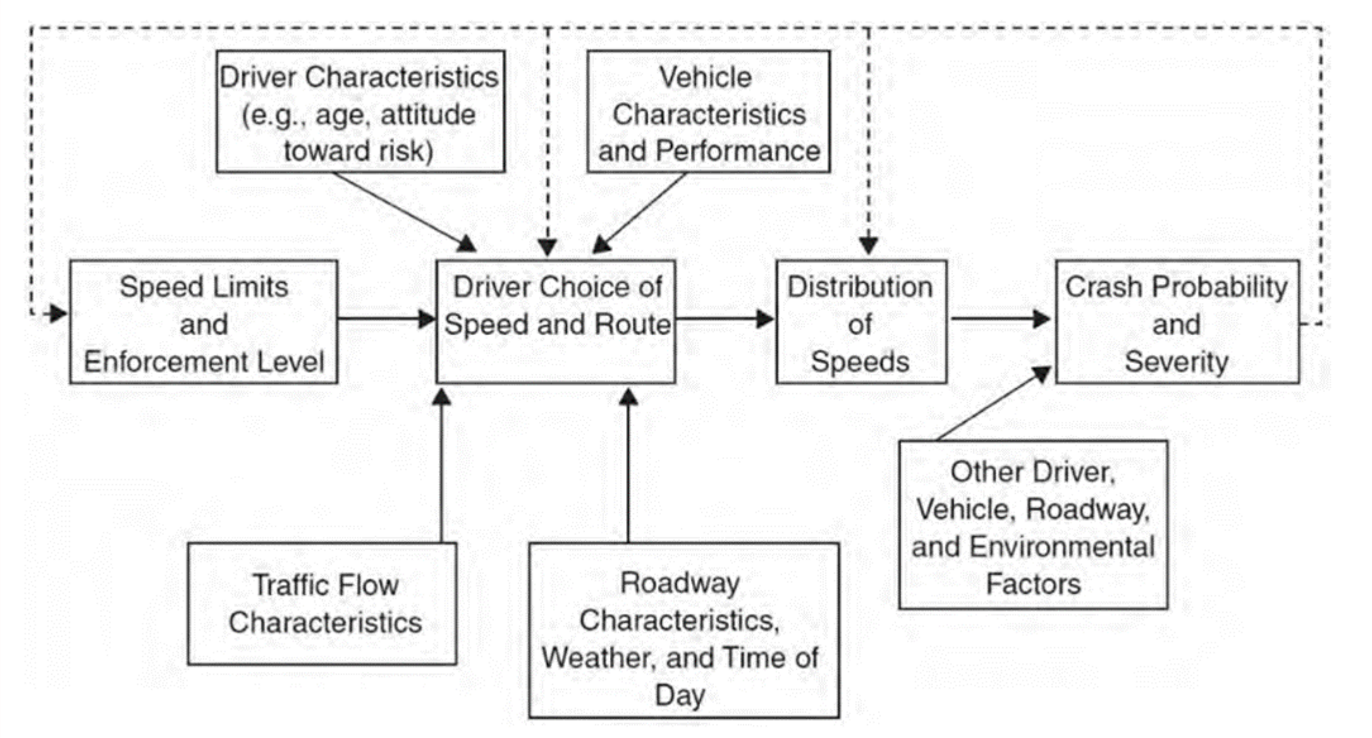

Figure 31. Factors influencing driver speed (Source: Milliken et al.)[68]

As the reasons for speeding are multifaceted, there is no single answer. Rather a holistic solution requires a layered approach, including countermeasures related to engineering, enforcement, and community engagement/education.

5.2.1.2. Why is speed a concern on Blake Lane?

On Blake Lane, the posted speed for the study area is 35 mph. However, drivers frequently travel at speeds higher than the posted speed limit, as indicated by data collected in January 2021. The 85th percentile speed (speed that 85 percent of drivers are traveling at or below) is 44 mph in the eastbound direction and 43 mph in the westbound direction. Maximum speeds recorded in the January 2021 data collection were 79 mph around 10:30 pm in the westbound direction and 64 mph at roughly 10 am in the eastbound direction. During the midday and nighttime hours, data indicates that individual drivers exceed the speed limit by more than 15 mph. Although engineering countermeasures and road design are used to help the driver feel they are driving the correct speed at the speed limit, there will be individuals with higher risk tolerance. These individuals may speed due to drug and/or alcohol intoxication, overconfidence in their ability to

[68] Milliken, John G., F. M. Council, T. W. Gainer, N. J. Garber, K. M. Gebbie, J. W. Hall, C. A. Lave et al. "Special Report 254: Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits." Transportation Research Board, National Academy Press, Washington, D. C. 1998.

navigate the roadway at high speeds, or young drivers with poor traffic safety judgment. Efforts to reduce these outliers require robust education and routine enforcement.

Average and 85th percentile vehicular speeds on the corridor vary throughout the day; however, high average speeds of roughly 41 mph along the corridor were observed during morning peak hours, compared to an overall average speed of roughly 39 mph throughout the day. During this time, the general flow of traffic seemed to be traveling at consistently higher speeds, versus midday and night hours when there was more variation among drivers. The consistently higher speed in the morning aligns with the time when many students are walking to Oakton High School and residents in the area walking or biking for recreational or commuting purposes (7:30 to 8:30 am). This overlap in peak pedestrian and bicyclist activity and high speeds can introduce additional risk to all road users.[69]

5.2.2. Behavioral Approach: Why is the average driver speeding on Blake Lane?

Speeding is a complex driving behavior impacted by a multitude of demographic, roadway, environmental, vehicular, behavioral, and situational factors. Though various factors impact drivers' speed selection, drivers' beliefs and attitudes also play a crucial role in shaping driving behavior and cultural acceptance related to speeding. A National Highway Traffic Safety Administration (NHTSA) study, "Motivations for Speeding", using naturalistic driving study data evaluated the reasons why drivers speed and identified the effects of situational, demographic, and personality factors in impacting travel speed.[70] The findings indicated that driver motivations, attitudes, and beliefs are significant predictors of both which drivers speed and the extent to which they speed. Demographic factors such as age and gender, situational factors such as time-of-day and day-of-week, and key personal inventory factors such as attitudes towards reckless driving significantly impacted speeding. Prior studies also outlined being impatient with other drivers, aiming to reach the destination as fast as possible, enjoying fast driving, and having the belief that speeding is not dangerous for skilled drivers are some of the traits contributing to speeding.[71] NCHRP Synthesis 600 reported that the posted speed limit is not the primary reason why people drive at a certain speed.[72] Most drivers will drive at a speed they consider appropriate and it is dependent on factors including driver perception of risk, traffic flow (i.e., how fast others are going around them), and road design.

Drivers often subconsciously categorize roadways (e.g., highways, city streets, or rural roads) to reduce cognitive demands, enabling them to focus attention and resources on other pertinent

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[69] Traffic data collected at various intersections on Blake Lane October 25, 2023.
[70] Richard, C. M., Campbell, J. L., Lichty, M. G., Brown, J. L., Chrysler, S., Lee, J. D., Boyle, L., & Reagle, G. Motivations for speeding, Volume I: Summary report. (Report No. DOT HS 811 658). Washington, DC: National Highway Traffic Safety Administration. 2012.
[71] Xu, G., Zineddin, A., Atkins, R., and Abe, S. Speed Management is Key to Road Safety. Federal Highway Administration (FHWA-HRT-22-002). 2022.
[72] Campbell, J. L., Lichty, M. G., Brown, J. L., Richard, C. M., Graving, J. S., Graham, J., O'Laughlin, M., Torbic, D., & Harwood, D. Human Factors Guidelines for Road Systems: Second Edition. Transportation Research Board. 2012. https://doi.org/10.17226/22706

information like crash risks and navigation.[73] To do this, they use their experience with similar roadway/roadside characteristics such as the presence of distinctive road signs, lane configurations, and the density of traffic. The cognitive effort reduction achieved through road categorization helps drivers to manage information overload, and make split-second decisions, promoting safer and more efficient driving experiences. However, this can mean that drivers may unconsciously categorize a roadway incorrectly based on physical features typical of other roads they have driven before – such as incorrectly categorizing and driving on a low-speed roadway with features similar to a principal arterial. For example, a driver may associate a four-lane suburban arterial with limited access points and little traffic control with roadways that have speed limits greater than 45 mph. Alternatively, a two-lane road with bike lanes, sidewalks, and buildings close to the road may give drivers the perception of a more urban environment with speed limits lower than 30 mph.

Additionally, drivers tend to perceive events that are in line with their expectations and disregard events that deviate from those expectations. [74] Crash statistics revealed that a significant portion of drivers involved in crashes do not react too late, but do not react at all. So, when a mis-categorization of a roadway is made, and the driver behaves as they would based on their initial assessment, it can be difficult for them to adapt to the reality of that road. This could mean that a driver who categorizes the roadway as one with higher speeds may not expect slower drivers or pedestrians or bicyclists on the roadway. Due to this cognitive limitation, it is crucial to design and add different roadway elements that align with the context and expectations.

Using a **context-sensitive design approach** would help drivers to make an initial appropriate roadway categorization. Studies have estimated over 90% of driver cues to be visual.[73] Applying context-sensitive design using a variety of visual cues – such as roadway design, markings, signs, and roadside features – can provide the necessary information for drivers to judge and apply a safe operating speed on roadways. This further strengthens the need for the roadway and roadside environment to provide visual cues on expected travel speed.

5.2.2.1. Variation in driver workload

Human factors, such as driver workload (the variety of tasks that the cognitive system must balance while driving a vehicle), must also be considered because our cognitive system is limited.[75] Driver workload varies greatly by age and ability, with younger or less experienced drivers having less cognitive capacity and older or more experienced drivers having greater cognitive capacity.

[73] Theeuwes, Jan, and Horst, Richard van der. Designing Safe Road Systems : A Human Factors Perspective. Abingdon: Taylor & Francis Group, 2012.
[74] Theeuwes, Jan, and Horst, Richard van der. Designing Safe Road Systems : A Human Factors Perspective.
[75] Wierwille, W., Tijerina, L., Kiger, S., Rockwell, T., Lauber, E., Bittner, A. *Heavy vehicle driver workload assessment. Task 4, review of workload and related research*. Report No. DOT HS-808 467. Federal Highway Administration. Washington, D.C. 1996.

An experienced driver operating on a roadway with few visual cues, consistent characteristics, and significant familiarity requires less attention and the driver may become complacent and less reactive to changes in the roadway.[76] This cognitive underload, where driving on parts of Blake Lane may feel easy, can make drivers feel as though they are driving more slowly than in areas with higher cognitive load – potentially resulting in speeding and/or an increase in lane changes and passing maneuvers.[77]

With younger or novice experienced drivers, particularly those driving to and from Oakton High School, have less cognitive capacity than more experienced drivers and more of their cognitive capacity is spent on the control and operation of the vehicle. Due to their lower cognitive capacity, these drivers are less able to respond to changing conditions, such as seeing and reacting to a crossing pedestrian. Additionally, other competing cognitive demands, such as music playing, phone use, and other passengers in the vehicle further reduce the ability for younger or novice drivers to complete the basic driving tasks.

There are currently several different groups of drivers that use Blake Lane, including young drivers and experienced drivers or regular commuters. These driver groups experience Blake Lane differently, with one being highly prone to cognitive overload and the other cognitive underload. **When driver workload is too low or too high, driver performance may decline.** This consideration is essential to the overall road design, as drivers with too low of a workload or exceeded workload capacity may miss changes in the roadway, such as pedestrians crossing or vehicles turning from side streets. Missing these changes may increase the risk of a collision.

A **context-sensitive design approach** is proposed to combat the effects of cognitive overload and underload in drivers – contextual elements such as landscaping, significant transit use, pedestrian and bicyclist infrastructure, and a reduced roadway cross-section width can help reduce the variation in operating speed caused by differences in cognitive load by providing consistency along the corridor.

Additionally, **an educational campaign** at Oakton High School on the impact of distractions and speeding on the ability to focus and respond to potential threats could help raise awareness of the potential crash risk while driving. Virginia currently has a state law that prohibits the number of passengers under the age of 21 that are allowed to be in the vehicle with a driver under the age of 18, with several exceptions. An enforcement through education campaign could also be conducted at Oakton High School on the number of people allowed to ride in a vehicle with a teen driver. This could be conducted through the use of warnings for students with more than the legal number of riders during dismissal.

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[76] Theeuwes, J. *Designing Safe Road Systems: A Human Factors Perspective.* Chapter 5, Workload Management. Taylor & Francis Group. 2012.
[77] Insurance Institute for Highway Safety. “Speed”. Washington, D.C. 2023. https://www.iihs.org/topics/speed

5.2.2.2. What makes drivers feel like they are driving too slowly?

An NCHRPH Synthesis aggregated several factors that affect driver speed perception (i.e., how fast a driver is going) as presented in Figure 32 below.[78] Using design standards (turn lane lengths, sight distance, signal timing) for design speeds higher than the intended operating speed, wider travel lanes, divided roadways, and daylight may be some of the factors causing drivers to underestimate their speeds, which are all factors present on Blake Lane. Speed estimation also varies by driving experience, with less experienced drivers more likely to underestimate their travel speed.[79]

FACTORS THAT AFFECT SPEED PERCEPTION

Factors that May Cause Drivers to UNDERESTIMATE Their Travel Speed	Factors that May Cause Drivers to OVERESTIMATE Their Travel Speed
• Higher design standard • Greater roadway width • Divided, walled urban roads • Rural roads without roadside trees • Daylight compared to nighttime illumination conditions	• Two-lane narrow urban roads • Roads densely lined with trees • Transverse pavement markings

Figure 32. From NCHRP Report 600: Human Factors Guidelines for Road Systems.

When drivers underestimate their travel speed, they may unintentionally drive faster than they think they are. This can result in operating speeds that exceed the posted speed limits or are higher than what is safe for the road conditions. Additionally, if some drivers underestimate their speed and drive too fast, while others are driving at or below the speed limit, it can lead to increased speed variance and potential conflicts between vehicles. Similar to the potential solutions for addressing variation in the cognitive load and driver categorization of roadways, a **context-sensitive design approach** can reduce the likelihood of a driver unintentionally driving higher than the posted speed limit. This means a redesign of the corridor to address elements in Figure 32 can help drivers better estimate their operating speed.

