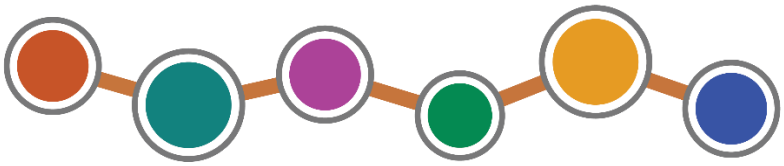
DUKE STREET
LAND USE PLAN



Transportation Study

October 2026

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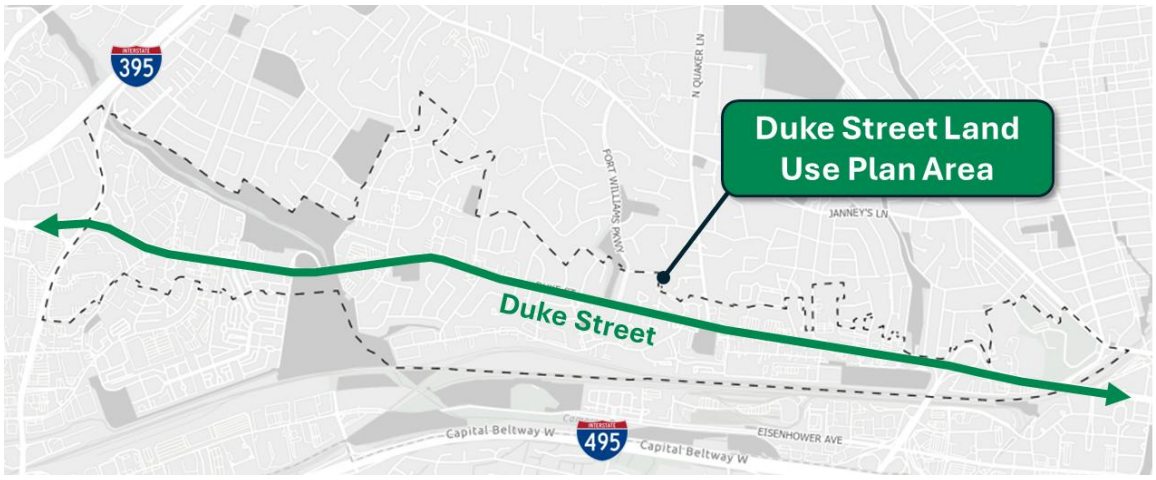
Executive Summary

STUDY PURPOSE AND BACKGROUND

The purpose of the overall Duke Street Land Use Plan is to update the corridor's long-term land use vision, which has not been comprehensively updated since 1992, to allow the City to proactively plan for change and prepare for challenges and opportunities.

Duke Street Land Use Plan Study Area



TRANSPORTATION STUDY

The Duke Street Land Use Plan Transportation Study was performed to evaluate existing and future mobility conditions along Duke Street and identify improvement strategies that can be advanced along with future development of the corridor. The effort included three separate but interconnected assessments and analyses:

- **Macro Transportation Assessment and Best Practices (Focus Level – Regional)**: A review of key regional transportation plans and studies as well as a review of transit case studies to provide context for the regional transportation trends that shape travel in and around the Duke Street corridor. This assessment aimed to identify proven strategies that can be employed to improve safety and access for people moving along active urban corridors such as Duke Street. This assessment also included an analysis of regional transportation travel patterns based on Replica, a transportation data tool that synthesizes multiple data sources to model how and why people travel.
- **Transportation Conditions Analysis (Focus Level – The Duke Street Corridor)**: An analysis to quantify and understand the long-term impacts of planned land use and transportation changes on Duke Street. The analysis followed a structured, five-step process to quantify planned development, estimate associated travel demand, assign that demand to Duke Street, project future year traffic volumes, and perform a capacity analysis that reflects planned changes to Duke Street.
- **Spot Analyses (Focus Level – Duke Street Intersections and Blocks)**: Based on the Transportation Conditions Analysis, a more "zoomed-in" analysis of transportation improvements at specific locations along Duke Street that took traffic volumes, signal timing, turning movements, and other detailed transportation data into account.

KEY TAKEAWAYS

The key takeaways from this series of assessments and analyses are:

At the Regional Level:

- Regional **population and employment growth** continues to increase congestion.
- The region faces **significant traffic in key corridors**, many of which pass through Alexandria.
- Flexible work patterns lead to **less concentrated traffic during peak periods** and **distribute congestion throughout the day**.
- Regionally, **cut-through traffic is an unavoidable reality**.
- These regional traffic trends put pressure on Duke Street today and will continue to in the future. Therefore, **it will remain important for the City to continue to make infrastructure improvements that better serve local travel for all modes of transportation** (automobile, transit, pedestrian, and bicycle).

Along the Duke Street Corridor:

- Duke Street between N Quaker Lane and Telegraph Road sees the most traffic today.
- ***Without*** new development, future traffic volumes along Duke Street will gradually increase.
- ***With*** new development, future traffic volumes will be nearly the same as today.
    - Properties in the Duke Street Land Use Plan area will **contribute generally the same amount of traffic to the network** compared to today. This is due to how residential land uses (a focus of the Duke Street Land Use Plan) generate traffic compared to existing commercial land uses (which characterize the corridor today).
    - Despite this, Duke Street's proximity to major regional roadways means it will **continue to carry a significant amount of traffic**, and any "freed-up" space risks getting used up by regional travel demand.
    - However, the City can mitigate the effects of regional traffic by continuing to advance improvements that **prioritize local trips** and **make Duke Street safer and easier to travel along and across** for all modes of transportation. This provides options for all users and prioritizes use of the corridor for more local traffic.
- While **most segments of Duke Street are projected to operate within capacity in the future**, the segment between Telegraph Road and N Quaker Lane remains constrained and is expected to operate near or above capacity regardless of future development.

At the Intersection and Block Level:

- **Delays at key Duke Street intersections are not anticipated to significantly grow** in the future. The Duke Street corridor is already serving a significant portion of regional travelers, and only minimal increases in regional traffic are projected by 2045.
- The development scenarios proposed in the Duke Street Land Use Plan **do not result in a significant increase in local trips or traffic volumes**, therefore the traffic challenges that need to be addressed along Duke Street in the future are comparable to today's challenges, including how to make traffic volumes, traffic speeds, and accessibility for people walking, biking, and using transit more aligned through improvements that center local travel needs over regional travel.

- In addition to physical infrastructure improvements for bus service, **the planned Duke Street Transitway will include corridor-wide improvements to roadway infrastructure along Duke Street**, with major improvements to accommodate people driving, walking, and biking.

Macro Transportation Assessment and Best Practices

The macro transportation assessment and best practices review was conducted to provide context for the regional transportation trends that shape travel in and around the Duke Street corridor and identify proven strategies that can be deployed to improve safety and access for people moving along this active urban corridor.

This assessment included a high-level review of key regional transportation plans and studies, as well as a case study review of peer regional agencies. This assessment also included analysis of regional transportation travel patterns based on Replica, a transportation data tool that synthesizes multiple data sources to model how and why people travel.

The macro transportation assessment revealed four key takeaways about regional traffic:

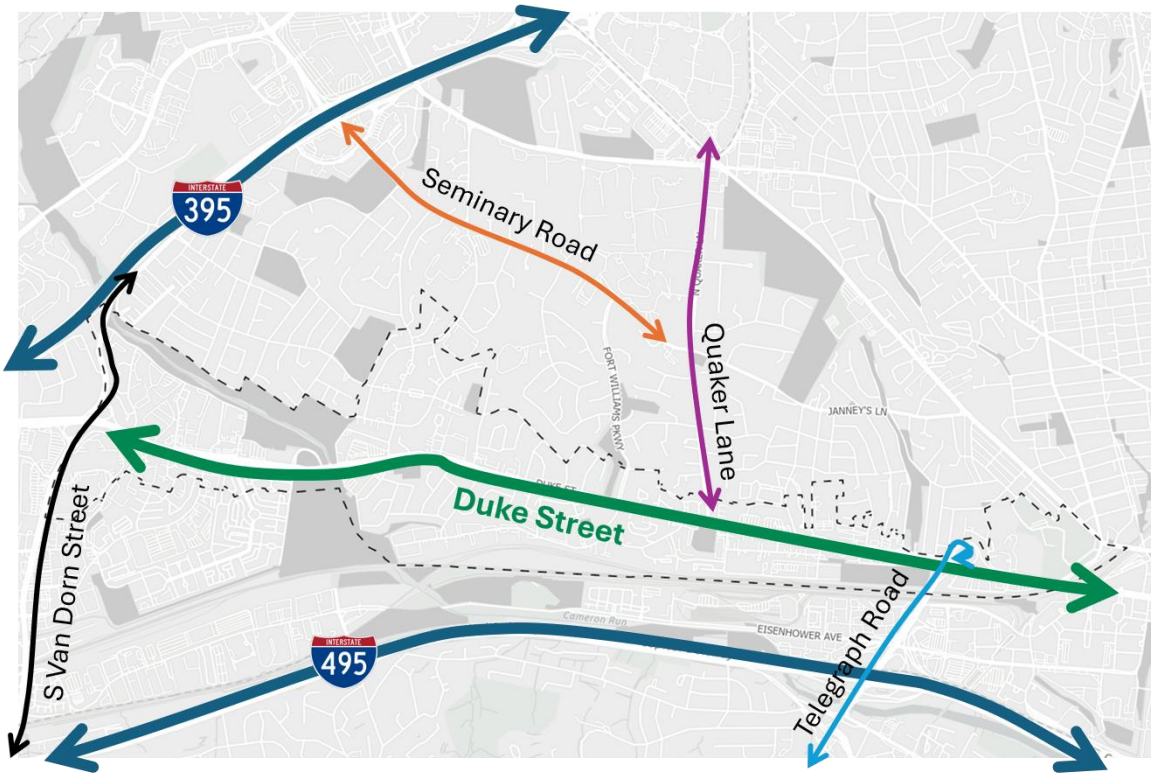
- Regional population and employment growth continue to increase traffic on major highways and local streets that are parallel to or connect to these highways. Duke Street, as a parallel or alternative corridor to I-495 and a connection to I-395, experiences the pressures of increasing regional traffic.
- As people work from home or have access to enhanced flexibility, traffic and congestion is becoming less concentrated to the traditional peak hours of travel, less predictable, and is distributed more sporadically throughout the entire day. Corridors like Duke Street experience more frequent instances of significant delay throughout the day.
- Corridors like Duke Street that serve the dual purposes of providing local access and regional mobility must be carefully managed to balance the safe and efficient movement of people and vehicles, while supporting broader economic and livability goals.
- Specific transportation countermeasures can be deployed to discourage regional travelers from using locally prioritized corridors or to encourage regional travelers to better align their behaviors by designing Duke Street as an “urban” street, with street trees, bike lanes, wide sidewalks and other integral street design measures to accommodate all users, rather than maintaining the street’s current design to simply move cars.

WHY THIS MATTERS FOR DUKE STREET

Understanding regional travel trends in Northern Virginia and throughout Alexandria is critical to interpreting how the Duke Street corridor operates today and how it may be affected by future growth.

Duke Street does not function in isolation. As shown in Figure **1**, it carries a unique mix of local neighborhood trips, transit riders, commuters, commercial and residential deliveries, visitors, and regional travelers moving between Alexandria, Fairfax County, Arlington County, Washington, DC, and the I-395 and I-495 interstate system and through connections with Telegraph Road and other regional roadways.