5.2.3. Infrastructure Approach: What are the physical characteristics of the roadway impacting speed?

Infrastructure design and physical characteristics impact operating speed in various ways. NCHRP Report 504 assessed several roadway factors impacting operating speeds including posted speed limit, functional classification, access density, pedestrian activity, centerline and edge line markings, on-street parking,

[78] National Academies of Science, Engineering, and Medicine. Human Factors Guidelines for Road Systems: Second Edition. 2012.
[79] Wu C, Yu D, Doherty A, Zhang T, Kust L, et al. An investigation of perceived vehicle speed from a driver's perspective. PLOS ONE 12(10): e0185347. 2017.

lane/shoulder/pavement width, median presence, signal density, and land use type.[80] The study reported posted speed limit and access density have a significant impact on speed and several other variables including median type, parking along the street, and pedestrian activity level that have some influence over operating speeds.

A study in Fairfax County, Virginia analyzed the interrelationships between the free-flow speed and roadway geometry-related variables on four-lane urban streets. The segments were on four-lane urban roads with speed limits ranging from 35 to 45 mph and had an average intersection density of less than 2 per mile.[81] The study explored the effects of posted speed limit, median type, median width, access density, lane width, and adjacent land use on free-flow speeds. The study also included segment length, defined as the ratio of the study segment length to the maximum signal spacing, in the analysis. Results showed that posted speed limit, median width, and segment length significantly impact free-flow speed. Parameter estimates from the statistical models indicated segment length to have a greater impact on the free-flow speed.

In another study, Mahmoud et al. examined the factors influencing operating speeds on arterial roads, categorizing them into suburban residential, suburban commercial, and urban general contexts.[82] The research identified 21 variables affecting operating speeds. In terms of traffic characteristics, higher AADT and daily transit volume were found to reduce operating speeds. The study found that narrower lanes were associated with lower speeds, whereas longer segment lengths and asphalt road surfaces corresponded with higher operating speeds. Urban roadways generally experienced lower operating speeds compared to suburban residential and suburban commercial roadways. Features such as wider shoulders were linked to higher speeds, while the presence of curbs or gutters lowered operating speeds. Higher speeds were also observed on roadways with higher speed limits, more lanes, superior pavement conditions, raised median, and fewer traffic signals. Interestingly, while the presence of sidewalks led to reduced speeds, the existence of bike lanes resulted in increased operating speeds. The study revealed lower speeds in commercial land use areas and higher speeds in residential land use areas and areas with a higher proportion of people living under the poverty line.

Subsequent research by Mahmoud et al. assessed the factors impacting the difference between target speed and operating speed.[83] Factors such as speed limit, traffic volume, shoulder width, proportion of sidewalks and shared paths, block length, number of signals, pavement conditions, residential and mixed land use,

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[80] Fitzpatrick, K., National Cooperative Highway Research Program, & National Research Council (U.S.) (Eds.). Design speed, operating speed, and posted speed practices. Transportation Research Board, National Research Council. 2003.
[81] Ali, A. T., Flannery, A., & Venigalla, M. M. Prediction Models for Free Flow Speed on Urban Streets (07–1954). Article 07–1954. Transportation Research Board 86th Annual Meeting Transportation Research Board. 2007. https://trid.trb.org/view/801967
[82] Mahmoud, N., Abdel-Aty, M., & Cai, Q. (2021). Factors Contributing to Operating Speeds on Arterial Roads by Context Classifications. Journal of Transportation Engineering, Part A: Systems, 147(8), 04021040. https://doi.org/10.1061/JTEPBS.0000548
[83] Mahmoud, N., Abdel-Aty, M., Cai, Q., & Abuzwidah, M. (2022). Analyzing the Difference Between Operating Speed and Target Speed Using Mixed-Effect Ordered Logit Model. Transportation Research Record, 2676(9), 596–607. https://doi.org/10.1177/03611981221088197

population density, and percentage of poverty were found to have a notable impact. Based on the research findings, the study provided several recommendations to achieve a lower operating speed. The recommendations included reducing the posted speed limit, reducing inside shoulder width, reducing average block length, constructing curb and gutter on the outside shoulder, increasing the proportion of shared paths and width of sidewalks, and installing more signalized intersections. A summary of the studies discussed in this section is provided in Table 17.

Table 17. Summary of existing literature on operating speeds on urban/suburban roadways.

Study	Roadway Description	Contributing Factors
Poe & Mason, 2000[84]	low-speed (25/35 mph) urban environment	degree of curvature, lane width, and hazard rating
Fitzpatrick et al., 2003[85]	all roadways class in suburban and rural areas	posted speed limit, access density, median type*, parking along the street*, and pedestrian activity*
Figueroa-Medina & Tarko, 2004[86]	multilane highways	available sight distance, clear zone, intersection density, and speed limits
Wang et al., 2006[87]	low-speed (25-45 mph) urban streets	roadside density (trees and utility poles), driveway density, intersection density, sidewalk presence, parking presence, number of lanes, presence of curb, and commercial and residential land uses
Ali et al., 2007[88]	urban four-lane streets with speed limits from 35 to 45 mph	posted speed limit, median width, and segment length
Transportation Research Circular, 2011[89]	urban low-speed, suburban highways	low-speed urban streets presence of median, degree of horizontal curvature, restricted roadside, vertical grade, parking, and sidewalk facilities suburban highways sight distance, horizontal curve radius, presence of paved shoulder, access density, restricted roadside,

[84] Poe, C. M., & Mason, J. M. Analyzing Influence of Geometric Design on Operating Speeds Along Low-Speed Urban Streets: Mixed-Model Approach. Transportation Research Record, 1737(1), 18–25. 2000. https://doi.org/10.3141/1737-03
[85] Fitzpatrick, K., National Cooperative Highway Research Program, & National Research Council (U.S.) (Eds.). Design speed, operating speed, and posted speed practices. Transportation Research Board, National Research Council. 2003.
[86] Figueroa-Medina, A., & Tarko, A. Reconciling Speed Limits with Design Speeds (FHWA/IN/JTRP-2004/26, 2661; p. FHWA/IN/JTRP-2004/26, 2661). Purdue University. 2004. https://doi.org/10.5703/1288284313302
[87] Wang, J., Dixon, K. K., Li, H., & Hunter, M. Operating-Speed Model for Low-Speed Urban Tangent Streets Based on In-Vehicle Global Positioning System Data. Transportation Research Record, 1961(1), 24–33. 2006. https://doi.org/10.1177/0361198106196100104
[88] Ali, A. T., Flannery, A., & Venigalla, M. M. Prediction Models for Free Flow Speed on Urban Streets (07–1954). Article 07–1954. Transportation Research Board 86th Annual Meeting. Transportation Research Board. 2007. https://trid.trb.org/view/801967
[89] Transportation Research Circular. Modeling Operating Speed: Synthesis Report: Vol. E-C151 (p. 22864). Transportation Research Board. 2011. https://doi.org/10.17226/22864

		deflection angle of the horizontal curve, and curvature change rate or ratio of successive horizontal curves
Bhowmik et al., 2019[90]	urban arterials with speed limits ≤40	segment length, AADT, intersection density, proportion of industrial areas, lane drop, travel direction, and day of the week
Mahmoud et al., 2021[91]	urban/suburban arterial roads	AADT, transit volume, lane width, asphalt road surface, segment length, shoulder width, shoulder type, land use type, speed limit, number of lanes, pavement condition, raised median, traffic signal frequency, presence of sidewalk, presence of bike lane, presence of bike slot, area type, and income level
Fitzpatrick et al., 2021[92]	urban roadways	AADT, percent trucks, posted speed limit, presence of median, median width, number of lanes, lane width, shoulder width, bike lane, horizontal alignment, vertical alignment, access density, school, parking, and lane use development
Mahmoud et al., 2022[93]	urban/suburban arterial roads	speed limit, traffic volume, shoulder width, sidewalk and shared path proportions, block length, number of signals, pavement conditions, residential and mixed land use, population density, and percentage of poverty

Note: *Indicates correlation but was not statistically significant

Based on this research, a **context-sensitive design approach** – including changes to roadway geometry, access density, land use, and the presence of features such as medians, sidewalks, and bike lanes – have the potential to reduce driver speed. Changing the physical infrastructure can then also result in associated changes to traffic operations, notably vehicular volume, transit usage, and pedestrian and bicyclist activity, all of which also have the potential to reduce driver speed.

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[90] Bhowmik, T., Yasmin, S., & Eluru, N. A multilevel generalized ordered probit fractional split model for analyzing vehicle speed. Analytic Methods in Accident Research, 21, 13–31. 2019. https://doi.org/10.1016/j.amar.2018.12.001
[91] Mahmoud, N., Abdel-Aty, M., & Cai, Q. Factors Contributing to Operating Speeds on Arterial Roads by Context Classifications. Journal of Transportation Engineering, Part A: Systems, 147(8), 04021040. 2021. https://doi.org/10.1061/JTEPBS.0000548
[92] Fitzpatrick, K., Das, S., Pratt, M. P., Dixon, K., & Gates, T. Posted Speed Limit Setting Procedure and Tool: User Guide. Transportation Research Board. 2021. https://doi.org/10.17226/26216
[93] Mahmoud, N., Abdel-Aty, M., Cai, Q., & Abuzwidah, M. Analyzing the Difference Between Operating Speed and Target Speed Using Mixed-Effect Ordered Logit Model. Transportation Research Record, 2676(9), 596–607. 2022. https://doi.org/10.1177/03611981221088197

5.2.4. Speed Summary and Recommendations

The speed assessment conducted on Blake Lane reveals a complex interplay of factors influencing driver behavior and speed selection on this roadway. In summary, the operating speed on roadways is influenced by an array of factors, spanning from road design to socio-cultural considerations. The multifaceted nature of speeding, as highlighted in this assessment, underscores the need for a comprehensive and layered approach to address this critical issue. Key findings from the assessment indicate that despite a posted speed limit of 35 mph, a significant number of drivers on Blake Lane frequently exceed this limit. Higher speeds pose safety concerns for all roadway users, most notably for vulnerable road users, resulting in more crashes and severe crash injuries.

Moreover, the assessment outlines the importance of roadway design, visual cues, and cognitive functions (in terms of categorization and workload) in influencing driver behavior. Adequate signage, road markings, and infrastructure play pivotal roles in guiding drivers to drive the roadway in alignment with posted speed limits. Additionally, the cognitive load experienced by drivers, particularly in suburban areas like Blake Lane, needs careful consideration. An environment or road segment that results in too low of a cognitive workload for drivers can lead to reduced attentiveness. Combining this behavioral consideration with the high cognitive workload associated with novice drivers requires thoughtful balancing.

The physical characteristics of the roadway, including its design, uninterrupted segment length, access density, and traffic characteristics, have a substantial impact on operating speeds. Infrastructure recommendations stemming from this assessment suggest improvements to infrastructure, and measures to enhance safety at intersections.

To effectively address speeding and enhance safety on Blake Lane, the layered approach should encompass engineering improvements, driver awareness, and community engagement/education, and enforcement measures. It is important to consider the diverse factors influencing driver behavior and to tailor interventions accordingly. **One key insight gleaned from this assessment is that lowering of posted speed limits is not enough to reduce speeding.** Instead, it can lead to unexpected consequences, including an increase in speed variance potentially resulting in an increase in crashes and severity of crashes. The assessment suggests that driver attitudes, perceptions of risk, and a variety of situational and environmental factors significantly influence speed selection. Thus, any strategy to mitigate speeding on Blake Lane must consider these nuanced elements.

As noted in the literature review, driver operating speed is influenced by a variety of physical characteristics present on Blake Lane. It is important to note that the presence of these factors does not necessarily imply inferior design practices. Rather, it suggests that these specific roadway conditions may be associated with the higher tendency for speeding observed in the study corridor. The factors contributing to driver speed choice and recommendations for Blake Lane are listed in Table 18.

Table 18. Roadway, environmental, operational, and behavioral factors influencing driver speeds and recommendations for Blake Lane.

Category	Speed Factor	Applicability to Blake Lane	Effects*	Recommendation
Behavioral: Drivers	Cognitive Overload: Inexperienced Drivers	Oakton High School generates a large number of trips on Blake Lane by younger drivers, particularly during arrival and dismissal times when students and residents are frequently walking/biking along Blake Lane. Inexperienced drivers are also those most susceptible to underestimating their speed.	Increase	Education campaign for Oakton High School on safely driving (including the impact of driving speed), walking, biking, etc.
	Cognitive Underload: Experienced and Familiar Drivers	Blake Lane is an arterial road used by commuters to get to the Vienna Metro station or to other arterials such as Route 29 and Chain Bridge Road. Commuters driving Blake Lane can lead to higher driving speeds due to comfort with the road.	Increase	Continue community-based campaigns to reduce speeding, as well education and engagement on speeding/driver behavior with the general public.
	Cognitive Approach: School Zone	School zones are frequently signed and enforced, which helps with driver awareness of the speed limit. Improvements to the Oakton High School Zone help with driver compliance with posted speed limits.	Decrease	Install and activate automated traffic enforcement, as well as school zone markings and signage.
Behavioral / Infrastructural: Roadway Context	Cognitive Approach/Context-Sensitive Design: Functional Class of Roadway	Arterial roadways such as Blake Lane encourage drivers to travel from end to end efficiently with few interruptions. The driver awareness of the road's purpose may discourage slowing or stopping, including yielding to or stopping for pedestrians, disregarding red signals, and traveling at higher speeds.	Increase	Encourage additional non-vehicle options for transportation among Fairfax residents and commuters.

	Cognitive Approach/Context-Sensitive Design: Pedestrian and Bike Facilities / Activity	The presence of pedestrian and bicyclist activity contributes to a neighborhood feel, which may make drivers inadvertently classify the roadway differently than a traditional arterial road. This reclassification can help reduce speeds to what the driver believes is appropriate for other neighborhood roads.	Decrease	Encourage walking and biking for transportation and recreation among residents of the community.
	Cognitive Approach/Context-Sensitive Design: Transit	The presence of transit can help change the way Blake Lane is perceived. Enhanced transit stops with well-connected bicyclist and pedestrian infrastructure helps the road have a boulevard feel, which can help reduce speeds through reclassification of the roadway context. Currently, there are four transit routes that operate along Blake Lane, which may currently help reduce driver speeds.	Decrease	Encourage additional multimodal options for transportation among Fairfax residents and commuters to increase transit availability and frequency.
Infrastructure: Physical Roadway Features	Context Sensitive Design: Number of Lanes	Two lanes in each direction allow for vehicles to pass one another. Additionally, during off-peak hours the lanes are under-utilized, allowing for drivers to travel at high speeds.	Increase	Reconfigure/redesign corridor with streetscaping and multimodal infrastructure.
	Context Sensitive Design: Lane Width	Blake Lane previously had 12-foot lanes during past speed data collection. Wider lanes can make drivers feel like there is less of a need to maintain path tight to the edge line, which may allow for them to drive faster (as less control is needed). Since repaving, lanes have been narrowed to 11 feet, which may help slightly reduce driver speeds.	Increase	Lanes have been reduced to 11 feet wide on Blake Lane through repaving. No recommendation to narrow lanes further at this time.
	Context Sensitive Design: Divided Roadway	Blake Lane is a divided roadway, which can help improve safety by reducing the risk of head on	Increase	Reconfigure/redesign corridor with streetscaping

		crashes and provide refuge space for pedestrians, but it can also give drivers a sense of security from conflicts with opposing vehicles, thus increasing speed.		and multimodal infrastructure.
	Context Sensitive Design: Median Type	Blake Lane is a divided roadway with a concrete median on most of the corridor and landscaped median west of Borge Street. Speeds and crashes are notably lower in the part of the corridor with the landscaped median, which helps contribute to the boulevard-type feel and introduces friction in the clear zones for drivers. Conversely, the concrete median does not provide the vertical elements that make drivers perceive the roadway as narrower, thus increasing speed.	Increase	Reconfigure/redesign corridor with landscaping in median.
	Context Sensitive Design: Cross-Section Width	Wider cross-sections may encourage higher speeds due to sub-factors related to physical cross-section elements. Blake Lane is roughly 70 feet wide curb-to-curb	Increase	Reconfigure/redesign corridor and allocate additional road width to multimodal needs.
	Context Sensitive Design: Horizontal Alignment	Parts of Blake Lane are long and straight, which means drivers have limited lateral shifts, allowing for higher driving speeds.	Increase	Reconfigure/redesign corridor with streetscaping and multimodal infrastructure.
	Context Sensitive Design: Vertical Alignment	The middle of the Blake Lane study corridor has a downgrade heading eastbound. This downgrade may encourage high speeds, as the effects of gravity speed up a vehicle not applying brakes.	Increase	Seek to reduce pedestrian crossings at locations where drivers are more susceptible to speeding due to natural characteristics of the road's topography.

	Context Sensitive Design: Sight Distance	The straight portion of Blake Lane allows for drivers to see well ahead, which can give a sense of security, and lead to driving at higher speeds.	Increase	None, an overall reconfiguration/redesign of the corridor is likely to have an impact on speeds, but not sight distance.
	Context Sensitive Design: Shoulder Presence/Clear Zone	There is no shoulder present on Blake Lane, which reduces the ability for drivers to recover if control is lost. Due to this discomfort, drivers may travel slower to maintain control.	Decrease	None
	Context Sensitive Design: Curb Presence	Similar to shoulders, curb presence influences a driver's perception of control needed to remain in a lane. Blake Lane has curbs adjacent to all travel lanes, which helps reduce driver speeds.	Decrease	None
	Context Sensitive Design: Access Density	There are limited access points on Blake Lane between Trevor House Drive and Sutton Road, which reduces the need for drivers on Blake Lane to slow down for vehicles turning on and off of the road without turn lanes.	Increase	None, while increased access points may reduce operating speeds, they also introduce conflict points for pedestrians, bicyclists, and vehicles.
	Context Sensitive Design: Parking Presence	There is no parking on Blake Lane, which reduces vertical elements that make the road feel more constrained.	Increase	None, parking is unlikely to be heavily utilized due to the presence of private driveways and parking lots.
	Context Sensitive Design: Pavement Condition	Blake Lane was recently repaved, which makes driving smooth. Roads that are poorly maintained often results in people slowing due to increased vibro-tactile feedback and noise in the vehicle.	Increase	None, Blake Lane was recently repaved.

Infrastructure: **Traffic Operations**	Context Sensitive Design: Traffic Volume	Blake Lane is a frequent commuter route from the Oakton neighborhood, between Chain Bridge Road and Route 29, as well as those connecting from surrounding neighborhoods to the Vienna Metro during morning and afternoon peak hours. However, off peak the road is underutilized allowing for drivers to weave and/or speed more easily. Data shows that Blake Lane experiences highest congestion from 7:15-8:15 am but operates at a high level of service outside of this hour.	Increase	Reconfigure/redesign corridor with streetscaping and multimodal infrastructure.
	Context Sensitive Design: Interrupted Flow	Blake Lane has uninterrupted traffic flow between Trevor House Drive and Sutton Road. This allows for drivers to continue uninterrupted along the straight portion of the corridor.	Increase	Investigate the use of pedestrian hybrid beacons at highly utilized crosswalks or rectangular rapid flashing beacons to alert drivers of crossing pedestrians.
	Context Sensitive Design: Speed Limit	Blake Lane has a speed limit of 35 mph, though drivers frequently exceed the limit as they are significantly influenced by the variables listed in this assessment. Given the volume, context, and features of the roadway, the current speed limit is appropriate if it is reflected in the roadway's operating speeds.	-	Implementing improvements recommended in this assessment may bring average and 85th percentile operating speeds closer to the speed limit, as indicated by extensive research.
	Context Sensitive Design: Turn Lanes	Blake Lane has main-line left turn lanes for nearly all side street approaches, which reduces friction between drivers slowing to turn left and drivers continuing through. This allows for drivers to	Increase	Reduce unwarranted turn lanes in existing configuration or maintain if

	continue uninterrupted for longer periods, increasing speed.		number of travel lanes are reduced.

Note: * Effects of Current Conditions on Blake Lane Driver Speed

A summary of recommendations categorized under cognitive and/or context-sensitive approaches to speed management on Blake Lane is shown in Table 19. Some recommendations have been consolidated from the previous table to provide an overall suggestion of a corridor redesign to accomplish several of the infrastructure-related factors.

Table 19. Summary of cognitive and context-sensitive approaches to speed management on Blake Lane.

	Recommendation
Cognitive Approach	Education campaign for Oakton High School on safely driving (including the impact of driving speed and driver distractions), walking, biking, etc.
	Continue community-based campaigns to reduce speeding, as well education and engagement on speeding/driver behavior with the general public.
	Install and activate automated traffic enforcement, as well as school zone markings and signage.
Cognitive/ Context-Sensitive Approach	Encourage walking and biking for transportation and recreation among residents of the community, and multimodal transportation among Fairfax residents and commuters.
Context-Sensitive Approach	Reconfigure/redesign the corridor and allocate additional road width to multimodal needs (bike lanes, curb extensions, refuge islands) on segments of Blake Lane that can accommodate a lane reduction. Segments that cannot accommodate a lane reduction should utilize landscaping, enhanced pedestrian crossings (PHBs, refuge space, etc..), and sidewalk buffers to change roadway context.
	Seek to reduce pedestrian crossings (transit stop optimization, enhanced crosswalks) at locations where drivers are more susceptible to speeding due to natural characteristics of the road's topography.
	Investigate the use of pedestrian hybrid beacons at highly utilized crosswalks or rectangular rapid flashing beacons to alert drivers of crossing pedestrians.
	Reduce unwarranted turn lanes in existing configuration if the number of travel lanes is not reduced.

5.3. Transit Stop Optimization

This section provides findings and recommendations for the Blake Lane Transit Stop Optimization assessment conducted as part of a pedestrian-focused Road Safety Audit (RSA). This Transit Stop Optimization assessment reviews existing transit stops along the corridor to determine optimal spacing, pedestrian crossing locations, and safety for all road users. This assessment considered observational data gathered during field visits, desktop review of readily available safety and site condition data, and future development along the corridor. Based on the review, there are opportunities to consolidate or relocate multiple stops and introduce new crosswalks to improve pedestrian safety.

5.3.1. Corridor Overview

The study corridor features 24 transit stops – 12 in each direction – that are served by the following three different transit providers and four distinct routes:

1. Washington Metropolitan Area Transit Authority (WMATA)
    - Route 2B
2. Fairfax County Connector
    - Route 466
3. City of Fairfax's CUE service.
    - Route Gold 1
    - Route Gold 2

Ridership data for all four routes was reviewed for Fall 2022 through Winter 2023. Overall, transit ridership is low along the corridor, except for stops on the east side of Blake Lane between Lindenbrook Street and Route 29. Many of the existing transit stops along Blake Lane serve as stops for multiple routes, as shown in Figures 33 through 39.

Among challenges that contribute to transit stop-related pedestrian safety concerns are significant variation in ridership among the stops on the corridor; close spacing of multiple stops; and relatively long distances between some stops and the nearest marked pedestrian crossing.

5.3.2. Required Coordination

This engineering assessment includes recommendations about transit stop placement based on desirable crossing locations, geometric and safety factors, and ridership. While Fairfax County is responsible for the installation and maintenance of transit shelters, stop placement is at the discretion of the transit service operator. Coordination with each of the transit operators on the corridor will be required to relocate, remove, or consolidate existing transit stops. Furthermore, community input and engagement are also essential to understand the impact on transit users

Figure 33. Sheet 1 of 7 showing transit stops along Blake Lane with ridership and route information.

Figure 34. Sheet 2 of 7 showing transit stops along Blake Lane with ridership and route information.

Figure 35. Sheet 3 of 7 showing transit stops along Blake Lane with ridership and route information.

Figure 36. Sheet 4 of 7 showing transit stops along Blake Lane with ridership and route information.

Figure 37. Sheet 5 of 7 showing transit stops along Blake Lane with ridership and route information.

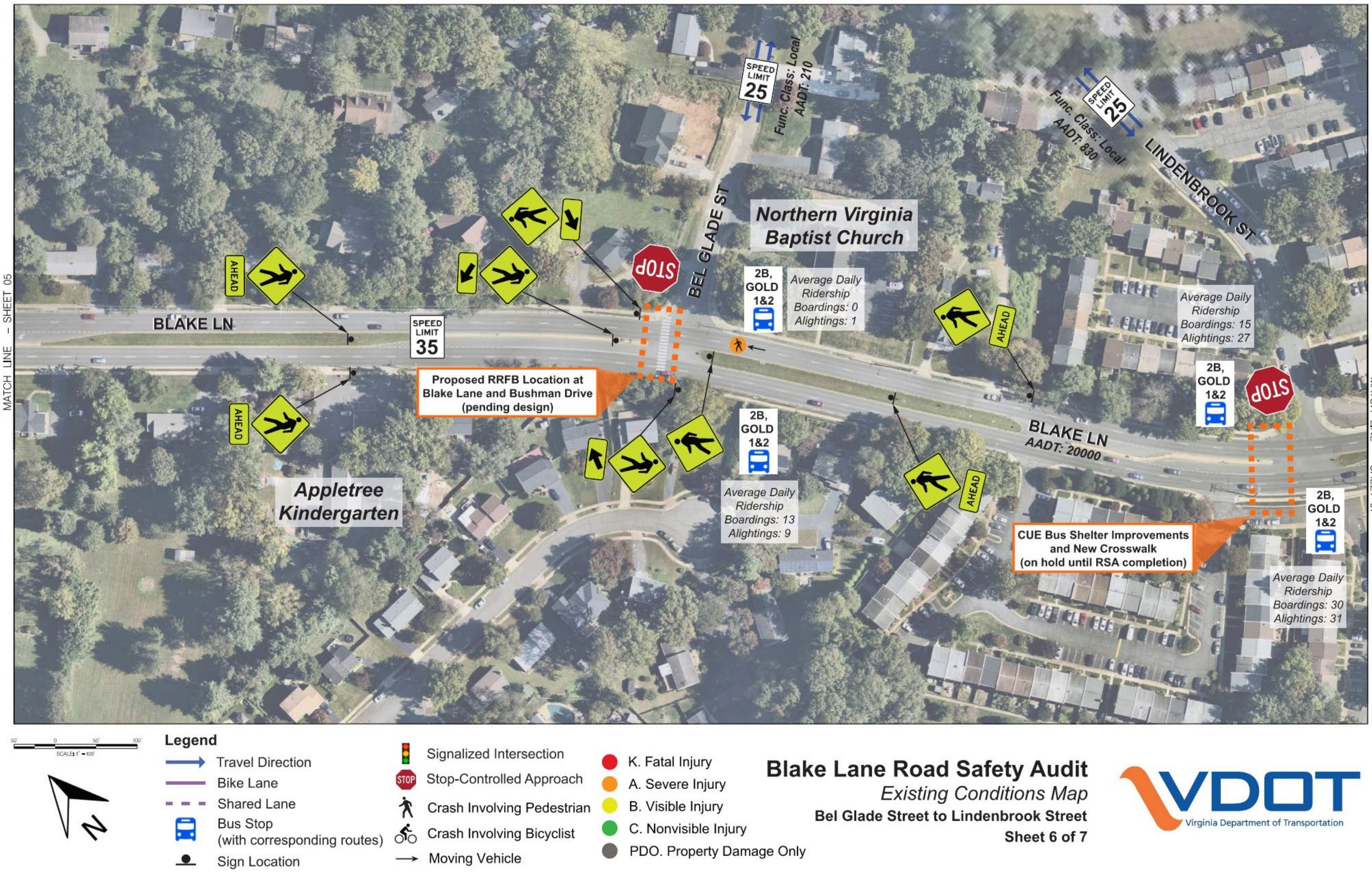

Figure 38. Sheet 6 of 7 showing transit stops along Blake Lane with ridership and route information.