Figure 1: Duke Street's Relationship and Proximity to Major Regional Roadways and Highways



As future development and high-capacity transit investments occur along and near Duke Street, these regional travel trends will influence when and where congestion occurs, the reliability of transit, the safety and comfort of the walking and bicycling experience, how curbside access is managed, and how viable businesses are along the Duke Street corridor.

Understanding regional travel trends also provides clarity on Duke Streets's capacity—which refers to the number of vehicles that a street can serve—is shared between local and regional users. Capacity is a limited resource, and it is critical to evaluate the following questions:

- How is the existing capacity along Duke Street used to serve local and regional trips?
- How much excess capacity, if any, does Duke Street have today?
- How much excess capacity, if any, remains to serve future local development growth?
- What is the desired balance of local and regional trips along Duke Street today and in the future?
- How can capacity be rebalanced to achieve the desired goal of more local trips in both the current and future contexts?

Placing Duke Street within this broader transportation context helps separate corridor challenges that are driven by local land use and design decisions from those shaped by larger regional travel patterns. With this context, it is important for the City to better anticipate the traffic impacts of growth, identify strategies to manage multimodal transportation demand, and support a corridor that serves Alexandria's local needs first, while also acknowledging its role in the regional network.

REGIONAL TRANSPORTATION PLAN REVIEW

The regional transportation plan review was conducted to understand the regional and local travel trends that influence traffic conditions on Duke Street, in the City of Alexandria, in Northern Virginia, and in the broader Washington, DC, metropolitan region. The plan review identified the regional demographic, transportation, and land use pressures that the City must plan for, such as population growth, traffic congestion, and traffic diversion from congested corridors to local streets.

The review included recent documents that were published, approved, or adopted between 2021 and 2026. Multiple plans were reviewed to consider broader perspectives on how people travel today and will travel in the future. This review was informed by the following plans:

- **Alexandria Mobility Plan (adopted 2021):** The Alexandria Mobility Plan (AMP) is the City's strategic update to the 2008 Transportation Master Plan and guides transportation decision-making for the municipality. The plan, co-created with the community, establishes the agreed-upon policies, strategies, and implementation framework that the City uses to expand high-quality transportation choices, to improve access to key destinations, and to align mobility investments with broader goals for livability, equity, sustainability, safety, and quality of life.
- **Visualize 2050 (approved 2025):** Visualize 2050 is the National Capital Region Transportation Planning Board's (TPB)'s federally mandated long-range transportation plan for the Washington, DC, metropolitan region. The plan is updated every four years and evaluates how the region's planned transportation system will perform as population, household sizes, and employment demand continue to grow.
- **2024 Congestion Management Process Technical Report (published 2024):** The Congestion Management Process Technical is updated every two years by the National Capital Region TPB and describes the region's approach to monitoring congestion, evaluating transportation system performance, identifying congestion management strategies, and integrating those strategies into long-range planning. This report is used as a background document to inform the development of strategies in Visualize 2050.
- **2025 State of the Commute (published 2026):** The 2025 State of the Commute Technical Report is the National Capital Region TPB's triennial summary and evaluation of commuter behavior, telework patterns, mode choice, commute satisfaction, employer benefits, and awareness of commute assistance programs across the Washington, DC, metropolitan region. The primary goal is to help jurisdictions understand who is commuting to work, (including how, when, and why) to better inform transit reliability, roadway operations, transportation demand management (TDM) programs, and other jurisdictional strategies to manage commute traffic.
- **TransAction 2045 (adopted 2022):** TransAction is developed by the Northern Virginia Transportation Authority (NVTA) every five years. As required by State code, the plan serves as Northern Virginia's fiscally unconstrained long-range multimodal transportation plan. The plan evaluates existing and future transportation conditions and identifies the potential projects and investments needed to reduce congestion, improve connectivity, and expand travel choices.

Some of the reviewed documents are focused on the impact of commute trips exclusively, while others evaluate the impacts of travel for all purposes and across all hours of the day. Some of the reviewed documents are focused on Northern Virginia, while others apply a broader lens and consider the entire Washington, DC, metropolitan region. Some of the reviewed documents

identify future transportation investments in a fiscally constrained manner, highlighting only what can be done to address congestion with the resources at hand, while others are fiscally unconstrained. Because of these differences in scope, perspective, and forecasted outcomes, the specific findings of the reviewed documents are unique and may at times appear to conflict. With this as caveat, for the purposes of this macro transportation assessment, the reviewed documents, in total, reveal key takeaways about travel in the region and along Duke Street today and in the future.

Key Takeaways from the Regional Transportation Plan Review

- **Population and employment in the region are expected to grow locally and regionally, creating additional demand on the existing street network as a region**.
  - As documented in the TPB's Visualize 2050 Plan, the region could add approximately 1.2 million residents and 800,000 jobs by 2050, while maintaining a multimodal system that already supports more than 18 million daily trips.
  - The Visualize 2050 Plan notes that total daily vehicle hours of delay (VHD) in the Washington, DC, metropolitan region, which represents time spent in traffic in congested conditions, is predicted to increase 70 percent by 2050, with average minutes of delay per trip predicted to increase 46 percent by 2050, or from four minutes to six minutes of delay.
  - The Visualize 2050 Plan also noted that, under a fiscally constrained forecast, driving will remain the dominant mode for most trips in the region. Today, 41 percent of trips in the region are made by driving alone in a car; in 2050, this will drop to 38 percent. Despite a slight reduction in drive-alone rates, both the region and Duke Street will still face regional traffic pressures due to single occupancy vehicles.
- **Many residents, particularly in the region's inner and outer suburbs, will continue to face limited access to timely multimodal options to access work due to long travel distances and impracticality of travel times. Accordingly, single-occupancy vehicles will remain most people's mode of choice for commute trips**.
  - As documented in NVTA's TransAction 2045 Plan, even as the region continues to invest in Metro Rail, VRE, commuter bus, BRT, express lanes, and active transportation options, automobile travel remains dominant for many regional trips, particularly for longer-distance commuters coming from outer suburban areas. This creates continuous pressure on corridors that feed toward the metropolitan core, including the Beltway, I-395, I-495, I-95, U.S. Route 1, Seminary Road, King Street, and Duke Street.
- **Northern Virginia's transportation challenges are driven by the interaction of dispersed regional growth, concentrated employment centers, constrained river crossings, and multiple interstate bottlenecks, with significant single-occupancy vehicle demand on a limited number of east–west and north–south corridors**.
  - The TransAction Plan notes that population and employment in Northern Virginia is expected to increase by 23 percent and 33 percent, respectively, through 2045.

Arlington and Alexandria will have higher population growth while Loudoun and Prince William Counties[1] will have the highest employment growth.
- The TransAction Plan also notes that commute and non-commute trips in Northern Virginia are projected to grow by 31 percent and 27 percent through 2045, respectively.
- As a result, the TransAction Plan indicates that peak period delays along regional corridors such as I-95/I-395/U.S. Route 1 and I-495/the Beltway are forecasted to double.

- **Alexandria's land use planning intentionally concentrates growth in transit and amenity-rich locations and planned redevelopment areas so that new development can be served by high-capacity transit, walking, biking, and shorter local trips rather than relying primarily on added vehicle capacity.**
  - There are more opportunities for trips to be completed by walking, bicycling, and taking transit in the more developed inner suburbs and core of the region. Residents that live in these areas benefit from dense, mixed-use development, access to high-capacity transit, and a broad range of travel options. The Visualize 2050 Plan notes that in 2050, half of all trips in urban core communities (including Alexandria) are expected to be made using these modes.

What This Means for Duke Street

- Automobile travel will remain dominant for many regional trips, particularly for long-distance commuters coming from outer suburban areas. This creates pressure on Alexandria, I-495, and Duke Street.
- With or without redevelopment, traffic will increase slightly along the Duke Street corridor.
- Excess roadway capacity will be used, if not by local trips, then by regional travelers.
- Traffic delays are increasing regionwide. This means regional travelers should not expect to move through the Duke Street corridor at high speeds or without experiencing delays. This trade-off creates more opportunities for local, multimodal users along and across the corridor.
- Development patterns that support shorter, more locally serving trips and more mobility options can be a tool that prioritizes Duke Street for local trips.
- Duke Street's land use strategy has been evaluated through a multimodal lens and coordinated with City and regional investments in transit, managed lanes, and demand management.

[1] Central: Arlington, Alexandria; Inner: Fairfax, Falls Church, Fairfax City; Outer: Loudoun, Prince William, Manassas, Manassas Park.

COMPARABLE TRANSIT CASE STUDY

Metroway

The Metroway presents a case study in using dedicated transit infrastructure to improve mobility, serve an area planned for growth, and mitigate congestion. The Metroway is a 4.5-mile dedicated transitway running along U.S. Route 1 (Richmond Highway), physically separated from general traffic. This physical separation improves the reliability of transit service by keeping buses out of general traffic congestion, with reported travel-time savings that range from roughly 1.25 to 10 minutes per trip.

Metroway serves as evidence that investments in transit priority can deliver meaningful congestion mitigation along a busy arterial within the same jurisdictional context. **Figure 2** shows the annual average daily traffic along Richmond Highway between 2009 and 2025, based on data from the Virginia Department of Transportation (VDOT). Between 2009 and 2025, Richmond Highway experienced a significant decline in vehicles using the corridor each day—from approximately 41,000 to 21,000 vehicles per day, which equates to a 49 percent decline. Between 2020 and 2025, daily traffic volumes dropped by 20 percent even as other regional corridors experienced a post-pandemic increase in daily traffic volumes. This decrease in traffic along Richmond Highway has occurred despite the significant development in the Potomac Yard and Oakville Triangle neighborhoods. This demonstrates that density increases and redevelopment do not automatically result in additional traffic volumes added to the existing network. The Metroway, the City's strategic land use planning approach, and other investments made by the City and private sector have allowed the Richmond Highway corridor to serve more people and not more vehicles.

In contrast, as shown in **Figure 2**, in the five years between 2020 and 2025, daily traffic volumes along Duke Street increased by 16 percent, despite no significant increases in land use density or increases in the capacity of the roadway.

**Figure 2: Richmond Highway and Duke Street
Annual Average Daily Traffic (AADT) Comparison**



Source: Virginia Department of Transportation (VDOT)

The Metroway case demonstrates that dedicated, physically separated transit can deliver faster, more reliable service while supporting lower vehicle volumes on an arterial that provides both local and regional access. The most striking takeaway is the decoupling of growth from traffic: Richmond Highway absorbed new development, while its daily traffic volumes fell by nearly 50 percent since 2009. The Duke Street comparison reinforces that the decline in traffic is corridor-specific rather than a regionwide drop, strengthening the argument that transit investment and planned land-use change shifted travel behavior on Richmond Highway.

CUT-THROUGH TRIP ANALYSIS

It is critical to understand the degree to which travel through Alexandria and along Duke Street is "cut-through" (defined as regional trips that travel through the City without stopping) versus local and how development is reshaping that balance today and may continue to reshape it in the future.