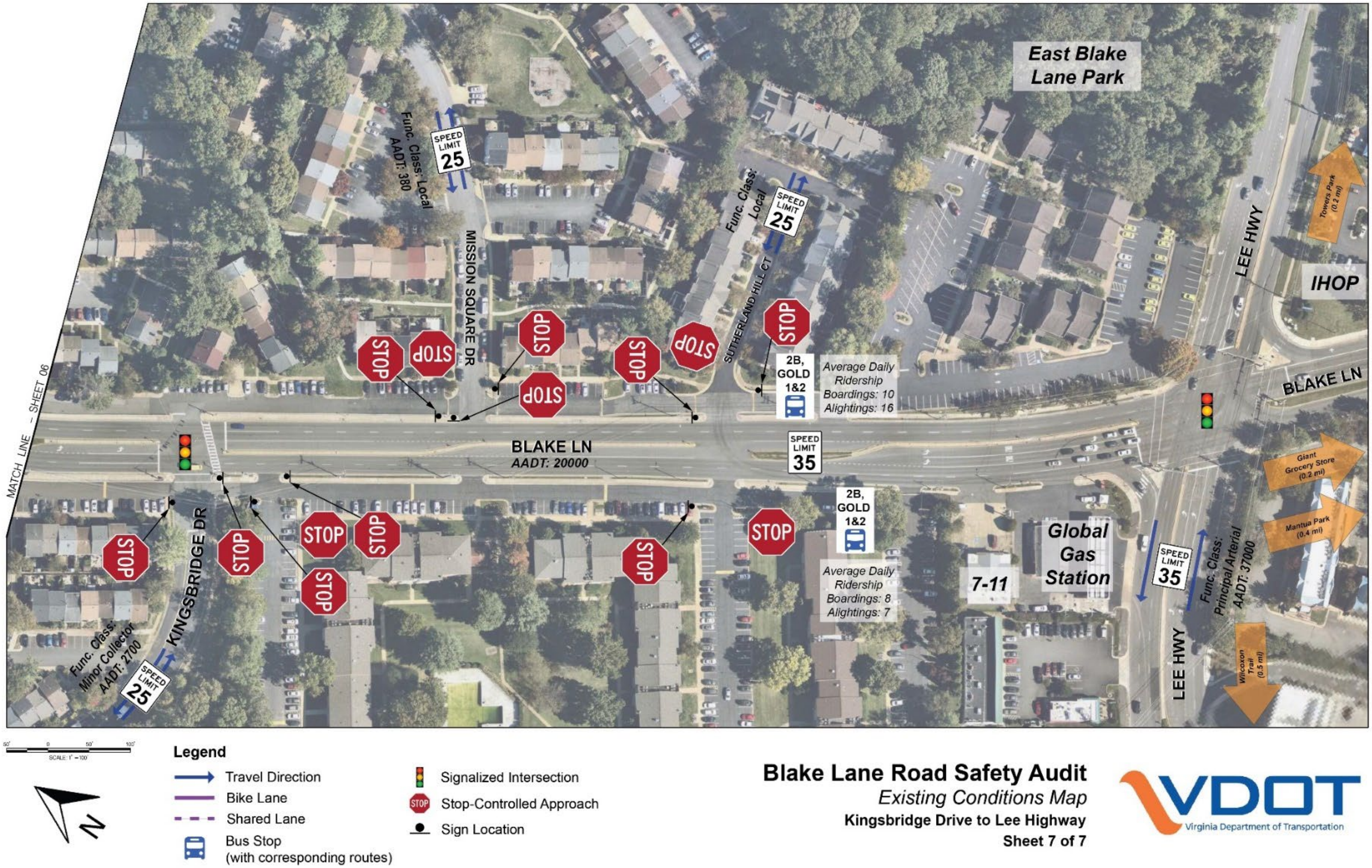

Figure 39. Sheet 7 of 7 showing transit stops along Blake Lane with ridership and route information.

5.3.3. Transit Stop Optimization Considerations

Transit stops are pedestrian generators. Placing transit stops near marked crossing locations aligns stop location with driver expectations about pedestrian activity; conversely, drivers may not expect to encounter a crossing pedestrian at stop locations away from marked crossing locations. Stop optimization may result in the reduction or relocation of stops and would allow for enhancement of the remaining transit stops and nearby marked crosswalks.

Relocation of transit stops could address challenges with sight lines between oncoming vehicular traffic and alighting passengers that may by trying to cross the roadway. Particularly at uncontrolled crossing locations, far side transit stops could improve pedestrian safety, as marked crosswalks would be located behind the transit stop, allowing for clear sight lines between vehicles approaching the intersection and pedestrians looking to cross Blake Lane.

One way to address pedestrian safety at transit stops is to consider placing them on the near side or far side of the intersection. Near side transit stops refer to stops that are located on the approach, just before the intersecting road at an intersection, while far side transit stops are those situated on the receiving side of the intersection. Near side transit stops can obstruct sight lines between pedestrians crossing in front of the bus and approaching vehicles, creating the multiple-threat crash risk (Figure 40).

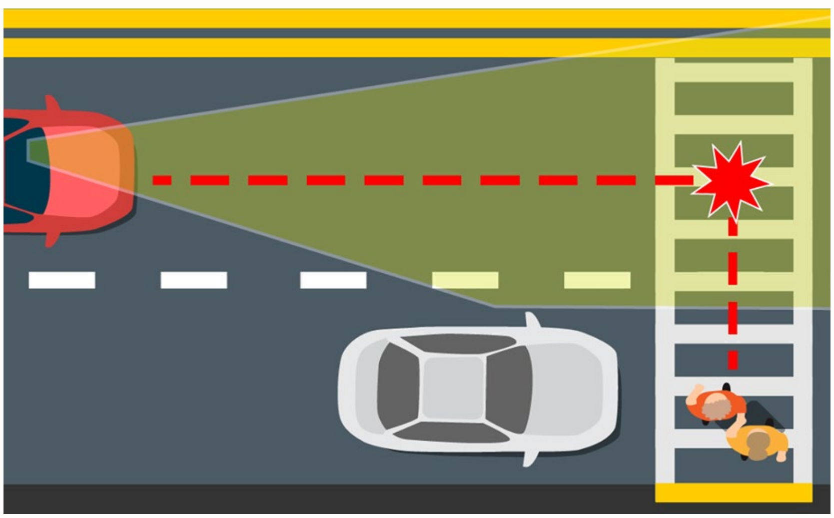

Figure 40. Multiple-threat crash caused by obstructed sight lines from stopped vehicle blocking view of pedestrian and approaching driver (Source: FHWA).

At signalized intersections on the corridor, transit stops may be better suited on the near side to encourage pedestrians to cross at the signal during the walk phase. Near side stops do entail potential disadvantages at signalized intersections with right-turn lanes, including the potential for increased conflicts between right-turning vehicles and buses utilizing right-turn lanes and challenges with buses attempting to merge back into the through lane.[94] Alternatively, far side stops may increase the risk of rear end and sideswipe crashes cause by vehicles not expecting the bus to stop or vehicles attempting to merge into the other through lane. Table 20 summarizes the advantages and disadvantages of each location for bus stop placement.

Transit stops should also be easily accessible to all road users and located appropriately near those that are using transit. According to WMATA guidance, the recommended spacing is 700 to 2,000 feet or 4 to 5 stops per mile for local bus service.[95] Locating transit stops in proximity to places transit users want to go – including home, work, school, shopping, or other key services and amenities – helps reduce walking distances between transit stops and generators/destinations. High quality pedestrian facilities should be present to directly and comfortably connect stops and generators and to direct users to desirable crossing locations.

Table 20. Comparative analysis of bus stop locations (Source: FHWA).

Stop Type	Advantages	Disadvantages
Near Side	• Minimizes interference when traffic is heavy on far side of intersection • Allows passengers access to buses closest to the crosswalk • Intersection available to assist in pulling away from curb • Prevents double stopping, which occurs when a transit vehicle stops for both the red light and the far side stop • Allows buses to service passengers while stopped at red light • Provides driver with opportunity to look for oncoming traffic including other buses with potential passengers	• Conflicts with right-turning vehicles are increased • Potentially obscures curbside traffic control devices and crossing pedestrians • Potentially obscures sight distance for crossing vehicles stopped to the right of the bus • Potentially blocks the through lane during peak periods by queuing buses • Increases sight distance problems for crossing pedestrians
Far Side	• Minimizes conflicts between right-turning vehicles and buses • Provides additional right turn capacity by making curb lane available for traffic	• Potentially blocks intersections during peak periods by queuing buses • Potentially obscures sight distance for crossing vehicles

[94] Goughnour, E., Bonner, T., Sweester, E., Smith, D. "Improving Safety for Pedestrians and Bicyclists Accessing Transit Guide". Report No. FHWA-SA-21-130. Federal Highway Administration. Washington, D.C. 2022
[95] Washington Metropolitan Area Transit Authority. "Guidelines for the Design and Placement of Transit Stops" Washington, D.C. 2009.

Stop Type	Advantages	Disadvantages
	• Minimizes sight distance problems on approaches to intersection • Encourages pedestrians to cross behind the bus • Accommodates shorter deceleration distances for buses • Creates gaps in traffic flow for buses reentering the flow of traffic at signalized intersections	• Interferes with bus operations and all traffic in general when stopping after a red light • Potentially increases number of rear end crashes since drivers do not expect buses to stop again after stopping at a red light
Midblock	• Minimizes sight distance problems for vehicles and pedestrians • Minimizes pedestrian congestion in passenger waiting areas • Reduces conflicts with different movements of vehicles (vehicles turning right and left) and can eliminate turning lanes	• Necessitates additional distance for no parking restrictions • Encourages patrons to cross street at midblock (jaywalking) • Increases walking distance for patrons crossing at intersections

5.3.4. Transit Stop Optimization Assessment Findings and Recommendations

This assessment identified a series of challenges and concerns associated with existing transit stop placement along the Blake Lane corridor. Those challenges and concerns include:

- **Inconsistent stop spacing.** Transit stops on the corridor range from as little as 400 feet to as long as 1,700 feet apart, meaning that drivers may not expect stops to be closely spaced.
- **Misalignment of stop placement and pedestrian generators.** Several stops are located away from an intersection even though most pedestrian generators are not located at midblock locations.
- **Lack of marked / enhanced pedestrian crossings near transit stops.** Most transit stops are not located at crosswalks, with only three crossings located directly adjacent to a controlled crosswalk.
- **Sight line obstructions due to intersection geometry and vegetation.** Throughout the corridor, intersection skew and vegetation obstruct sight lines between drivers and pedestrians.
- **Consideration of intersection operations.** Transit stop placement should consider intersection operations, especially in areas of high traffic volumes. For example, uncontrolled intersections with heavy right turns onto Blake Lane may not be well suited for a far side stop.

Based on the findings from field and desktop review of the corridor, the project team identified a series of potential countermeasures to improve transit-related pedestrian safety on the corridor. Countermeasures considered included transit stop relocation, transit stop consolidation, installation of new or improved marked crossings, improved sidewalks or sidewalk buffers, and access management strategies.

The transit stop optimization changes and measurements from the proposed transit stops to the next stop downstream (after the stop) are outlined in Table 21 and Table 22.

Table 21. Proposed changes to eastbound transit stops along Blake Lane.

Eastbound Transit Stops	Recommendation	Routes	Boardings	Existing Spacing from Downstream Stop	Proposed Spacing from Downstream Stop
Jermantown Rd & Chain Bridge Rd	Remain	2B	3	1,000′	1,000′
Jermantown Rd & Borge St	Remain	2B	1	700′	700′
Jermantown Rd & Trevor House Dr	Remain, with addition of new marked crosswalk[1]	2B	1	600′	1,100′
Blake Ln & Windwood Farms Dr	Remove[1,3]	2B	1	500′	-
Blake Ln & Bushman Dr	Remain	2B	1	900′	900′
Blake Ln & Cyrandall Valley Rd	Relocate to far side of Hibbard Street intersection[1,2]	2B 466	1	700′	1,100′
Blake Ln & Platten Dr	Remain	2B 466	6	900′	900′
Blake Ln & Sutton Rd	Remain	2B	1	1,000′	1,000′
Blake Ln & Five Oaks Rd	Remain	2B Gold 1 Gold 2	12	1,100′	1,200′
Blake Ln & Bel Glade St	Consolidate far and near side stops to far side of Bel Glade Street intersection[1,3]	2B Gold 1 Gold 2	13	800′	900′
Blake Ln & Lindenbrook St	Remain, with consideration of pedestrian crossing improvements[1,5]	2B Gold 1 Gold 2	30	1000′	800′
Blake Ln & Blake Ln Loop/ Fairfax Blvd	Relocate to far side of Blake Lane Loop entrance opposite Sutherland Hill Court, with access management, new crosswalk with Pedestrian Hybrid Beacon (PHB) [1,4]	2B Gold 1 Gold 2	8	-	-

[1] No crosswalk currently adjacent to the existing transit stop location.
[2] Move transit stop to the far side of the uncontrolled approach to reduce multi-threat crash risk.
[3] Existing transit stop is closely spaced to upstream/downstream transit stops.
[4] Move transit stop to far side of the controlled crosswalk to encourage pedestrian compliance with the walk phase.
[5] Stop to remain with sidewalk improvements and proposed crosswalk addition on the west side of Kingsbridge Drive.

Table 22. Proposed changes to westbound transit stops along Blake Lane.

Westbound Transit Stops	Recommendation	Routes	Boardings	Existing Spacing from Downstream Stop	Proposed Spacing from Downstream Stop
Blake Ln & Blake Ln Loop/Fairfax Blvd	Relocate to far side of Sutherland Hill Court, with access management, new crosswalk with Pedestrian Hybrid Beacon (PHB) [1,4]	2B Gold 1 Gold 2	10	1,000′	600′
Blake Ln & Lindenbrook St	Remain, with consideration of pedestrian crossing improvements[1,6]	2B Gold 1 Gold 2	15	800′	1,100′
Blake Ln & Bel Glade St	Relocate to far side of Bel Glade Street intersection.[1]	2B Gold 1 Gold 2	0	1,100′	1,000′
Blake Ln & Five Oaks Rd	Remain	2B Gold 1 Gold 2	2	1,300′	1,100′
Blake Ln & Oakton Crest Pl	Relocate to far side of Sutton Road intersection[1,3]	2B 466	5	900′	1,200′
Blake Ln & Edgelea Rd	Relocate to far side of Edgelea Road intersection[1,2]	2B 466	2	500′	1,100′
Blake Ln & Cyrandall Valley Rd	Relocate to far side of Hibbard Street intersection[1,2,3]	2B 466	0	1,700′	700′
Blake Ln & Gray St	Relocate to far side of Bushman Drive intersection[1,2,3]	2B	1	400′	900′
Blake Lane & Palmer St	Remove[1,3]	2B	0	700′	-
Jermantown Rd & Blake Ln	Relocate midblock stop to near side of Trevor House Drive intersection[1,5]	2B	0	500′	1,000′
Jermantown Rd & Borge St	Relocate to far side of intersection[2]	2B	1	1,000′	600′
Jermantown Rd & AT&T Driveway	Relocate stop to near side of intersection following signalization[5]	2B	1	-	-

[1] No crosswalk currently adjacent to the existing transit stop location.
[2] Move transit stop to the far side of the uncontrolled approach to reduce multi-threat crash risk. Ensure relocated stop has sufficient curb space without blocking intersection.
[3] Existing transit stop is closely spaced to upstream/downstream transit stops.
[4] Move transit stop to far side of the controlled crosswalk to encourage pedestrian compliance with the walk phase.
[5] Move transit stop to near side of the controlled crosswalk to encourage pedestrian compliance with the walk phase.
[6] Stop to remain with sidewalk improvements and proposed crosswalk addition on the west side of Kingsbridge Drive.