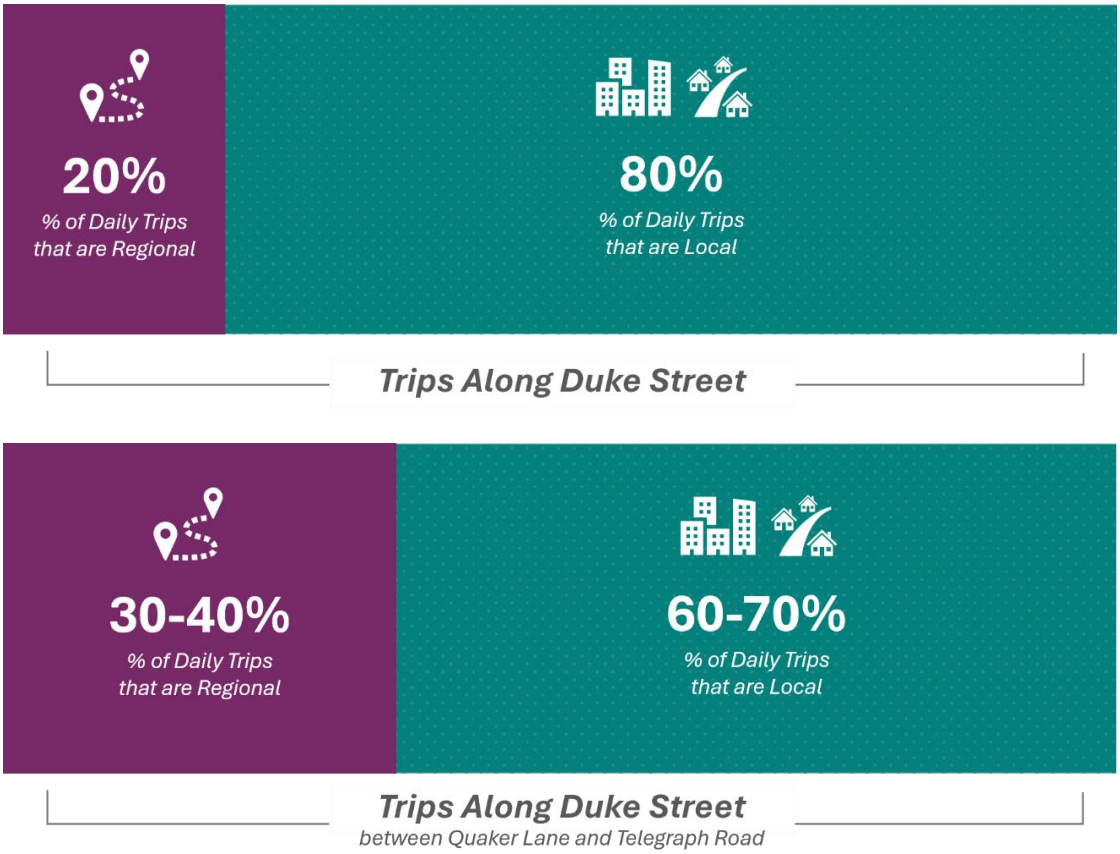
Cut-through traffic is not unique to Duke Street; it occurs throughout Alexandria as regional travelers use the City's street network to reach destinations within and beyond the region or to avoid congestion on major highways. However, Duke Street's location near I-395, I-495, Telegraph Road, N Quaker Lane, and other regional connections makes the corridor particularly susceptible to this travel pattern. This broader context is important to the Duke Street Land Use Plan because it helps distinguish traffic generated by development within the Plan area from traffic cutting through the corridor without a local origin or destination.

The following analysis focuses specifically on Duke Street to quantify the extent of cut-through travel and better understand how local and regional trips share the corridor today. This analysis draws on Replica travel data. Replica data is a synthetic, privacy-protected dataset that models daily travel behavior—showing where people go, when, and how—by combining multiple data sources and calibrating them to real-world counts to reflect actual mobility patterns.[2]

Duke Street Cut-Through Volumes

Focusing on the Duke Street corridor, cut-through volumes represent 20 percent of all trips along Duke Street and represent 30 to 40 percent of all trips in the segment of Duke Street between N Quaker Lane and Telegraph Road (**Figure 3**).

Figure 3: Duke Street Local–Regional Trip Balance



Source: Replica, Mid Atlantic Spring 2025 Dataset

[2] Replica was used to understand high-level regional trip origins, destinations, routes, and the local/regional trip balance. VDOT-based traffic volumes from the Duke Street in Motion Existing Conditions Report (2023) were used as the base for the corridor traffic volume analyses in the Transportation Conditions Analysis section. Because the datasets serve different analytical purposes, their total trip or traffic-volume estimates should not be directly compared.

More than half of all daily vehicles along N Quaker Lane (53 percent) are cut-through vehicles without an origin or destination in the City. Similarly, 43 percent of all daily vehicles along Telegraph Road are cut-through. These vehicles treat the segment of Duke Street from N Quaker Lane to Telegraph Road as a regional bypass rather than a local street.

Replica also includes prior years of data, which allows for an analysis of how traffic trends are changing over time. As shown in **Table 1**, between 2019 and 2025, daily traffic along Duke Street (between Telegraph Road and N Pickett Street) has increased by approximately 5,800 vehicle trips—a 7 percent increase from about 78,100 to 83,900 trips per day. These trends confirm that Duke Street is increasingly serving as a regional corridor for commuters and travelers bypassing other routes, which has significant implications for local congestion and neighborhood livability.

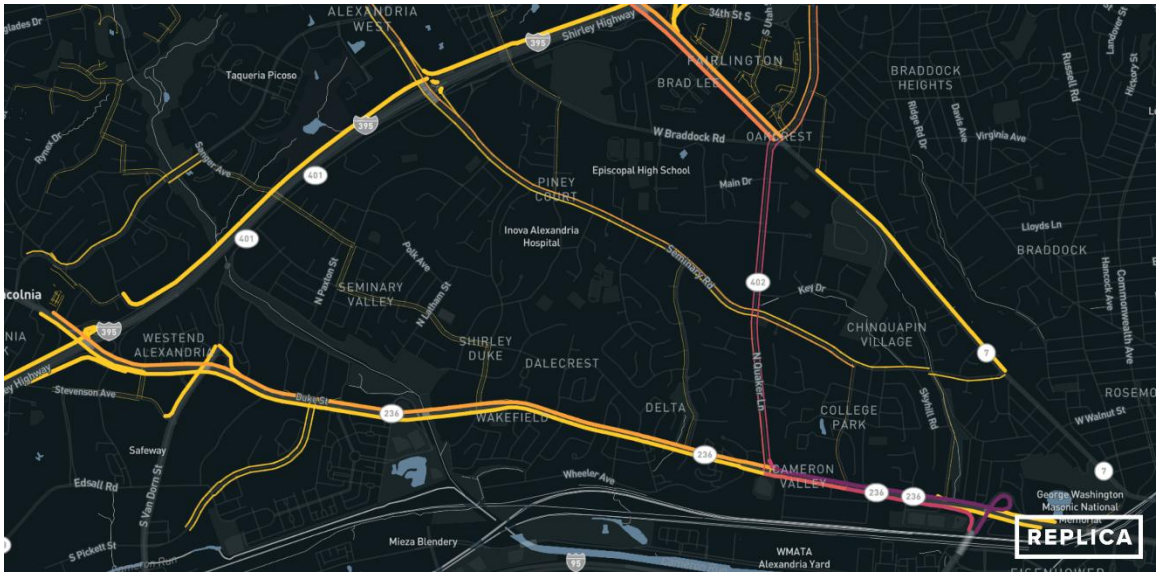
Table 1: Duke Street Cut-Through Analysis:
N Quaker Lane to Telegraph Road (2019 to 2025)

Trip Statistics	2019	2025	Difference
Total Trips	78,100	83,900	+5,800
Cut-Through Trips	13,200	16,600	+3,400
Cut-Through as % of Total	16.9%	19.8%	+2.9%

Source: Replica, Mid Atlantic Fall 2019 and Spring 2025 Datasets

Figure 4 shows that regional trips spill onto neighborhood connectors—including Yale Drive, N Quaker Lane, Fort Williams Parkway, and Cambridge Road—illustrating how cut-through traffic affects streets beyond the main arterials. A destination analysis of the daily cut-through trips that use Duke Street shows that these trips have diverse destinations, with the heaviest concentration of trips ending in Arlington, Washington, DC, and the Huntington neighborhood in Fairfax County (**Figure 5**).

Figure 4: Duke Street Cut-Through Trip Segment Analysis

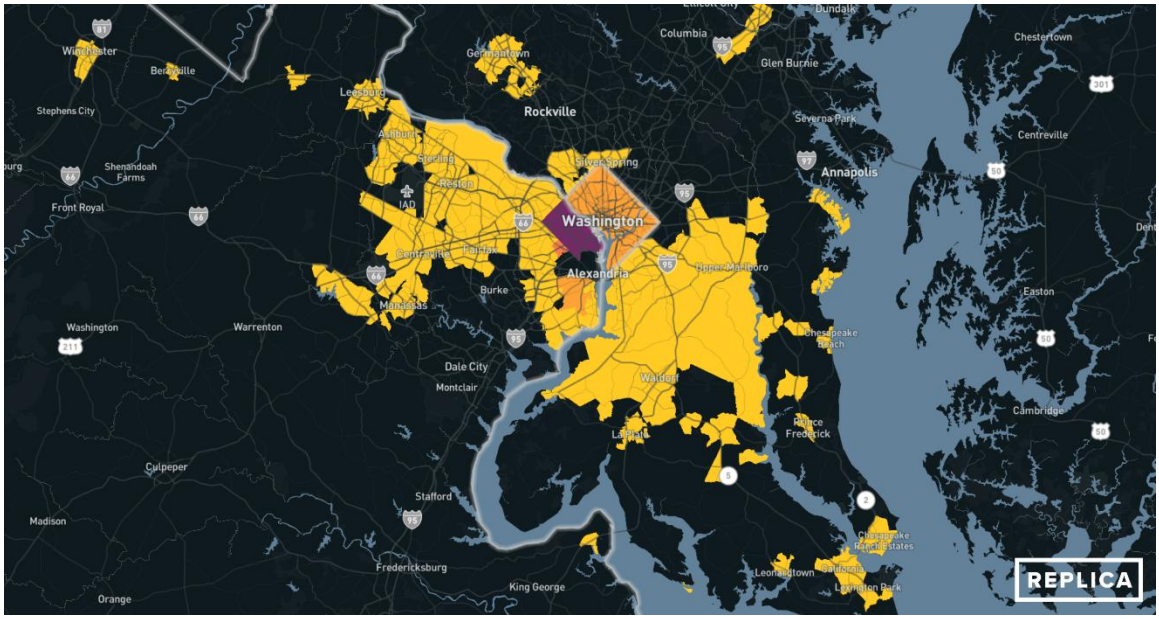


Daily Trips Along Each Segment

1 1400 2800 4200 5600 7000 8400 9710

Source: Replica, Mid Atlantic Spring 2025 Dataset

Figure 5: Duke Street Cut-Through Trip Destination Analysis



Daily Trips Ending in Each Location

1 600 1200 1800 2400 3000 3600 4210

Source: Replica, Mid Atlantic Spring 2025 Dataset

The Replica analysis appears to suggest that the primary reason that vehicles cut through Duke Street is to avoid real or perceived congestion and slow down along I-395 and I-495.

The I-495/I-395 interchange is typically congested on weekdays primarily due to people traveling to work and/or school. When traffic speeds drop substantially at and around the interchange, navigation apps actively reroute drivers through Alexandria's local street grid as a strategy to avoid delay. Similarly, I-495 near the Woodrow Wilson Bridge is typically a bottleneck for drivers traveling eastbound toward Maryland or westbound into Virginia. These drivers frequently encounter heavy back-ups on I-495 near the bridge; thus, regional commuters cut through Duke Street access routes such as Telegraph Road or U.S. Route 1. For travelers heading north into Washington, DC, or south toward Woodbridge, I-395 is a daily bottleneck. Commuters who are aware of the potential slowdowns leave the interstate early, using Duke Street and N Quaker Lane to maneuver through the City and region.

N Quaker Lane provides a connection to Duke Street from Seminary Road, Route 7, and I-395 via Shirlington Circle. Using Seminary Road or VA Route 7 (aka Leesburg Pike) to connect to N Quaker Lane and Duke Street allows motorists to "cut the corner" and avoid the southwest portions of I-395 and I-495.

Other trips appear to be traveling from, to, or through Annandale, the City of Fairfax, Chantilly, and areas farther west using U.S. Route 50, Main Street, and Little River Turnpike.

Regional Cut-Through Analysis Takeaways

This analysis underscores the reality faced by the Alexandria community every day—that cut-through traffic is a major, citywide issue. Corridors like Duke Street must contend with the pressures of these cut-through movements because they offer real or perceived travel time advantages and allow regional travelers to avoid other congested facilities.

While Duke Street functions as an important regional connector today, and will continue to in the future, the addition of more local-serving, mixed-use, transit-oriented development can rebalance corridors like Duke Street away from disproportionately serving regional cut-through traffic, supporting the broader strategy of land use being one of many levers for managing congestion.

Understanding how much traffic on Duke Street is regional versus local provides important context for the next level of analysis, which evaluates whether planned development will materially change future traffic conditions along the corridor.

Transportation Conditions Analysis

The transportation conditions analysis seeks to quantify and understand the long-term impacts of planned land use and transportation changes on Duke Street. The planned land use changes identified in the Duke Street Land Use Plan (DSLUP) and planned transportation changes and assumptions used in the Duke Street in Motion (DSIM) study were the baseline underlying assumptions used in this analysis.

The analysis follows a structured, five-step process, illustrated in **Figure 6**, which quantifies planned development, estimates associated travel demand, assigns that demand to Duke Street, projects future year traffic volumes, and performs a capacity analysis that reflects planned changes to Duke Street.

The following sections describe the process and results of each step:

Figure 6: Transportation Conditions Analysis Process



WHY THIS MATTERS FOR DUKE STREET

Duke Street is one of Alexandria's most important east–west corridors. Understanding how planned changes to Duke Street and surrounding land use impacts travel conditions will help the City prepare for change and to engage in dialogue with stakeholders and the public.

The transportation analysis found that planned development is expected to result in a net decrease in travel demand in the Duke Street corridor by 2045, largely driven by a shift from higher-trip-generating commercial uses to residential uses that generate fewer trips.

While most segments of Duke Street are projected to operate within capacity in both scenarios, the segment between Telegraph Road and N Quaker Lane remains constrained and is expected to operate near or above capacity regardless of development conditions.

This analysis establishes a corridorwide understanding of future conditions and informs subsequent, more detailed hotspot analyses to further diagnose localized operational issues.

QUANTIFYING DEVELOPMENT

The first step in the transportation conditions analysis process quantifies future development by creating an inventory of planned land use changes in the corridor and translating them into measures of dwelling units, square footage, and population change.

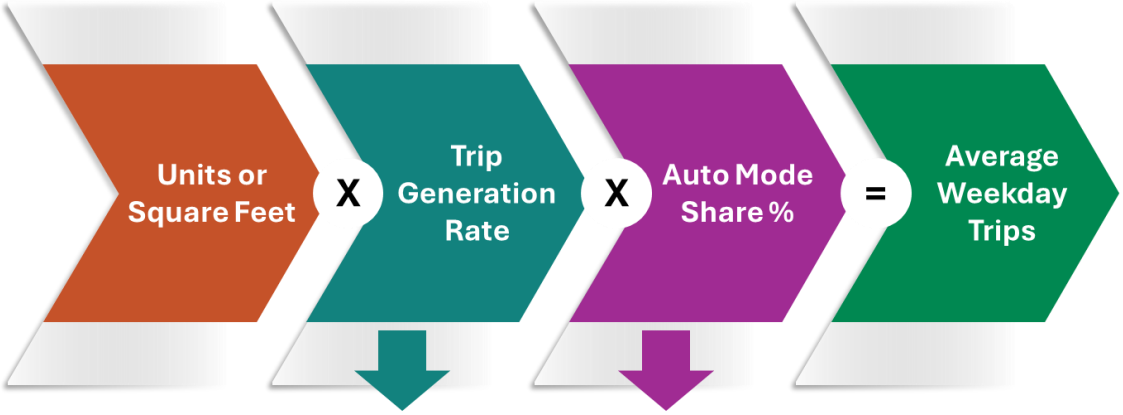
Future Land Use

Future 2045 land use data for the Duke Street corridor was compiled from the City of Alexandria's Duke Street Land Use Plan, planned developments in the Metropolitan Washington Council of Governments (MWCOG) travel demand model and supporting redevelopment information for identified development sites within the study area. The estimated amount of total development in the study area over the course of the Plan's horizon (through 2045) is set to increase by more than 2,000,000 square feet.

TRIP GENERATION

Trip generation, as illustrated in **Figure 7**, takes the estimates of dwelling units for residential uses or square footage for nonresidential uses from the previous step and multiplies them by trip generation rates obtained from the Institute of Transportation Engineers' (ITE) Trip Generation Manual, 12th Edition, which establishes the expected number of daily trips produced by different land use types. An auto mode share factor is subsequently applied to account for the proportion of trips made by vehicle, recognizing that not all trips occur by car. The result is an estimate of average weekday vehicle trips generated by each land use.

Figure 7: Trip Generation Methodology



LAND USE	AUTO MODE SPLIT
Residential	50%
Retail	65%
Office	65%
Fire Station	100%
Hospital	85%

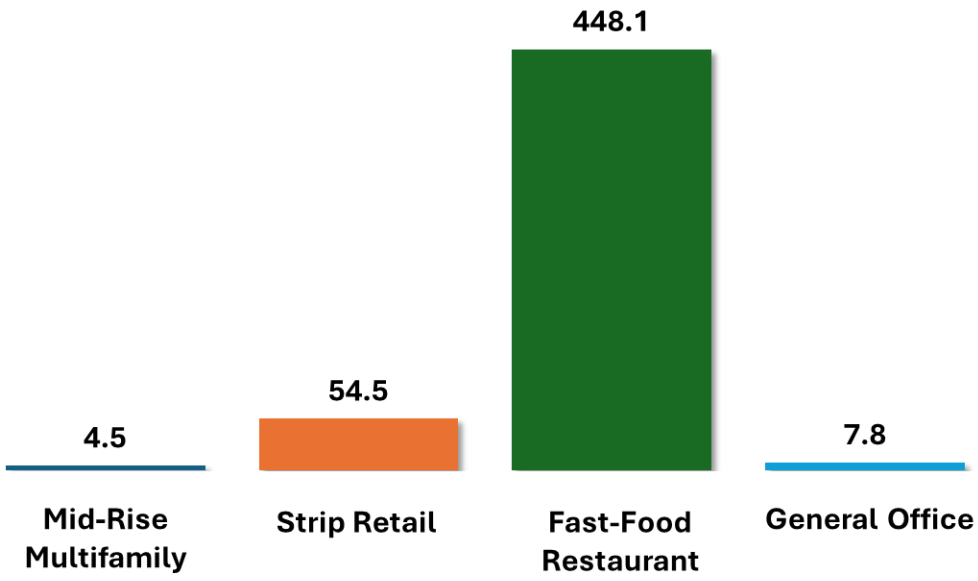
Source: Landmark Mall Redevelopment Multimodal Traffic Study

It is important to note that commercial land uses generate significantly more trips than residential uses, as illustrated in **Figure 8**. These average weekday trips generated for each type of land use provides context to why the Duke Street Land Use Plan area is expected to see a reduction in trips by 2045.

Residential buildings generate traffic because people travel to and from where they live—but the number of trips is generally limited and predictable:

- **Households make a small number of trips per day**: Residents typically leave home in the morning (for work, school, or errands) and return in the evening. That means most traffic is tied to regular daily routines.
- **The same people are making trips**: Unlike stores or restaurants that can attract hundreds or thousands of visitors throughout the day, residential buildings primarily serve the same group of people. This results in fewer trips overall compared to commercial uses.
- **Trips are spread across many destinations**: Residents travel to a variety of places—jobs, schools, shops, and services—rather than all going to one location, which helps distribute traffic across the network.
- **Location and options matter**: In walkable, transit-accessible areas, more residents may choose to walk, bike, or use transit, which reduces the number of vehicle trips overall.

Figure 8: Examples of Average Weekday Trips per 1,000 Square Feet of Development



Source: ITE Trip Generation, 12th Edition

Calculating Future Trips

To calculate future trips, each development was assigned an ITE Trip Generation land use code based on the land use type. Trip ratios, or the number of daily vehicle trips that each development is anticipated to generate based on the size and scale of development, are shown in **Table 2** and **Table 3.** The trip ratios shown in these two tables are directly sourced from ITE guidance and do not reflect additional adjustments. Adjustments that were considered as part of this analysis included a higher likelihood of people traveling by walking, bicycling, or public transit and a higher likelihood of people visiting multiple destinations as part of a single vehicle trip.

Table 2: Future Trip Ratios for Land Uses to be Added

ITE Use Code	Daily Trips per Dwelling Unit
210 (Single-Family Detached Housing)	9.09
215 (Single-Family Attached Housing)	6.57
220 (Multifamily Housing [Low-Rise])	6.21
221 (Multifamily Housing [Mid-Rise])	4.46
222 (Multifamily Housing [High-Rise])	4.54
223 (Affordable Housing)	4.81

Table 3: Existing Trip Ratios for Land Uses to be Redeveloped

ITE Use Code	Daily Trips per 1000 Square Feet
840 (Automobile Sales [New])	27.84
880 (Pharmacy/Drugstore without Drive-Through Window)	90.08
820 (Shopping Center [>150k])	36.39
944 (Gasoline/Service Station)	172.01
930 (Fast Casual Restaurant)	225.89
929 (High-Volume Fast-Food Restaurant)	653.22
912 (Drive-in Bank)	98.85
712 (Small Office Building)	14.39
575 (Fire and Rescue Station)	0.48
710 (General Office Building)	7.83
610 (Hospital)	10.70
560 (Church)	6.78
732 (United States Post Office)	319.08
110 (General Light Industrial)	3.60
943 (Automobile Parts and Service Center)	16.60
170 (Utility)	12.29
150 (Warehouse)	1.38