It should be noted that, in some locations on the corridor, right-of-way limitations pose a challenge to implementing more substantial infrastructure improvements. These locations include stops located on the east side of the corridor between Lindenbrook Street and Route 29. WMATA also requires that all relocations are required to include a 5-foot by 8-foot concrete boarding pad if not constrained by right-of-way.

5.3.5. Location-Specific Transit Stop Changes

The following section outlines the transit stop optimization recommendations for each intersection/segment of the study corridor.

5.3.5.1. Jermantown Road and AT&T Driveway

On the west side of the study corridor, the existing AT&T campus is in the process of redevelopment into a mixed-use community with retail, restaurants, and medium-density housing. As a result of the projected increase in motor vehicle trips, it is likely that the intersection with the existing driveway will become signalized. A highlight of the new development is multimodal access, so the traffic signal will also feature two new crosswalks and pedestrian signals. Depending on the final layout of the intersection, the transit stop on the westbound side of Jermantown Road may be better suited on the near side of the approach. Pedestrians looking to cross Jermantown Road into the new development from the stop will likely cross behind the bus in the crosswalk to access sidewalks into the development. Given the potential for high usage of these transit stops, an evaluation of the need for transit stop amenities should be considered with relocation. Figure 41 shows potential locations for the transit stops following installation of the traffic signal.

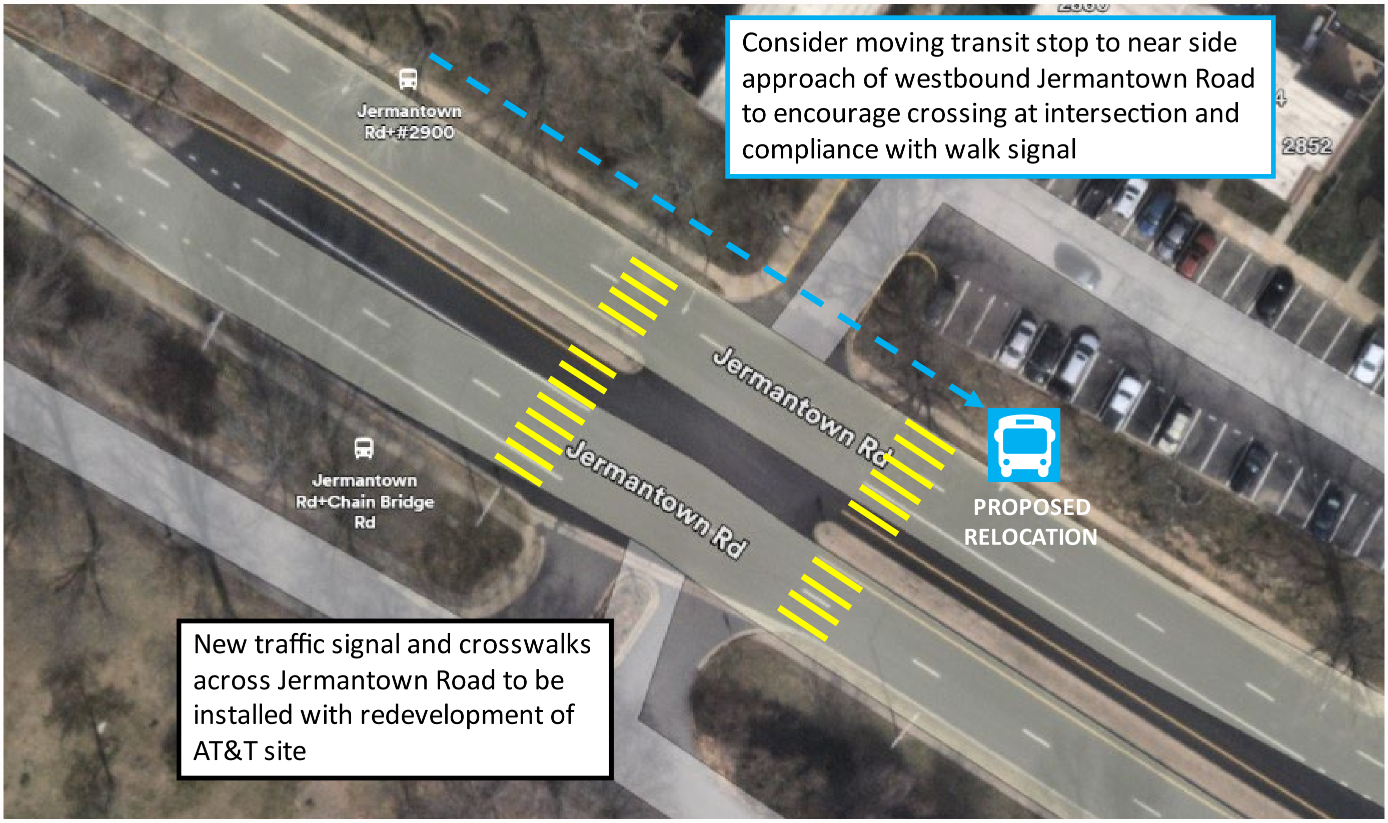

Figure 41. Potential transit stop changes at Jermantown Road and AT&T driveway.

Ultimately, the placement of the bus stops will depend on the final design of the intersection following the construction of the new mixed-use development.

5.3.5.2. Jermantown Road and Borge Street

The Jermantown Road and Borge Street intersection is uncontrolled on the Jermantown Road approaches and stop-controlled on the Borge Street approach. Since the crosswalks across Jermantown Road are uncontrolled at this location, this causes a multiple-threat crash risk for near side transit stops riders. For this reason, the stop on westbound Jermantown Road could be relocated to the far side of the intersection to encourage crossing behind the bus. This would allow for drivers approaching the intersection from the westbound direction to clearly see pedestrians crossing the left lane of traffic.

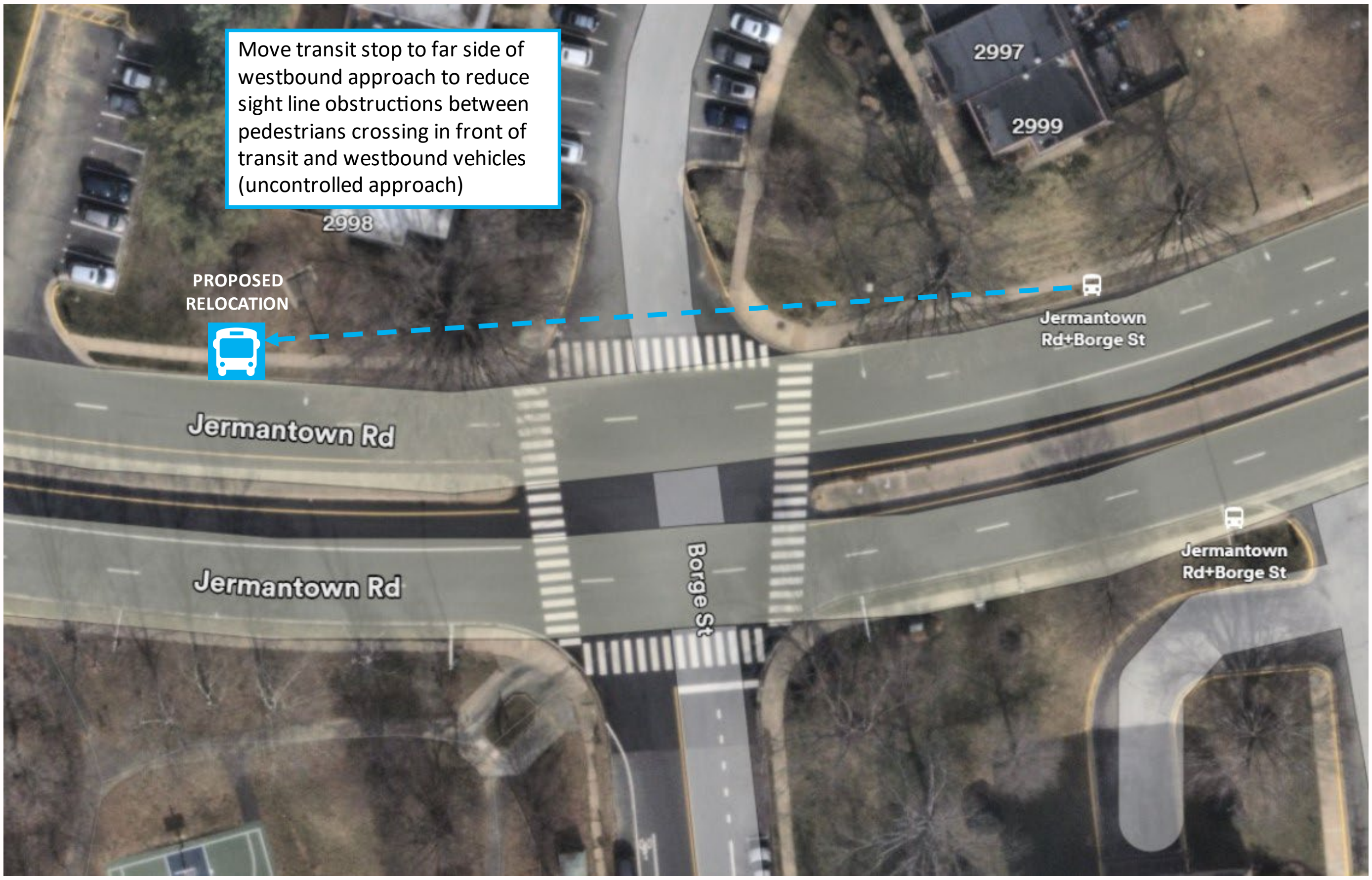

Figure 42. Potential transit stop changes at Jermantown Road and Borge Street.

5.3.5.3. Jermantown Road / Blake Lane and Trevor House Drive

Between Borge Street and Windwood Farms Drive/Palmer Street, there are currently three transit stops in each direction over a span of roughly 1,400 feet. One of the existing stops in the westbound direction is located midblock, although it is intended to serve the intersection of Blake Lane/Jermantown Road and Trevor House Drive. This midblock crossing does not have a crosswalk near the stop, as the closest marked crossing is roughly 300 feet away on the east side of the Trevor House Drive intersection. To discourage midblock crossings, the transit stop could be relocated to the near side of the westbound approach to Trevor House Drive. This would enable crossings at the intersection and compliance with the walk signal, as well as additional spacing between stops.

The current stop at Trevor House Drive in the eastbound direction also does not have a crosswalk directly adjacent. This means that pedestrians traveling to the community directly across Jermantown Road would have to cross the intersection three times (Trevor House Drive, Blake Lane – east side, Blake Lane – north side). If the transit stop remains in this location, it is recommended to add a crosswalk on the western leg of the intersection to provide a more direct crossing opportunity.

Lastly, the two transit stops at Windwood Drive and Palmer Street are closely spaced to the Trevor House Drive stops. These two stops could potentially be consolidated with options for riders at two adjacent transit stops, including Trevor House Drive or Gray Street / Bushman Drive. In the eastbound direction, the existing Windwood Drive transit stop is roughly 450 feet from the stop at Bushman Drive and roughly 550 feet from the stop at Trevor House Drive. Transit stops in the westbound direction are similarly close, with the existing transit stop at Palmer Street at roughly 300 feet from the stop at Trevor House Drive and roughly 600 feet from the relocated stop at Gray Street. Figure 43 demonstrates the proposed transit stop changes in the area.

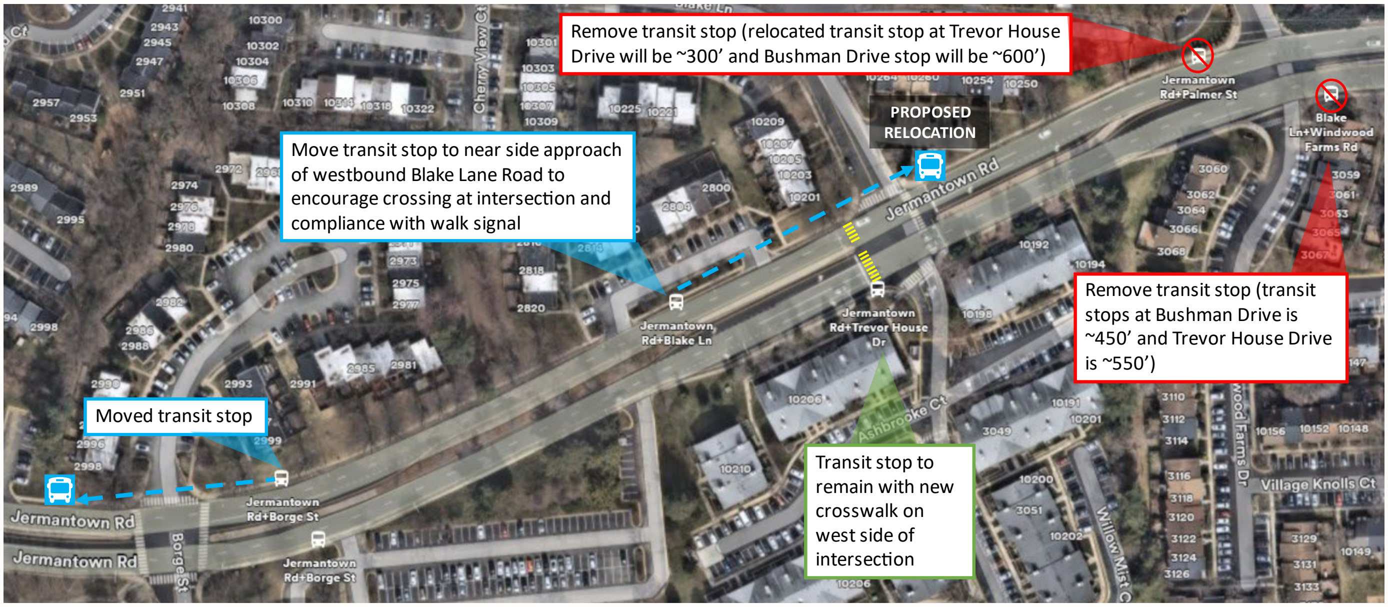

Figure 43. Potential transit stop changes between Borge Street and Windwood Farms Drive / Palmer Street.