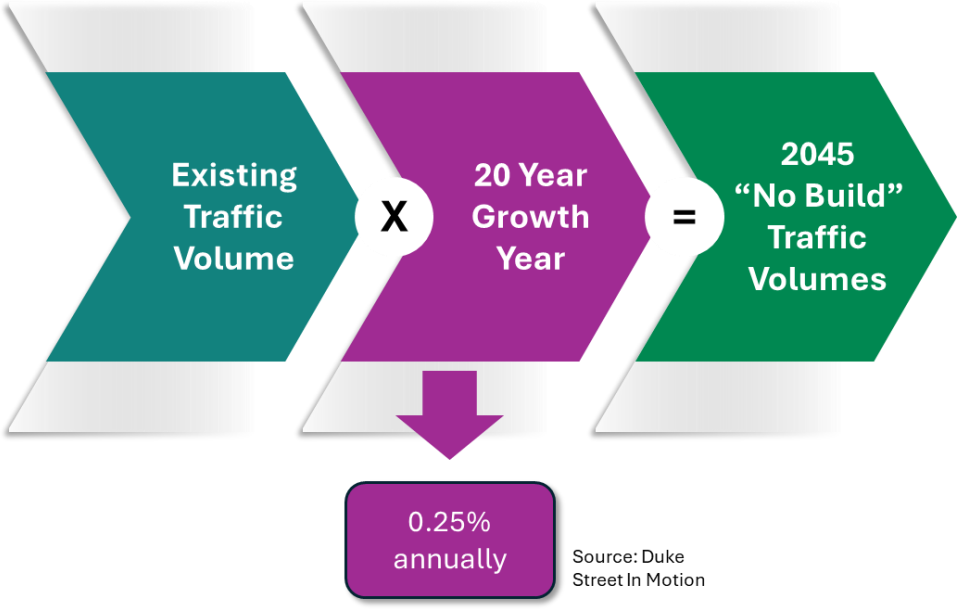
FUTURE-YEAR TRAFFIC VOLUMES

Future-year traffic volumes were estimated under two scenarios to understand how the proposed development in the Duke Street Land Use Plan may affect traffic along the corridor. Both the 2045 "No-Build" (a future ***without*** the proposed Duke Street Land Use Plan development) and 2045 "Build" (a future ***with*** the proposed Duke Street Land Use Plan development) scenarios assume that the planned Duke Street Transitway improvements are in place, allowing the analysis results to focus on the effects of proposed future development.

"No-Build" Traffic Volumes

Future-year No-Build traffic volumes are calculated to determine what traffic along Duke Street will look like ***without*** the proposed development in the Duke Street Land Use Plan, but ***with*** the planned Duke Street Transitway improvements in place. As illustrated in **Figure 9**, this is achieved by estimating "background traffic," future trips with neither a beginning or end in the study area, by growing existing (2023) volumes[3] to the 2045 future build-out year using a 0.25 percent annual growth rate, which is comparable to the growth rate assumed in the previous Duke Street in Motion study.

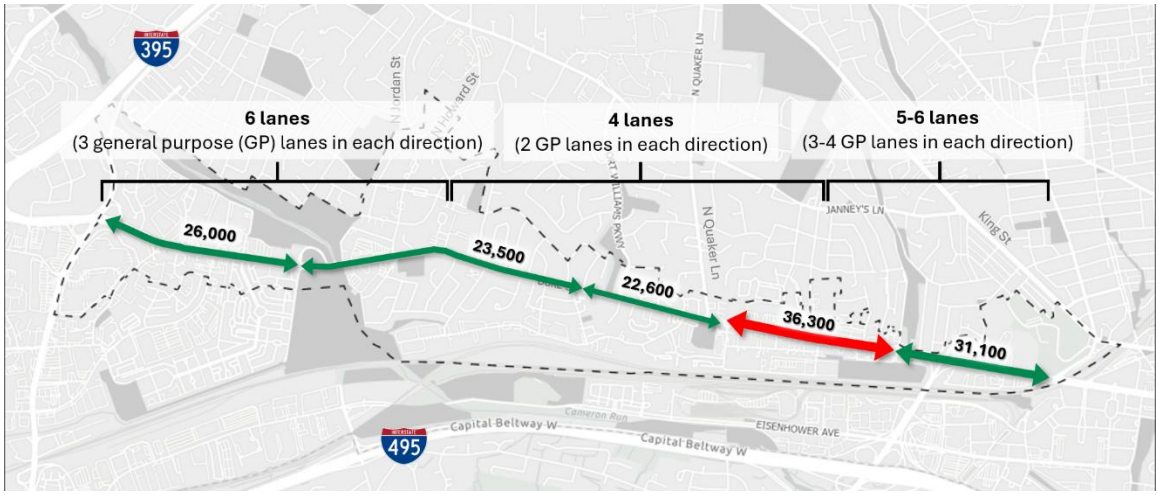
Figure 9: Future-Year No-Build Traffic Volumes Calculation



[3] Existing traffic volumes are sourced from the City of Alexandria's Duke Street in Motion Existing Conditions Report (2023)

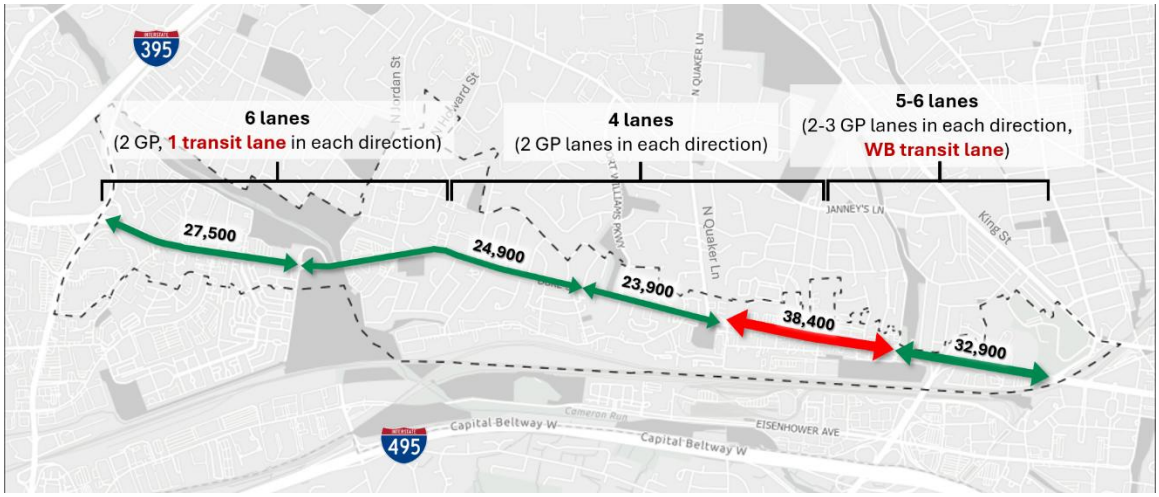
Figure 10 shows existing traffic volumes on Duke Street and **Figure 11** shows 2045 No-Build traffic volumes. Existing Duke Street traffic volumes vary from 22,600 to 36,300 vehicles per day, with the largest amount of traffic occurring on the segment of Duke Street between N Quaker Lane and Telegraph Road. As shown in **Figure 11**, 2045 No-Build traffic volumes on Duke Street range from 23,900 to 38,400 vehicles per day, representing an increase over existing conditions.

Figure 10: Existing (2023) Traffic Volumes



Source: Duke Street in Motion Existing Conditions Report (2023)

Figure 11: No-Build (2045) Traffic Volumes



"Build" Traffic Volumes

Future-year Build traffic volumes are calculated to determine estimated traffic along Duke Street ***with*** the proposed development in the Duke Street Land Use Plan and includes the planned Duke Street Transitway improvements. As shown in **Figure 12**, 2045 Build traffic volumes are calculated by adding the projected future trips generated by the projected future development to the 2045 No-Build traffic volumes.

Figure 12: Future-Year Build Traffic Volume Calculation

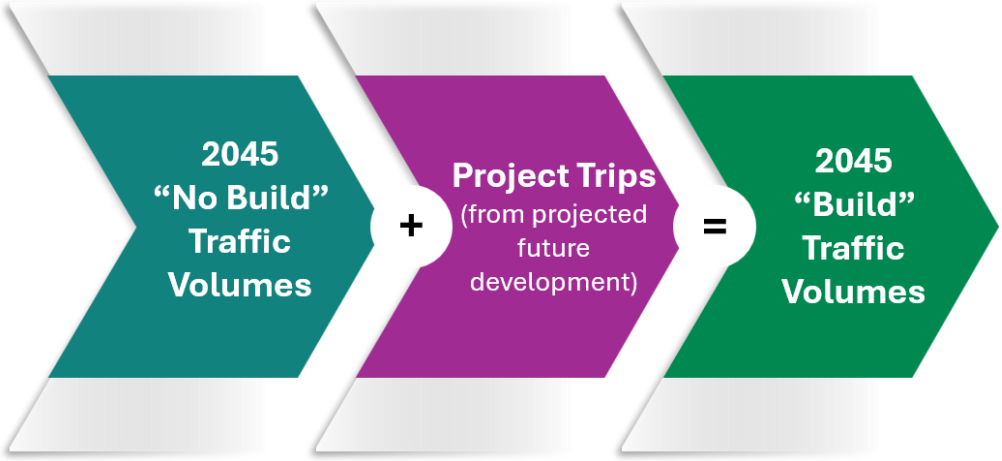


Figure 13 shows that estimated 2045 Build traffic volumes on Duke Street range from 23,700 to 38,200 vehicles per day. The segment between N Quaker Lane and Telegraph Road remains the segment of the corridor that sees the most traffic.