5.3.5.4. Blake Lane and Bushman Drive / Gray Street

The intersection of Bushman Drive / Gray Street is also included in the engineering assessments as part of the Blake Lane RSA for geometric improvements and a new pedestrian crosswalk. Depending on the configuration of the roadway in this portion of the corridor, the crosswalk is likely to be supplemented with either a Rectangular Rapid Flashing Beacon (RRFB) or PHB. Fairfax County has already approved funding for the installation of an RRFB. Installing a new crosswalk with enhanced safety countermeasures could help increase pedestrian visibility, as well as driver awareness of the crossing. For this reason, the existing westbound transit stop on the far side of Gray Street could be relocated to the far side of Bushman Drive (Figure 44). This would allow alighting passengers to cross behind the bus in the new crosswalk enhanced with use of an RRFB or PHB.

The transit stop in the eastbound approach has not been relocated to the far side, as a crosswalk on the east side of the intersection is infeasible due to the private driveway. Additionally, the morning hours features a heavy number of right turning vehicles (170 vehicles between 7:30-8:30 am) onto eastbound Blake Lane, meaning that a bus stopped in the curb lane during this time could make it challenging for drivers to turn onto Blake Lane safely due to the threat of rear end crashes or angle crashes due to limited gaps in traffic heading eastbound.

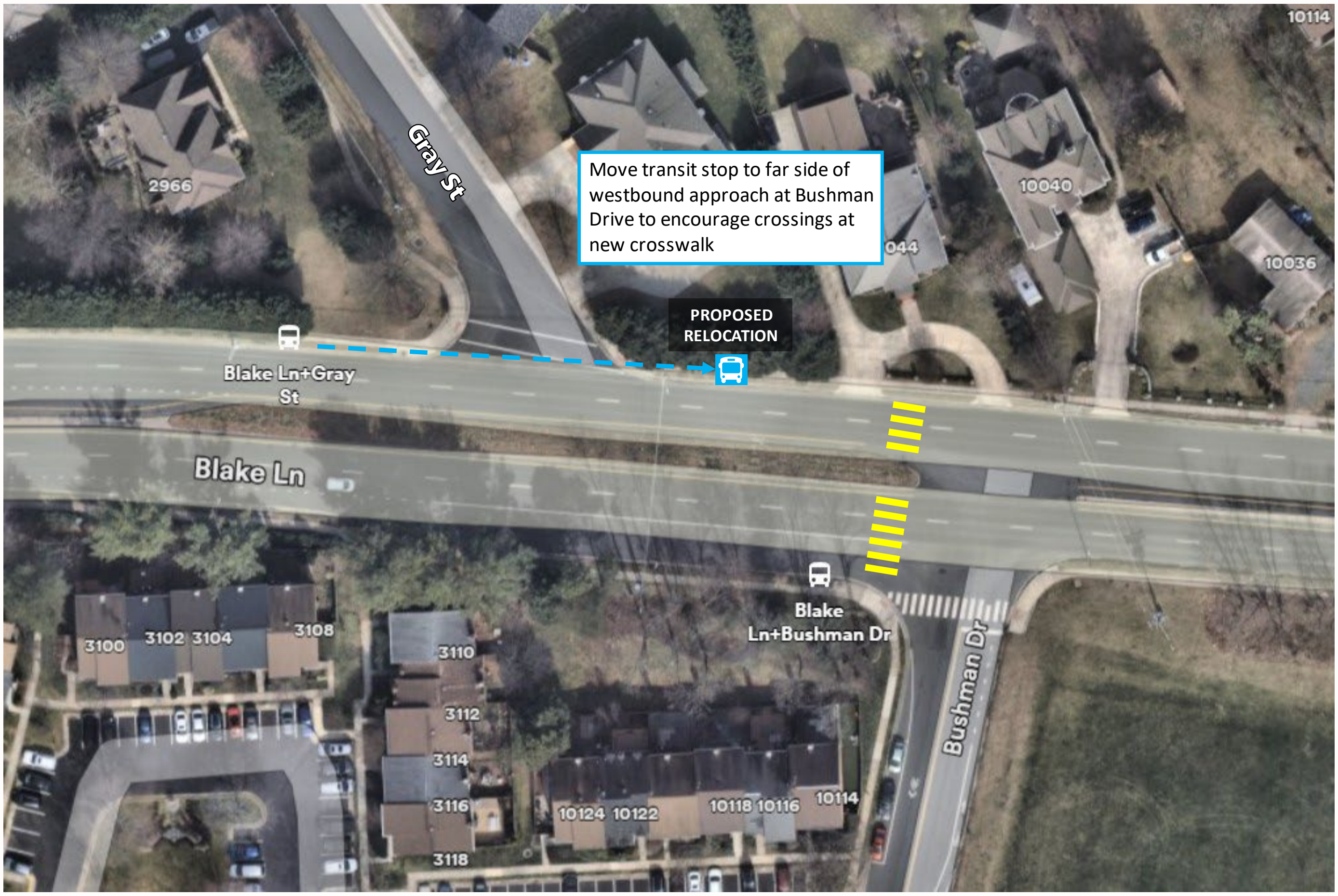

Figure 44. Potential transit stop changes at Blake Lane and Bushman Drive / Gray Street.

5.3.5.5. Blake Lane between Hibbard Street and Sugar Lane

There are currently transit stops in both directions of Blake Lane at Cyrandall Valley Road and Edgelea Road / Platten Drive, which are roughly 600 feet apart. The proposed distance between upstream and downstream stops with the new location at Hibbard Street would be 900 feet and 1,100 feet, respectively. Cyrandall Valley Road does not have a marked crosswalk on either side of the intersection, while the Edgelea Road / Platten Drive intersection only has a marked crosswalk on the western side. Potential changes to the transit stops in this part of the corridor include moving the Cyrandall Valley Road stops to the far side of each approach at Hibbard Street and moving the near side westbound stop at Edgelea Road to the far side. Additionally, the relocated bus stops should include new marked crosswalks on the east side of the Hibbard Street and Edgelea Road intersections. There is also a stop indicated in Google Maps on the far side of the eastbound approach to Sugar Lane; however, it appears that this stop has been recently removed. Figure 45 shows the changes to transit stops and new potential crosswalks on the mid-portion of the corridor. The crosswalks shown in Figure 45 are recommended with additional crossing enhancements with the relocation of the transit stops.

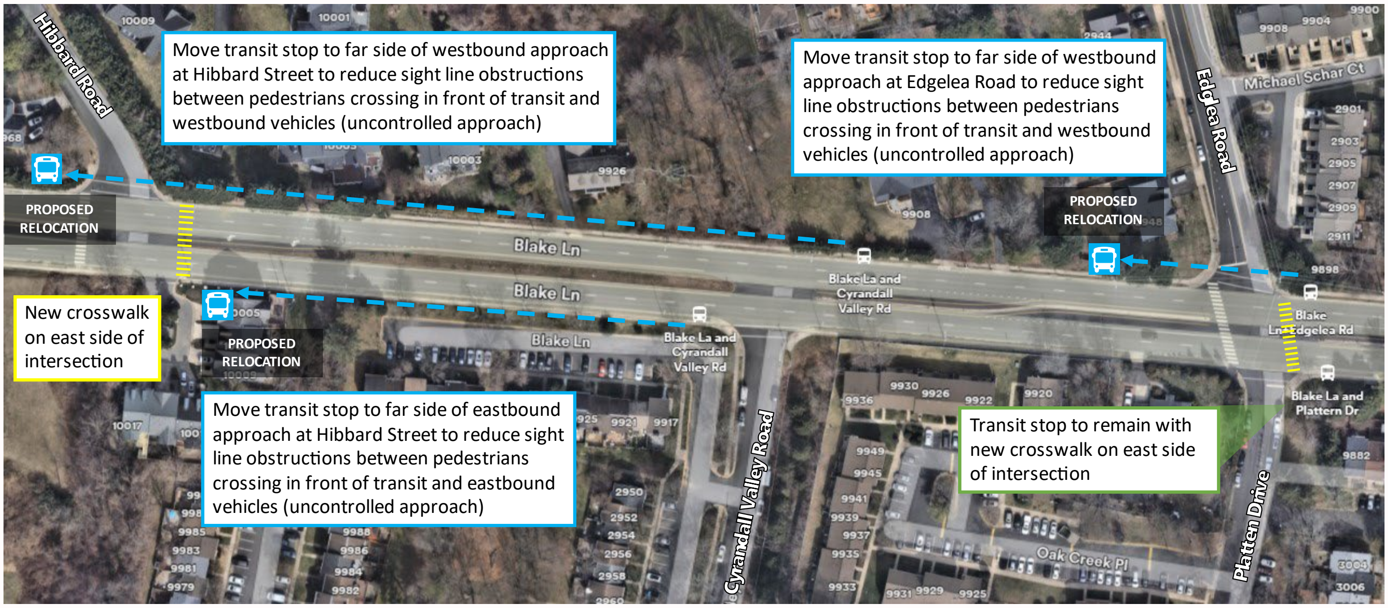

Figure 45. Potential transit stop changes between Hibbard Street and Edgelea Road/Platten Drive.

5.3.5.6. Blake Lane and Sutton Road

The intersection of Blake Lane and Sutton Road will be undergoing a redesign within the next several years (estimated construction 2025). Some of the changes to the intersection will include a crosswalk on the east side of the intersection, removal of the right turn slip lane, and connection to the I-66 trail. Transit stop locations should be reevaluated along with/following the reconstruction of the intersection. Currently, the eastbound transit stop is adjacent to crosswalk on the western side of the Sutton Road intersection, but the westbound transit stop is on the eastern side of the Oakton Crest Place intersection and not near a marked crosswalk. With this placement, transit riders who want to cross Blake Lane have three options: 1) they can cross directly from the the transit stop at Oakton Crest Place to the sidewalk/path leading into the townhomes on the south side of Blake Lane (this is mid-block and away from a marked crosswalk), 2) they can walk approximately 360 feet to use the existing marked crosswalk at Sutton Road (approximately 150 feet on each side of Blake Lane and roughly 60 feet across Blake Lane), or 3) they can cross at the intersection of Edgelea Road, which is roughly 1,000 feet to the west. Moving the westbound transit stop to the Sutton Road intersection reduces the inclination for pedestrians to cross away from a marked crosswalk and instead cross at the existing marked crosswalk at Sutton Road.

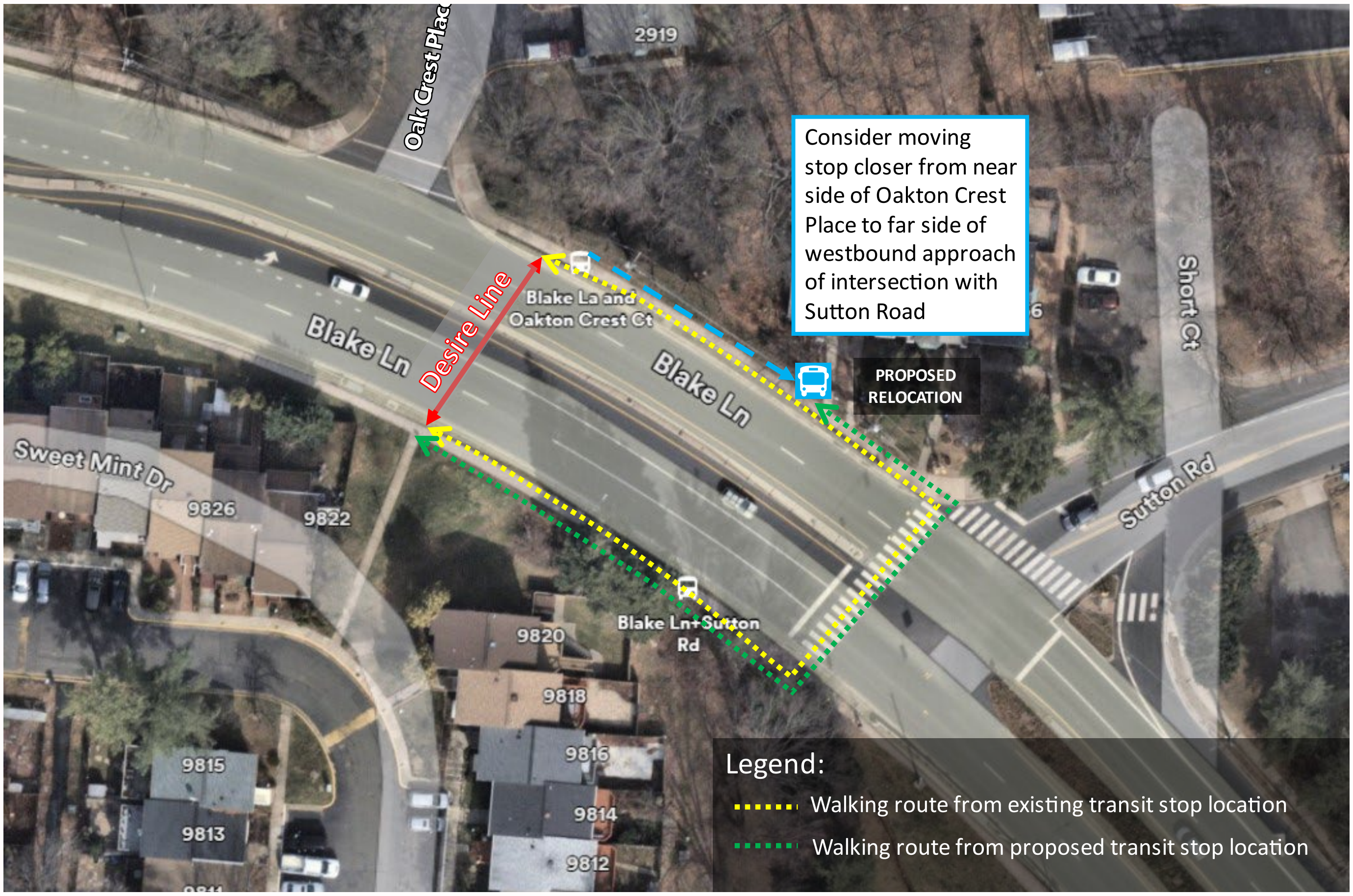

Figure 46. Potential transit stop changes at Blake Lane and Sutton Road.

5.3.5.7. Blake Lane and Five Oaks Road

Currently no changes are proposed to the transit stops at Blake Lane and Five Oaks Road. However, potential pedestrian safety improvements at the intersection have been recommended through the RSA report.

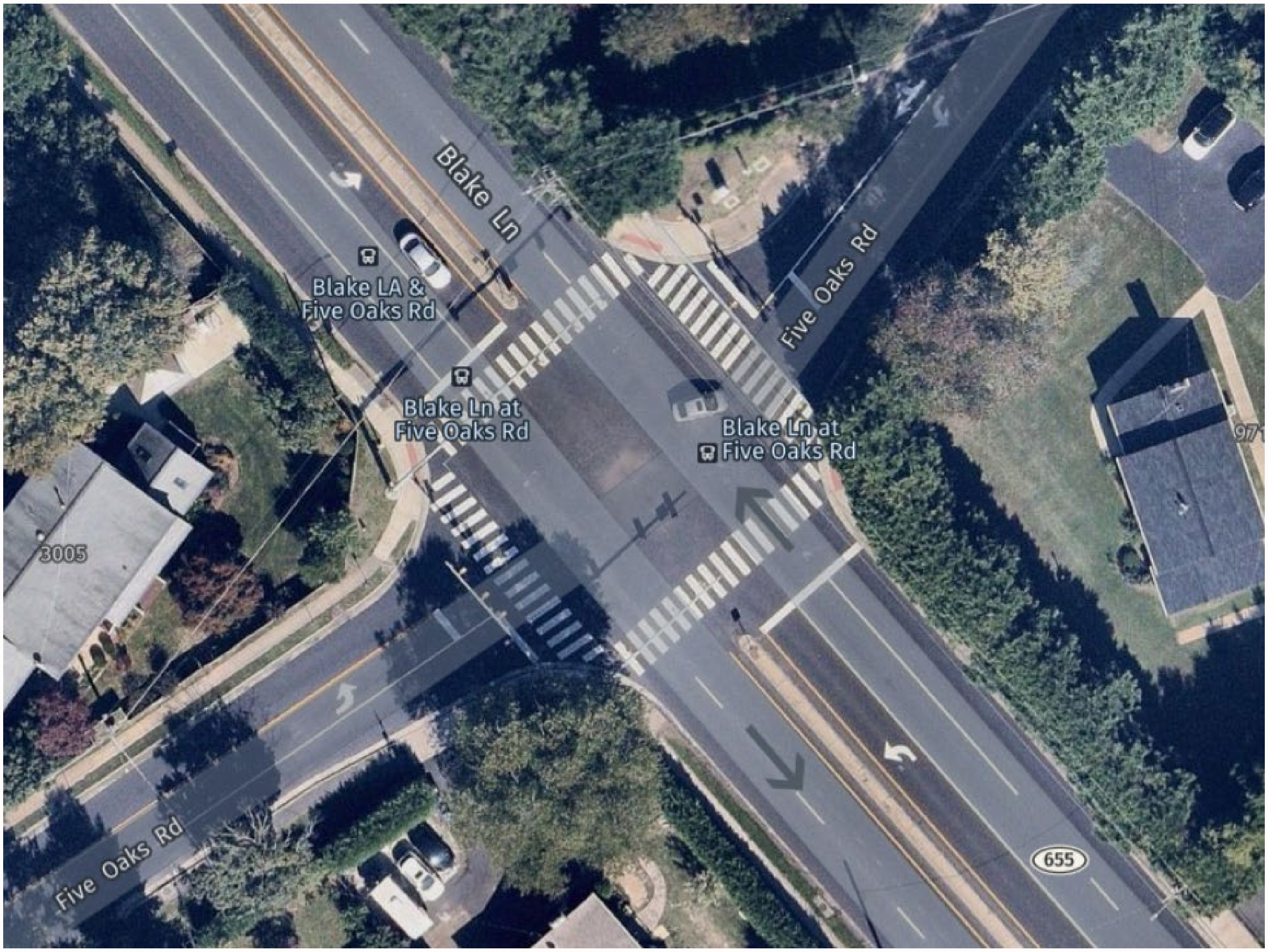

Figure 47. Existing transit stop placement at Blake Lane and Five Oaks Road.

5.3.5.8. Blake Lane and Bel Glade Street

The intersection of Blake Lane and Bel Glade Street has received funding for a new RRFB for the existing crosswalk on the northern leg of the intersection, crossing Blake Lane. However, the existing cross-section with four lanes is likely to remain due to high volumes (21,000-24,000 vehicles per day) on Blake Lane between Sutton Road and Route 29. This roadway configuration may mean that a PHB is more fitted for the crossing than an RRFB due to the high traffic volumes and number of lanes pedestrians are required to cross. Furthermore, a crosswalk on the east side of the intersection has a cross-section with only two lanes in each direction and no turn lanes, which also allows for a large pedestrian refuge space. If a crosswalk were added to the east side of the intersection, then the two eastbound stops, shown in Figure 48, could be consolidated to the far side of the intersection. The westbound transit stop should also be reviewed for relocation to the far side of the approach, as this is an uncontrolled crossing location with a multiple-threat crash risk for pedestrians crossing in front of a stopped vehicle.

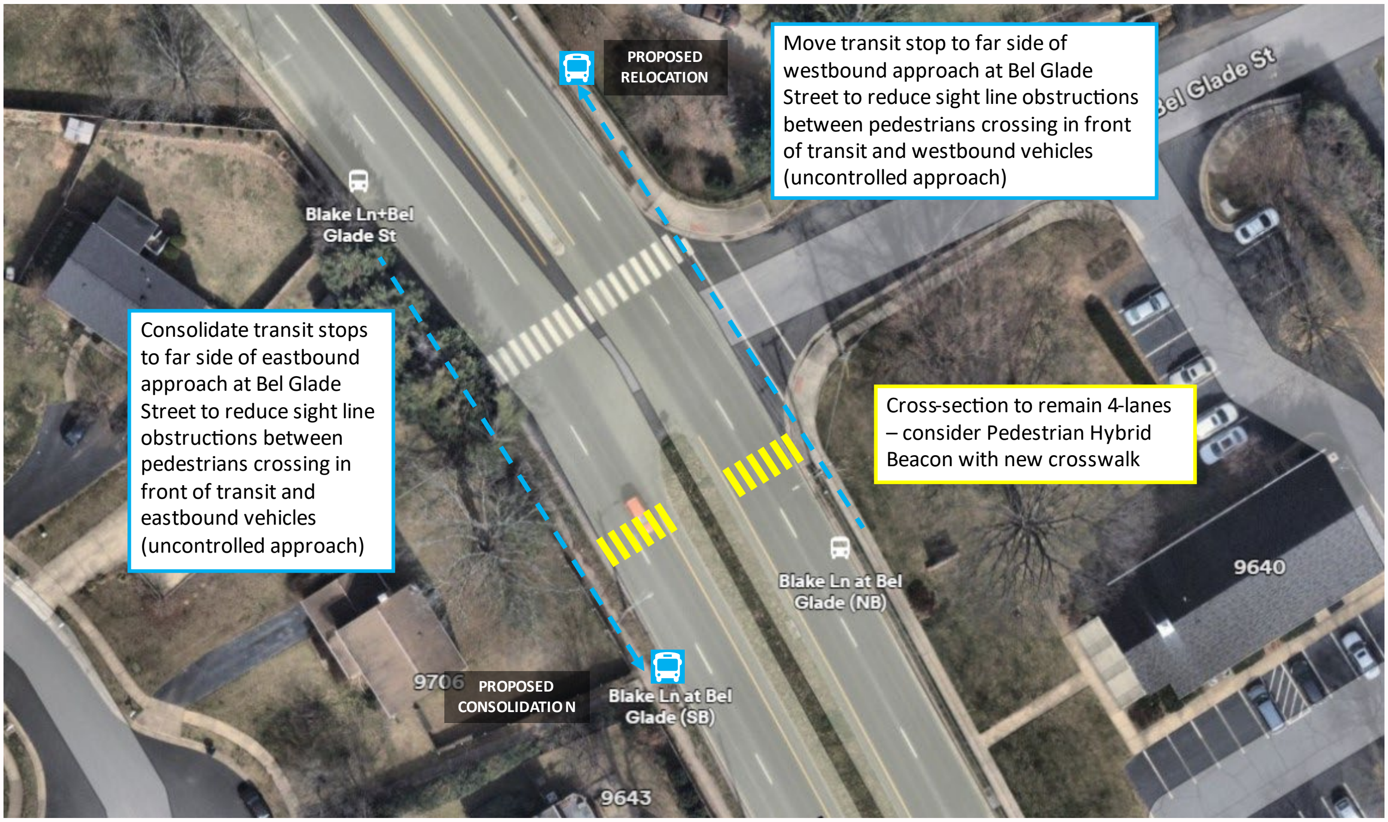

Figure 48. Potential transit stop changes at Blake Lane and Bel Glade Street.

5.3.5.9. Blake Lane between Lindenbrook Street and Route 29

The furthest east portion of the corridor approaches Route 29, which is a major route through the region that connects many suburban centers in Fairfax County and beyond. As a result, the context of Blake Lane changes, including service roads, narrow sidewalks, and limited crossing locations. This part of the corridor also experiences the most significant transit ridership. This combination of high transit usage and minimal pedestrian infrastructure poses challenges to locating transit stops. The RSA recommendations for this portion of the corridor are outlined in Figure 49. These include improvements to the existing pedestrian infrastructure, including additional separation between sidewalks and vehicle traffic, closure of access to Blake Lane, as well as new crosswalks at the existing signal of Kingsbridge Drive and possibly a PHB at a new crosswalk between Kingsbridge Drive and Route 29.

Currently, there are two sets of transit stops in this portion of the corridor, both located away from marked crosswalks. There are two crosswalks across Blake Lane in this section, spaced roughly 1,100 feet apart: one on the east side of the intersection with Kingsbridge Drive and another on the west side of the intersection of Route 29. Recommendations outlined in this assessment include do not include moving the Lindenbrook Street stops but do recommend they remain with pedestrian improvements such as widened sidewalks and the addition of a new crosswalk on the west side of the intersection of Kingsbridge Drive. A new crosswalk at Lindenbrook Street would not comply with guidance in VDOT IIM 384.1 if a new crosswalk were installed on the west side of Kingsbridge Drive. Additionally, a PHB would be highly recommended for any new uncontrolled crosswalk on this portion of Blake Lane. Given the close spacing and potential for a west side crosswalk at Kingsbridge Drive less than 300 feet away, crosswalk installation would not be recommended on either side of Lindenbrook Street across Blake Lane. Additionally, the stops just east of Sutherland Hill Court could be relocated near a new crosswalk across Blake Lane with the closure of access to Sutherland Hill Court.

Figure 49. Potential transit stop changes between Lindenbrook Street and Route 29.

5.4. Blake Lane and Bushman Drive

This section provides an engineering assessment of geometric design improvements at Blake Lane and Bushman Drive intersection, which builds off the discussion of including green paint, the inclusion of curb extensions, pedestrian crossing enhancements, and sight distance improvement at the intersection. The attached figures exhibit two potential options at the intersection of Blake Lane and Bushman Drive for conceptual design.

The following intersection improvements are highlighted from Figure 50.

- The lane widths for vehicles heading eastbound on Blake Lane and northbound on Bushman Drive were narrowed at the intersection.
- A curb extension is provided in the in the southwest corner, accompanied by a median refuge, effectively reducing the crossing distance for pedestrians and bicyclists across Blake Lane. A pedestrian hybrid beacon, high visibility crosswalk markings, and bike lane extension pavement markings are also proposed at the crossing to enhance driver awareness.
- By implementing the suggested curb extension, the crosswalk across Bushman Drive can be relocated northward. This shift enables the adjustment of the stop line, improving sight distance at the intersection. Furthermore, the separation of right and left turning movements for northbound Bushman Drive involves offsetting the northbound right turn stop line, enhancing visibility around left-turning vehicles.
- Enhancing bicyclist awareness on Bushman Drive at the intersection involves incorporating a southbound buffered bike lane with green paint. This not only separates cyclists from turning vehicles but also addresses the potential lack of anticipation by turning vehicles for bicyclists. Approximately 50 feet of on-street parking would need to be removed to accommodate the southbound buffered bike lane at the intersection. In the northbound direction, pavement markings define an extended mixing zone, emphasizing that right-turning vehicles must yield to northbound bicyclists.

Figure 51 highlights the following intersection improvements:

- The lane widths for vehicles heading eastbound on Blake Lane and northbound on Bushman Drive were narrowed at the intersection.
- A curb extension is provided in the in the southwest corner, accompanied by a median refuge, effectively reducing the crossing distance for pedestrians and bicyclists across Blake Lane. A pedestrian hybrid beacon, high visibility crosswalk markings, and bike lane extension pavement markings are also proposed at the crossing to enhance driver awareness.
- To minimize conflicts at the intersection, left turns from the northbound direction of Bushman Drive are restricted.
- A buffered bike lake is provided along the northbound direction of Bushman Drive. The southeast corner undergoes reconfiguration, incorporating corner islands to effectively separate cyclists from right-turning vehicles. This design not only enhances safety but also facilitates bicyclists crossing Bushman Drive parallel to the crosswalk, supported by bike lane extension pavement markings for improved visibility.
- A southbound buffered bike lane with green paint separates cyclists from turning vehicles and addresses the potential lack of anticipation by turning vehicles for bicyclists. Approximately 50 feet of on-street parking would need to be removed to accommodate the southbound buffered bike lane.