Figure 13: Future Year (2045) Build Traffic Volumes

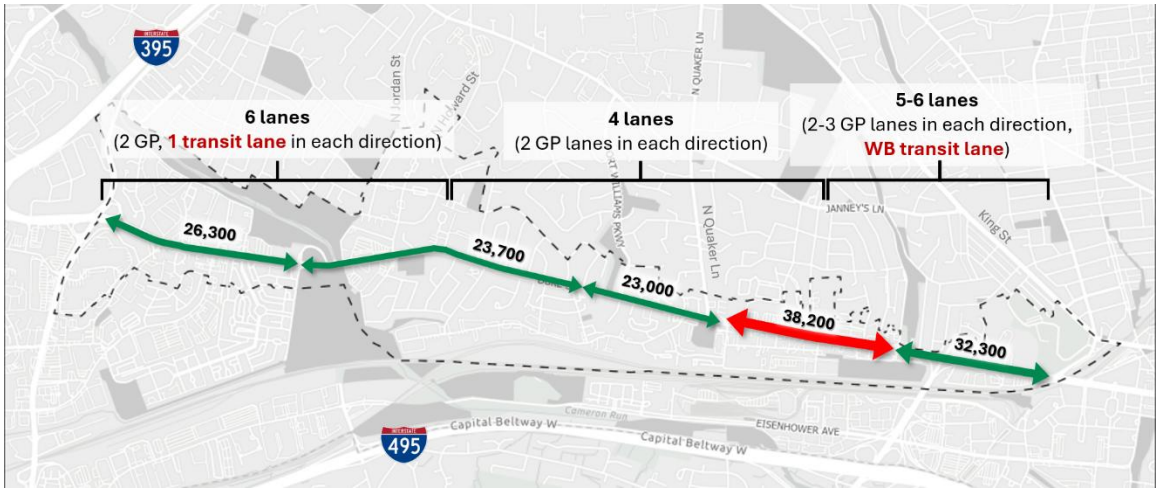
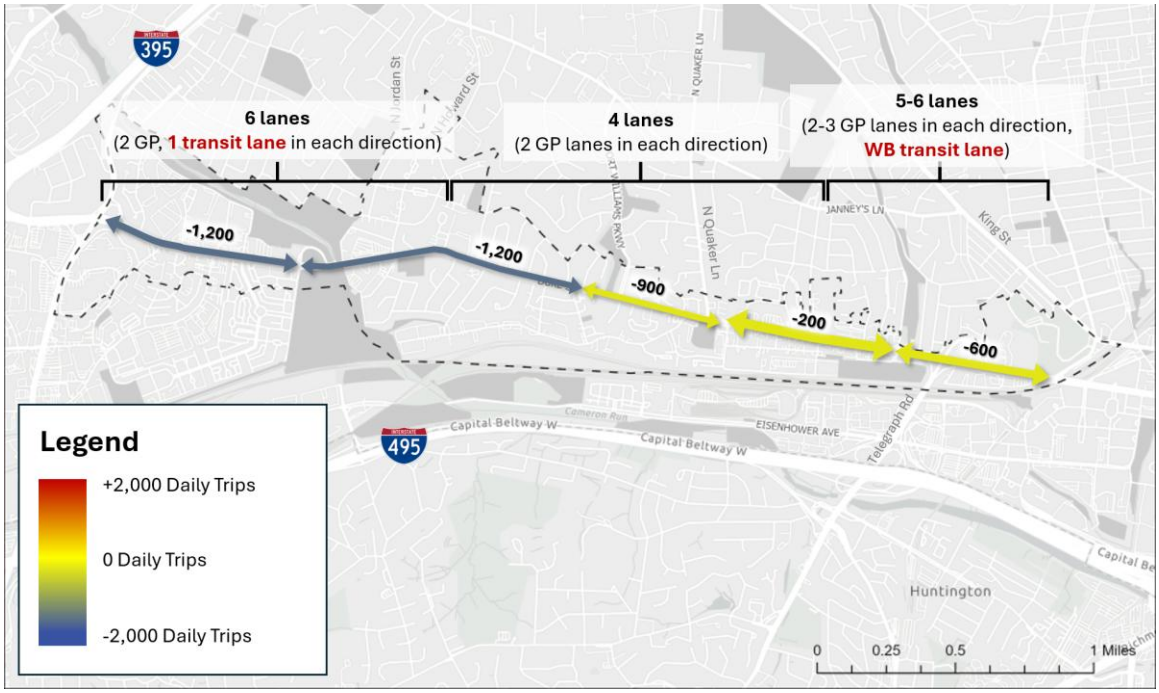


Figure 14 shows that Build future-year traffic volumes result in nearly the same (an overall slight decrease) traffic volumes on Duke Street when compared to No-Build traffic volumes. This is a direct result of the proposed increase in residential land uses in the Duke Street Land Use Plan, which generates lower levels of traffic compared to the predominantly commercial land uses that characterize the corridor today.

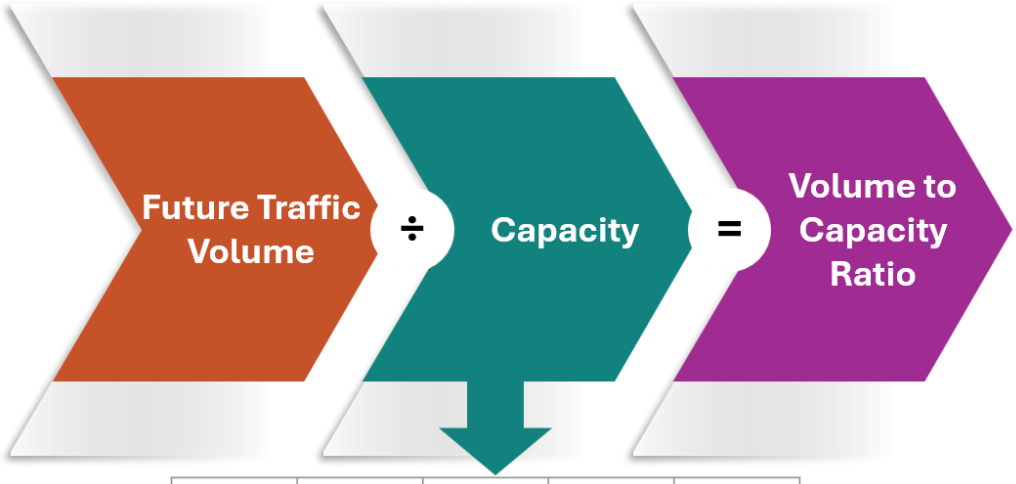
Figure 14: Comparison of Build and No-Build Daily Traffic Volumes



VOLUME-TO-CAPACITY ANALYSIS

A Volume-to-Capacity (V/C) analysis was conducted for the No-Build and Build scenarios to compare the amount of traffic on Duke Street to the amount of traffic that Duke Street is designed to carry. This analysis identifies which segments of Duke Street are operating efficiently, nearing capacity, or exceeding capacity. A V/C ratio greater than 1 indicates the roadway exceeds its capacity. **Figure 15** illustrates the process for calculating the V/C ratio, sourced from the Florida Department of Transportation (FDOT) Quality/Level of Service (LOS) Handbook from 2023.

Figure 15: Volume-to-Capacity Ratio Calculation



	B	C	D	E
2 Lane	*	15,300	21,700	**
4 Lane	*	30,700	36,600	**
6 Lane	*	47,700	54,100	**
8 Lane	*	64,000	64,200	**

Source: Florida DOT Quality/Level of Service Handbook (2023)
Cannot be achieved using table input value defaults.
** Not applicable for that level of service letter grade. For the automobile mode, volumes greater than level of service D become F because intersection capacities have been reached.
*** Segments with a dedicated right turn lane received a 5% increase in capacity; segments without a dedicated left turn lane received a 25% reduction in capacity.

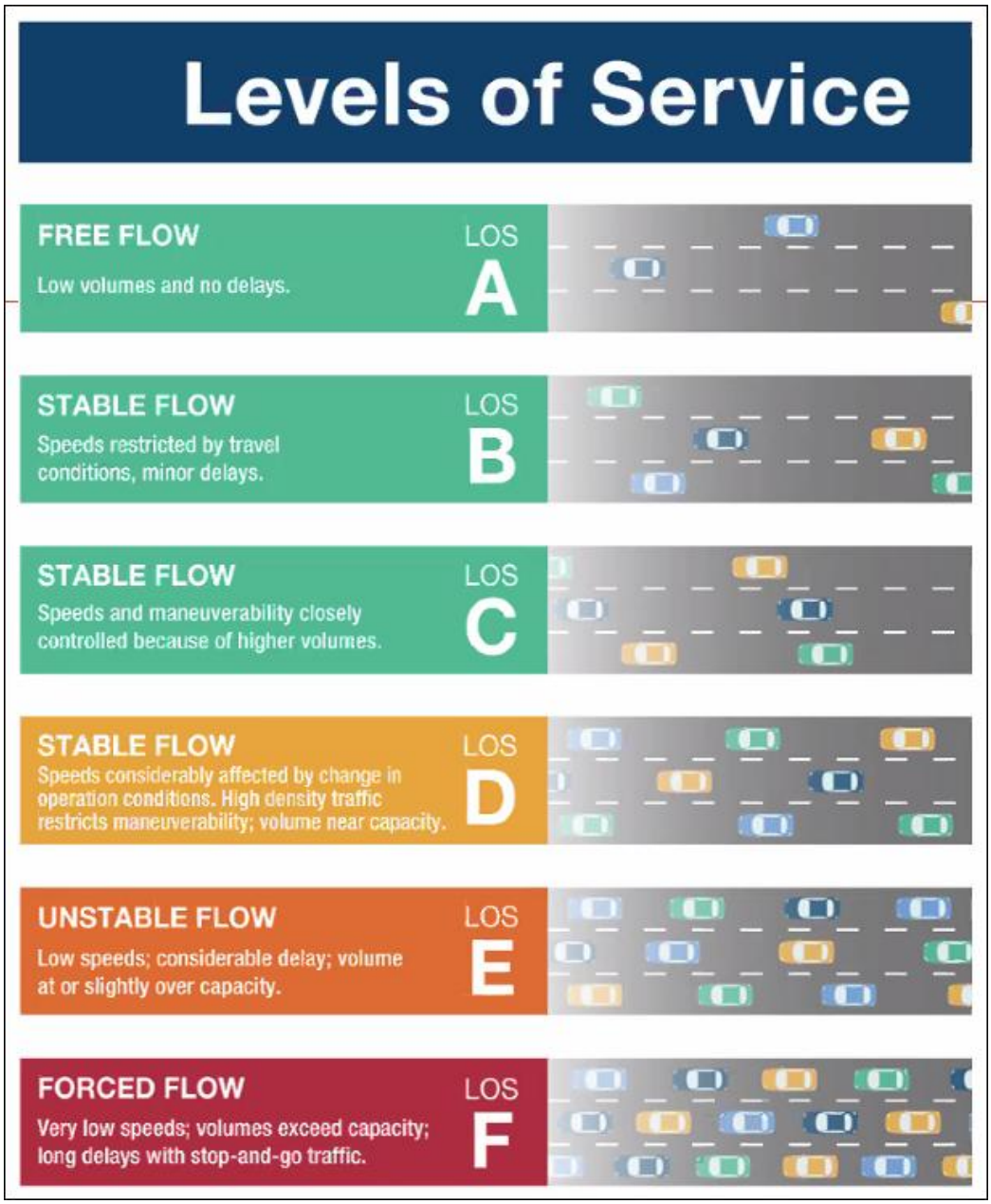
LOS is a method to conceptually measure the quality of travel relative to a road's maximum capacity. The FDOT Quality/LOS Handbook (2023) provides guidance for determining both V/C ratios and LOS, as shown in **Figure 16**. FDOT's LOS tables are generally considered a national standard for establishing roadway capacity.

The capacity of Duke Street was determined by using generalized service volume tables from Appendix B of the handbook. The capacity for each of the Duke Street segments was determined using the C4-Urban General AADT Table under the LOS E Column and varied with the number of lanes present in each segment.

When considering the LOS methodology, it is important to note that more frequent instances of LOS D and LOS E are normal in more urban neighborhoods, including those found along Duke

Street, because City streets must balance several different uses (bikes, cars and pedestrians, transit).

Figure 16: Level of Service Illustrations



Source: Utah DOT

Figure 17 shows the results of the 2045 V/C analysis for the No-Build scenario, in which most of Duke Street is expected to operate well within its capacity. The notable exception is the segment between N Quaker Lane and Telegraph Road, which will operate above capacity with a V/C ratio of 1.05, which indicates a significant capacity constraint and, most likely, significant congestion and delay.