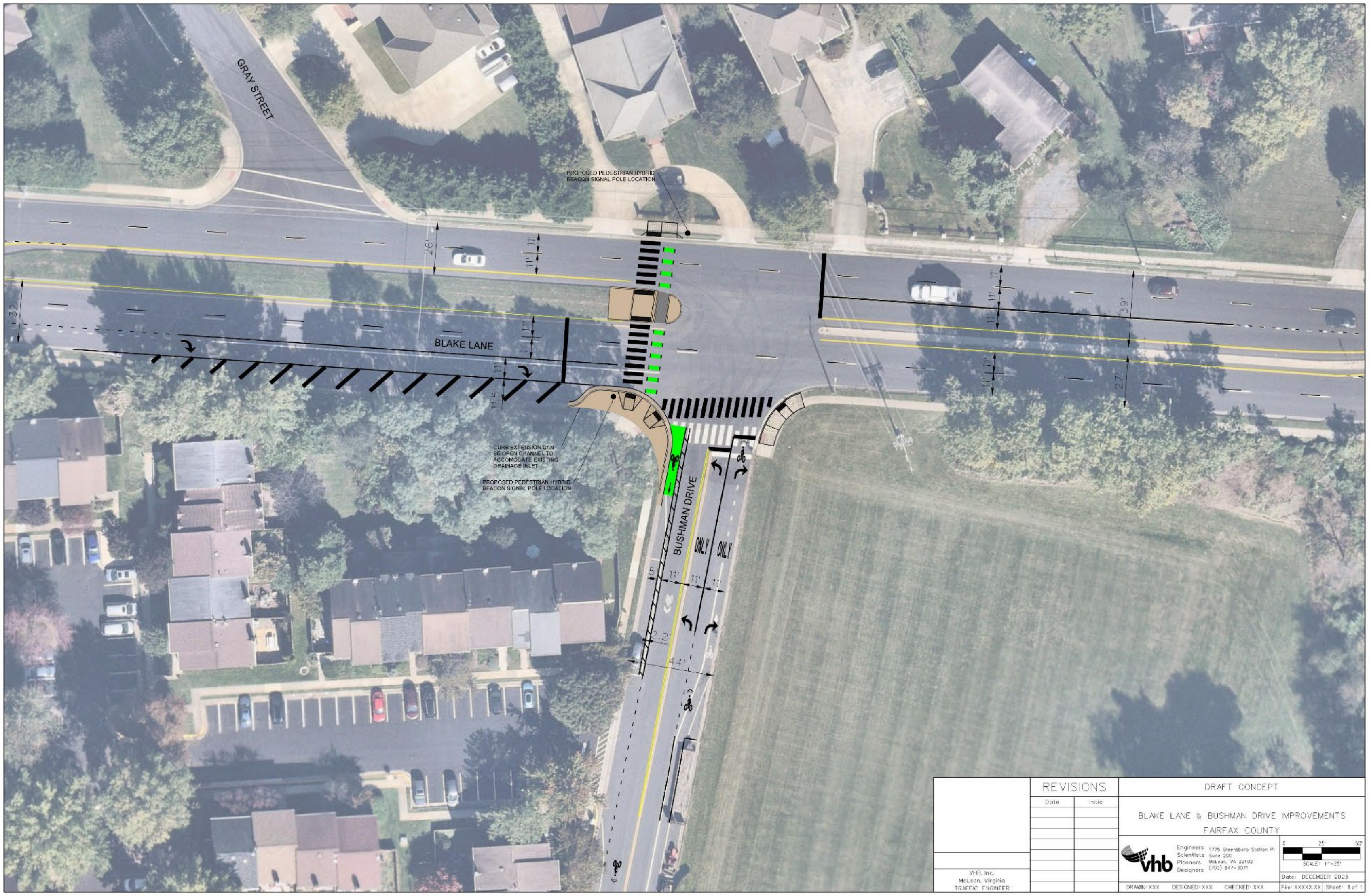

Figure 50. Blake Lane and Bushman Drive conceptual design-alternative 1.

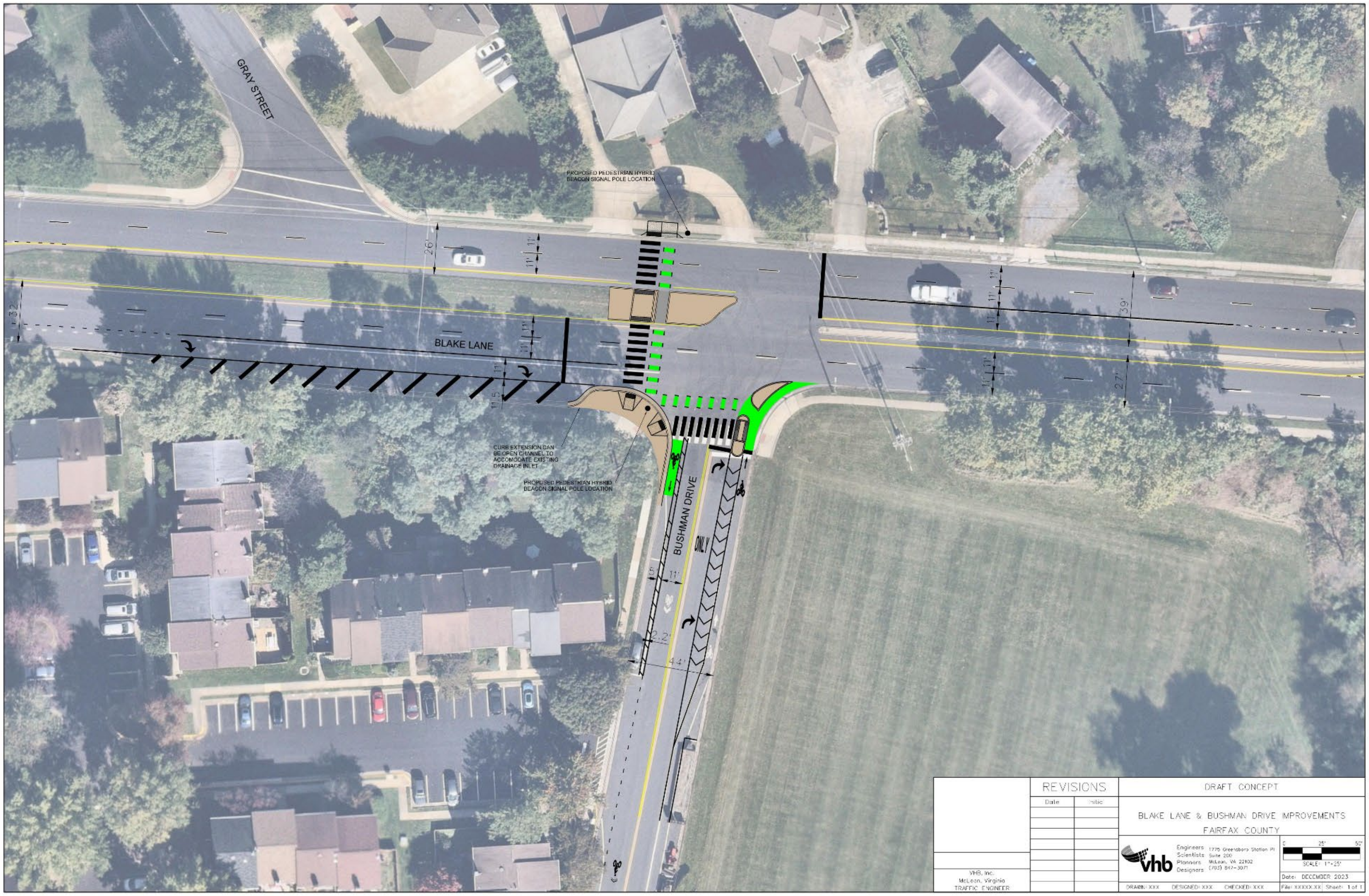

Figure 51. Blake Lane and Bushman Drive conceptual design-alternative 2.

5.5. Temporary Curb Extensions

Temporary curb extensions were identified as a potential safety improvement countermeasure and details on this are discussed earlier in Section 4.1.1. To address intersection skew, existing turning radius, and curb-to-curb width of the side streets, temporary curb extension concepts were developed for the following intersections:

- Blake Lane and Borge Street
- Blake Lane and Palmer Street
- Blake Lane and Gray Street
- Blake Lane and Hibbard Street
- Blake Lane and Edgelea Road / Platten Drive
- Blake Lane and Tipperary Pass

Temporary curb extensions were also recommended at the intersection of Blake Lane and Bushman Drive, however the concept for this specific intersection is included in the previous section. The temporary curb extensions utilize pavement markings and temporary curbing as a cost-effective, short-term solution to quickly implement improvements, allowing time for the design and funding of permanent treatments. The attached figures illustrate the proposed concepts for temporary curb extensions.

Figure 52. Temporary curb extension concepts on Blake Lane at the intersections with Borge Street and Palmer Street.

Figure 53. Temporary curb extension concepts on Blake Lane at the intersections with Gray Street and Hibbard Street.

Figure 54. Temporary curb extension concepts on Blake Lane at the intersections with Edgelea Road/Platten Drive and Tipperary Pass.

6. Conclusions

The study team has taken into consideration the existing conditions, community feedback, and identified safety concerns throughout the study area to develop a prioritized list of recommendations. Table 23 outlines a prioritized list of the various countermeasures proposed in this study based on the time needed to implement, along with the primary safety concern(s) that it addresses, installation cost range in $5,000 increments, and potential location(s).

Table 23. Summary of potential safety countermeasures, implementation time, and potential locations.

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Short	Centerline Hardening	Left-turning speeds in crosswalks	$5-10K per location	• Five Oaks Road approaches to Blake Lane • Edgelea Road approach to Blake Lane • Platten Drive approach to Blake Lane • Southbound Palmer Street approach to Blake Lane • Northbound Borge Street approach to Blake Lane
Short	Temporary Curb Extensions	Right-turning speeds in crosswalks	$10-20K per location	• Blake Lane and Bushman Drive • Blake Lane and Borge Street • Blake Lane and Palmer Street • Blake Lane and Gray Street • Blake Lane and Hibbard Street • Blake Lane and Edgelea Road • Blake Lane and Tipperary Pass
Short	Green Paint and Trail Crossing Signage	Bike crossings at intersections connecting to I-66 trail	$10K per location	• Jermantown Road and Borge Street • Blake Lane and Bushman Drive • Blake Lane and Platten Drive (with new bicyclist markings on Platten Drive)

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Short	Leading Pedestrian Interval (LPIs)	Driver yielding to crosswalk users at traffic signals	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road (pending intersection redesign) • Blake Lane and Five Oaks Road • Blake Lane and Kingsbridge Drive
Short	Pedestrian Recall	Pedestrian level of service at signalized intersections	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road (pending intersection redesign) • Blake Lane and Five Oaks Road • Blake Lane and Kingsbridge Drive
Short	Flashing Yellow Arrow for Left Turning Vehicles	Reduction of left-turning vehicle conflicts	$20K per signal improvement	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road • Blake Lane and Kingsbridge Drive
Short	No Turn on Red Restrictions	Reduction of turning vehicle conflicts with pedestrians	$5K per intersection	• Jermantown Road and Trevor House Drive • Blake Lane and Sutton Road • Blake Lane and Kingsbridge Drive
Short	Intersection Warning Sign	Kingsbridge Drive Intersection Safety	$5K per project	• Blake Lane and Kingsbridge Drive
Short	Vegetation Trimming	Sight distance challenges	$200 per crew hour	• Corridor wide
Short	Blake Lane and Sutton Road Signal Improvements	Pedestrian/ bicyclist crossing safety	As part of Vienna Metro Station Bicycle and Pedestrian Improvements ($10.5M)	• Blake Lane and Sutton Road
Short	Continue community-based education/	Speeding, pedestrian/ bicyclist safety	N/A	• Corridor wide

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
	engagement campaigns			
Intermediate	Red Light Extension Technology	Kingsbridge Drive intersection safety	$20K per intersection approach	• Blake Lane and Kingsbridge Drive
Intermediate	Reduction of Unwarranted Left and Right Turn Lanes	Pedestrian/ bicyclist crossing safety	$200-300K per lane closure	• Northbound Left-Turn onto Cedar Grove Drive • Westbound Left-Turn onto Platten Drive • Westbound Left-Turn onto Sugar Lane • Westbound Left-Turn into Townhomes at Hibbard Street • Eastbound Right-Turn onto Windwood Farms Drive • Eastbound Left-Turn onto Borge Street
Intermediate	Pedestrian Refuge Islands / New Crosswalks	Pedestrian/ bicyclist crossing safety	$30-80K per crossing (varies by size)	• [Relocated or Additional] South Crosswalk at Bel Glade Street • [Relocated] East Crosswalk at Edgelea Road / Platten Drive (pending intersection treatment) • [Relocated] East Crosswalk Hibbard Street • [New] West Crosswalk at Bushman Drive
Intermediate	Oakton High School Educational Campaign	Student safety, for drivers, pedestrians, and bicyclists	N/A	• Corridor wide
Intermediate	Transit Stop Optimizing	Pedestrian crossing safety and transit access	$40-60K per stop	• Corridor wide
Intermediate/ Long	Blake Lane between Lindenbrook and Route 29 Pedestrian Improvements	Pedestrian crossing safety and transit access	$5-10M per project	• Blake Lane between Lindenbrook and Route 29

Implementation Time	Improvement	Primary Safety Concern(s)	Installation Cost Range	Potential Location(s)
Intermediate/ Long	Blake Lane and Bushman Drive Geometric Improvements	Safety of All Road Users	$3-5M per project	• Blake Lane and Bushman Drive
Intermediate/ Long	Reduced Conflict Corridor	Safety of All Road Users	$1-3M per intersection	• Corridor wide
Intermediate/ Long	Roadway Reconfiguration / Complete Streets Project	Speed Management, Safety of All Road Users	$20M+	• Corridor wide

Some of these recommendations are dependent on implementation of other improvements before they can be advanced, such as the installation of new crosswalks and pedestrian refuge islands at locations where turn lanes could be removed. All of the suggested infrastructure improvements require additional engineering and assembly of plans for construction, funding for implementation, and coordination between appropriate entities (VDOT, Fairfax County, etc.)