Figure 17: Future-Year (2045) No-Build Volume to Capacity Analysis

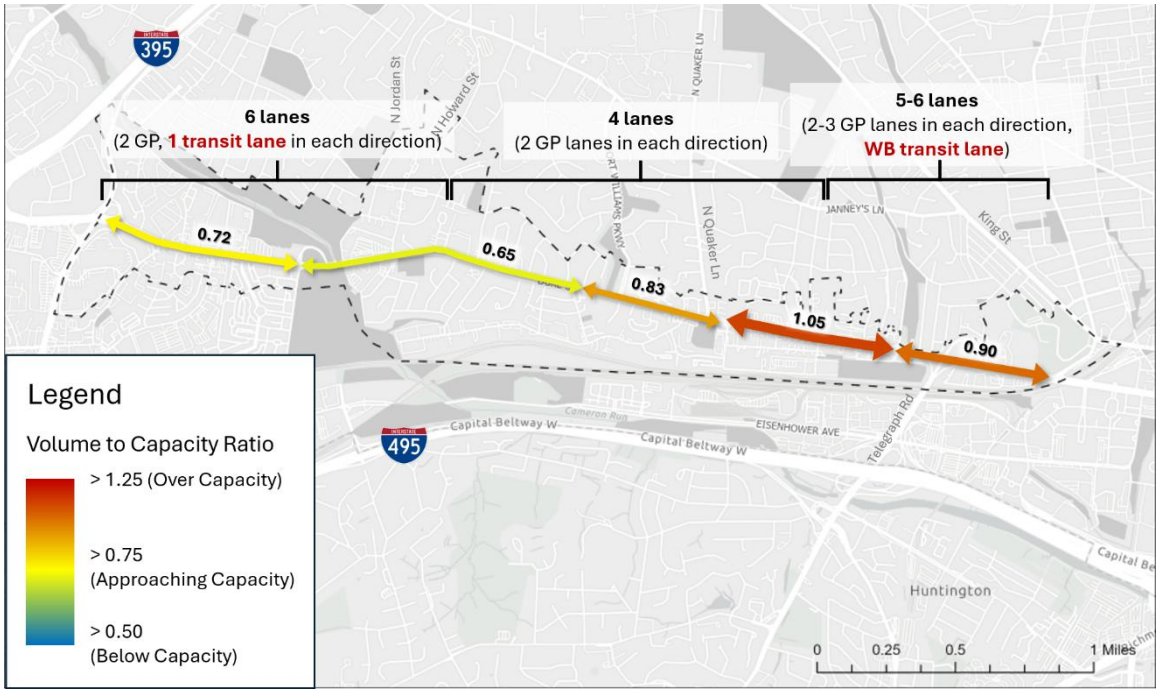
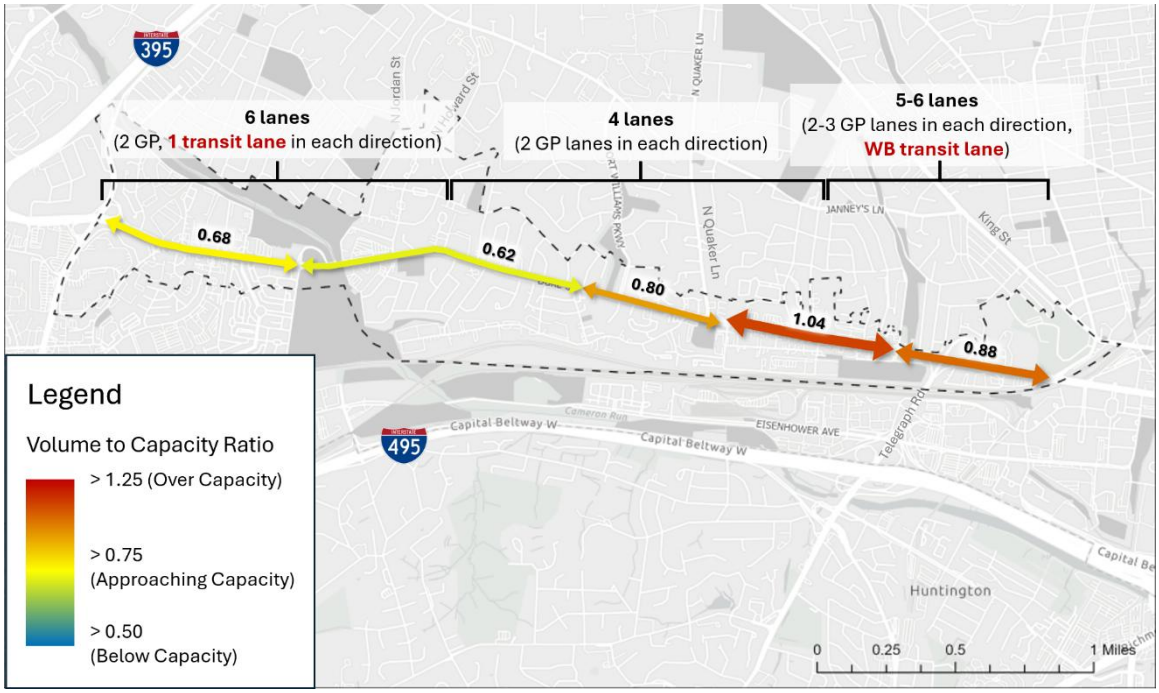


Figure 18 shows the results of the 2045 V/C analysis for the Build scenario. The difference between No-Build and Build V/C ratios is negligible. As such, the segment between N Quaker Lane and Telegraph Road is projected to experience a capacity constraint similar to the No-Build scenario.

Figure 18: Future-Year (2045) Build Volume to Capacity Analysis



ALTERNATIVE GROWTH ASSESSMENT

The V/C analysis demonstrates that the land use changes anticipated by the Duke Street Land Use Plan and other planned or proposed development would result in generally the same travel demand within the study area. As a result, many segments of Duke Street are projected to continue operating without capacity constraints under future conditions.

An alternative growth assessment was conducted to estimate how much additional residential development could occur before each segment of Duke Street reaches a capacity-constrained condition. The assessment found that residential growth could double or, in some areas, triple relative to the level currently anticipated in the Duke Street Land Use Plan, depending on the segment. These findings indicate that portions of the corridor could accommodate substantially more residential development than is currently envisioned before reaching the capacity thresholds used in this analysis.

KEY TAKEAWAYS

The Transportation Conditions Analysis sought to understand the long-term impacts of planned development on travel conditions on Duke Street. To that end, the analysis quantified the travel demand associated with planned development for the corridor, as identified in prior planning efforts Duke Street in Motion and the Duke Street Land Use Plan, and analyzed the impact of that demand on travel conditions in the corridor. The key findings include:

- **Capacity constraints:** The analysis shows that future travel demand on Duke Street, which takes into account both future development in the corridor as well as demand emanating from outside of the corridor ("background traffic"), will continue to experience capacity constraints on the segment between N Quaker Lane and Telegraph Road. This future capacity-constrained condition is anticipated to occur both with planned land use changes ("Build") and without ("No-Build").
- **Relatively equal travel demand**: The land use changes proposed in the Duke Street Land Use Plan will result in nearly the same traffic volumes as a future without this level of planned development. The slight decrease in travel demand can be attributed to the fact that the corridor is planned to transition from primarily car-centric, single-use commercial land uses to more mixed and residential land uses, with additional mobility options to support these uses. On a per-square-foot basis, residential land uses generate significantly fewer daily motor vehicle trips than commercial uses.
- **Opportunities to make Duke Street more local**: Despite this, Duke Street's proximity to major regional roadways means it will continue to carry a significant amount of traffic, and any "freed-up" space risks getting used up by regional travel demand. However, the City can mitigate the effects of regional traffic by continuing to advance improvements that prioritize local trips and make Duke Street safer and easier to travel along and across for all modes of transportation. This includes advancing the Duke Street Transitway and other infrastructure projects planned by the City. These planned improvements will bring significant safety and accessibility improvements for all modes of transportation that use Duke Street, including center medians, pedestrian refuge islands, shorter crossing distances, and improved signal timing.

This analysis was performed by developing projections of mainline daily traffic volumes and corresponding estimates of capacity. It is useful for screening locations of potential capacity constraint and congestion. A more granular analysis that takes into account travel demand and roadway characteristics at specific intersections will yield greater insight into future traffic conditions in the corridor.

While the corridor-wide analysis helps identify overall traffic trends, it does not explain how those trends affect specific locations. The next level of analysis takes a closer look at the corridor's most constrained intersections: the area between N Quaker Lane and Telegraph Road.

Spot Analyses Along the Corridor

In addition to the macro-level view of transportation along Duke Street, a more "zoomed-in" spot analysis of transportation conditions was conducted at select signalized intersection locations. This spot analysis consisted of a portion of Duke Street from N Quaker Lane and Telegraph Road, which is characterized as one of the most challenging segments of the Duke Street corridor today. This spot analysis was based on current traffic volumes as provided by the City of Alexandria and projected traffic volumes related to the trip generation of the land use plan development scenario by using current signal timings and the Synchro traffic analysis software.

The analysis considered the following five intersections:

1. Duke Street and N Quaker Lane
2. Duke Street and S Quaker Lane
3. Duke Street and Alexandria Commons Driveway
4. Duke Street and Sweeley Street/Alexandria Commons Driveway
5. Duke Street and Cambridge Road/Roth Street

Key assumptions that informed the analysis are as follows:

- Existing traffic volumes at the subject intersections are based on turning movement counts from 2023, as provided by the City of Alexandria.
- No-Build and Build refer to the conditions in 2045 without or with the influence of traffic associated with the Duke Street Land Use Plan.
    - Both No-Build and Build conditions assume a 0.25 percent annual linear growth rate of through movements along Duke Street and turning movements at N Quaker Lane to account for the growth of regional traffic.
    - Both No-Build and Build conditions assume the roadway improvements from the planned Duke Street Transitway project and associated adjustments to turning movements are implemented.
- To demonstrate the impact of the land use plan in the Build condition, vehicular traffic associated with potential development located directly adjacent to study intersections was routed through the intersections using the same proportion of turns at each intersection as existing conditions. For all other developments along the Duke Street corridor, it was assumed that 50 percent of the trips generated by these developments would travel east to west along Duke Street and through study intersections and the remaining 50 percent of trips do not affect the study intersections.

WHY THIS MATTERS FOR DUKE STREET

While corridor-wide traffic volumes provide an important understanding of overall transportation conditions, they do not tell the full story of how people experience Duke Street on a day-to-day basis. Transportation challenges are often most visible at specific intersections and blocks where vehicles queue, pedestrians cross the street, buses encounter delay, and people access homes, businesses, transit stops, and neighborhood streets.

The Transportation Conditions Analysis demonstrated that planned development along Duke Street is not expected to significantly increase overall corridor traffic volumes; however, even when traffic volumes remain relatively stable, localized operational challenges can still occur. Small changes in traffic patterns, signal timing, transit operations, turning movements, or roadway geometry can influence how efficiently intersections operate and how safely people can travel along and across the corridor.

Understanding conditions at these key locations is critical because Duke Street serves many different users with competing needs. People driving seek predictable travel times, transit riders depend on reliable bus service, pedestrians need safe and comfortable crossings, and bicyclists benefit from facilities that reduce conflicts with vehicle traffic. Evaluating how these users interact at specific locations helps identify where future investments can have the greatest benefit.

The spot analyses therefore focus on the portions of Duke Street where traffic volumes are highest and where operational challenges are most likely to occur. This analysis helps answer several important questions:

- How do existing intersections function today?
- How are intersection operations expected to change in the future with and without planned development?
- Which locations are most sensitive to future traffic growth?
- Where can targeted improvements improve safety, support transit operations, and enhance mobility for all users?

Answering these questions provides a more detailed understanding of future transportation conditions and helps identify practical, location-specific strategies that can complement the broader corridor improvements planned as part of the Duke Street Transitway and Duke Street Land Use Plan.

EXISTING, NO-BUILD, AND BUILD TRAFFIC VOLUMES

The existing traffic volumes at various study area intersections are shown in **Figure 19**. The 2045 No-Build traffic volumes at study area intersections are shown in **Figure 20**. The 2045 Build traffic volumes at study area intersections are shown in **Figure 21**.

Figure 19: Existing Peak-Hour Traffic Volumes along Duke Street

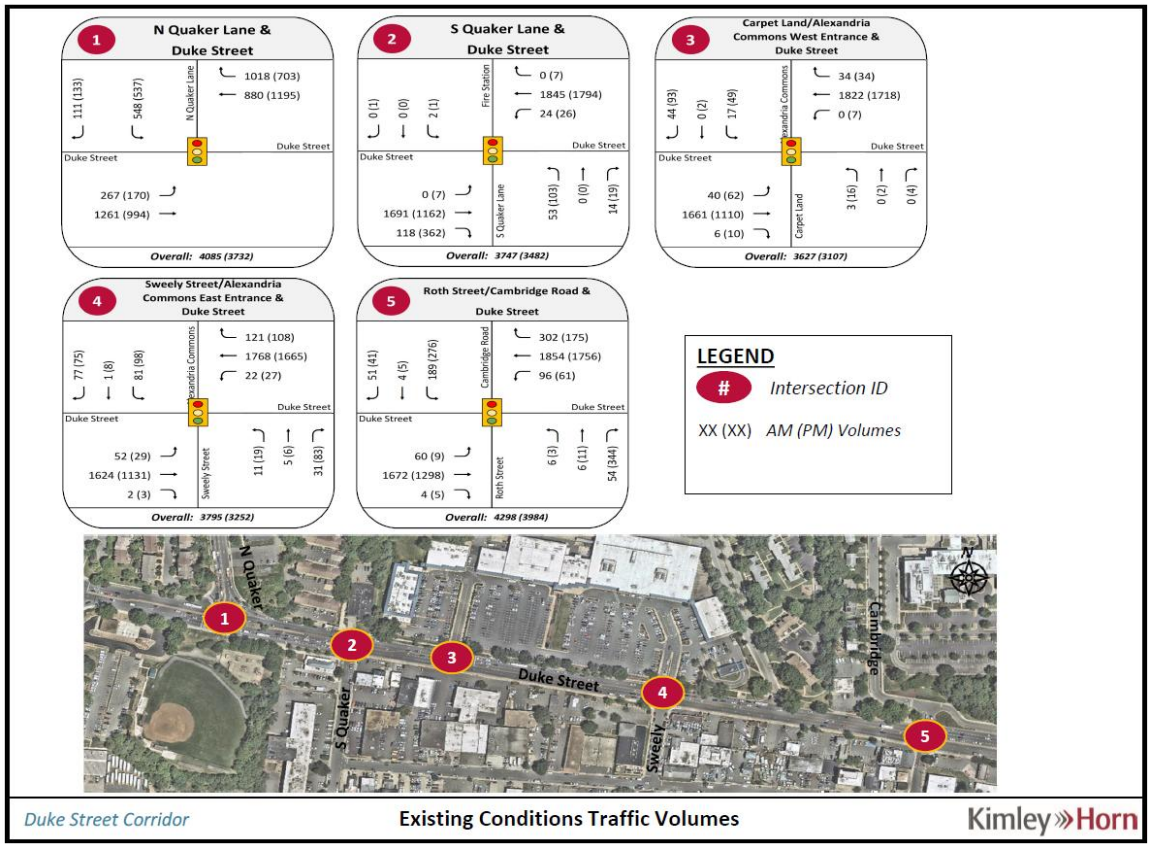


Figure 20: No-Build Peak-Hour Conditions Traffic Volumes Along Duke Street

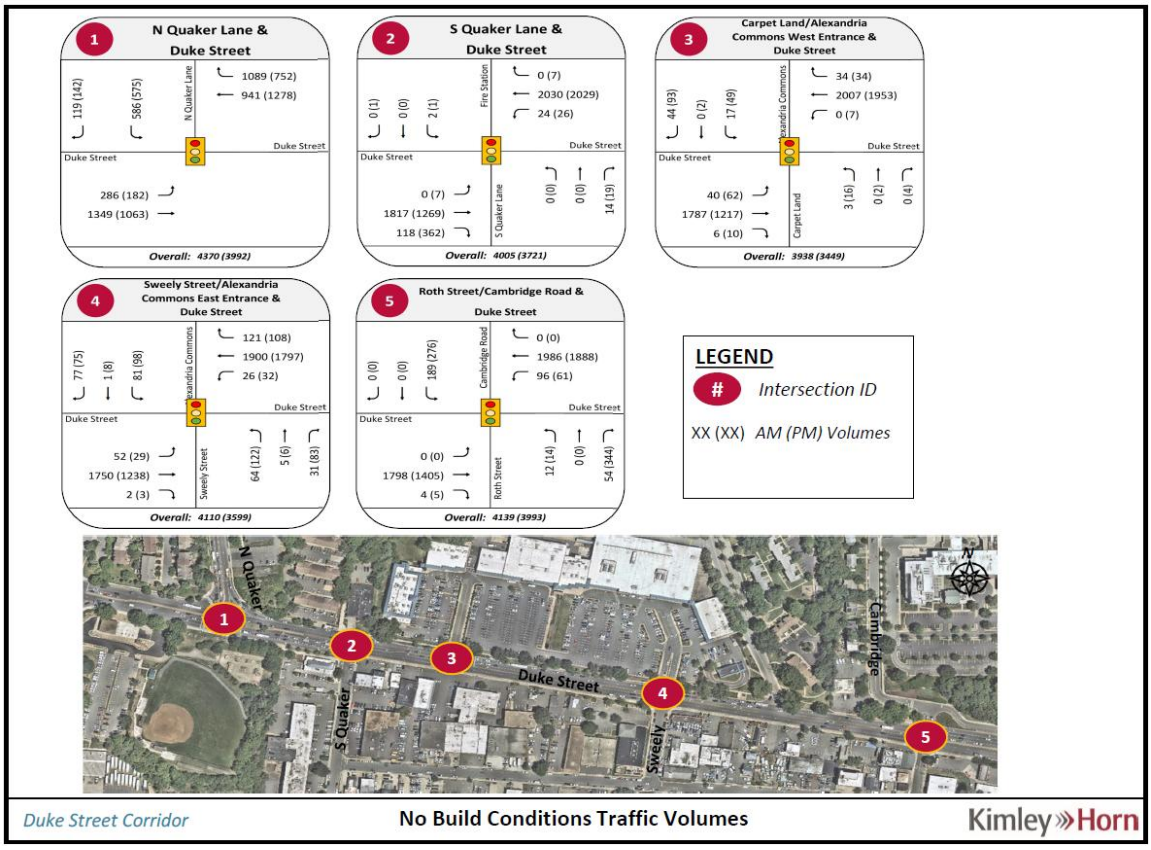
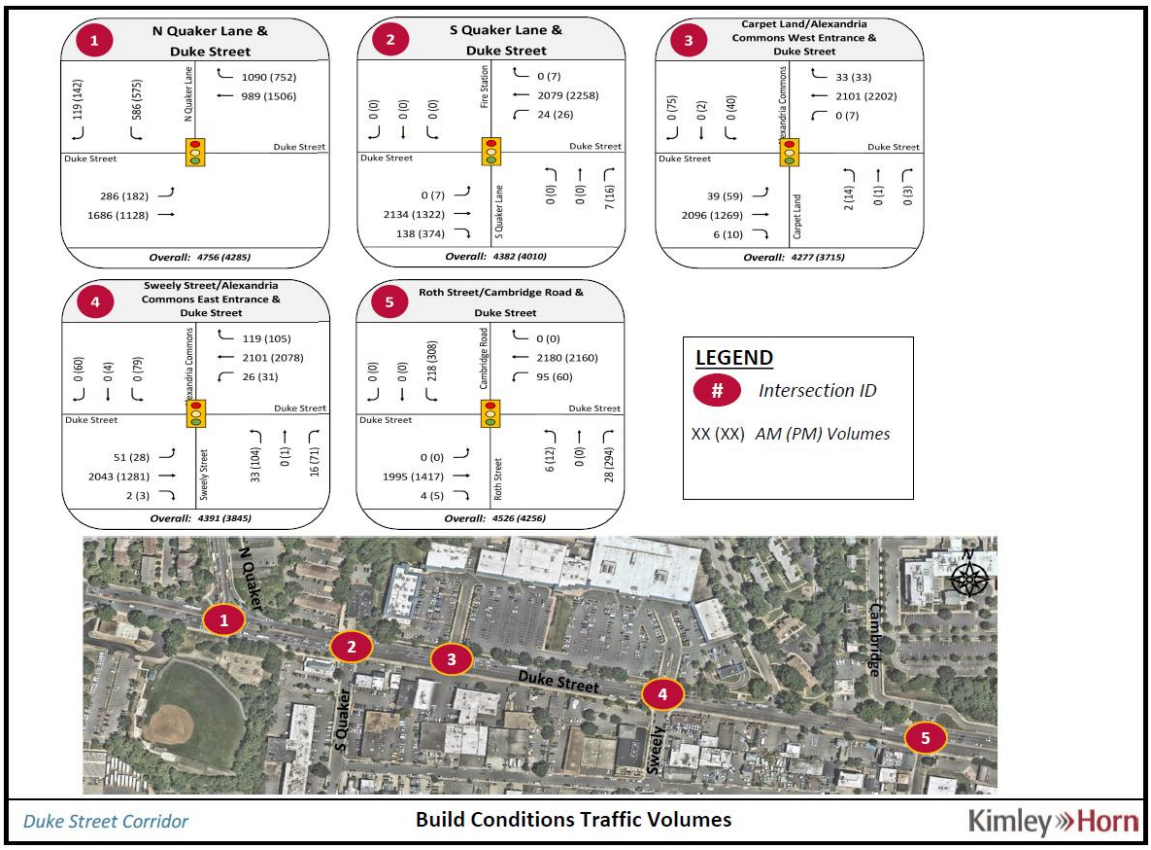


Figure 21: Build Peak-Hour Conditions Traffic Volumes



UNDERSTANDING THE RESULTS

As in the previous Transportation Conditions Analysis section, the results from the analysis are described by level of service (LOS), delay, and Volume to Capacity (V/C) ratio.

For intersections in urban environments, LOS E or better (i.e., less than 55 seconds of delay) and a 0.85 V/C ratio or less represents stable traffic flow and is considered an acceptable condition. Under these thresholds, the time that any individual motorist might wait at an intersection is balanced to efficiently process vehicle movements (including turns) and to give time for pedestrian crossing movements. Delays above 80 seconds, or a V/C ratio above 1.0, automatically indicate intolerable conditions.

MORNING PEAK HOUR FINDINGS

The spot analyses reveal the following key findings during the **morning peak hour** of travel:

- **Under existing conditions, all intersections operate with overall tolerable delays. However, some specific turning movements at each intersection exceed tolerable thresholds.**
  - Notably, the intersection of Duke Street and Cambridge Road operates nearly at capacity today with a V/C ratio of 0.98.
- **Under 2045 No-Build conditions, all intersections continue to operate with overall tolerable delays, though some intersections and turning movements experience moderate increases in delay.**
  - Overall, future No-Build intersection delay changes are limited at the intersections of Duke Street and N Quaker Lane, Duke Street and Sweeley Street/Alexandria Commons, and Duke Street and Cambridge Road. These intersections are projected to experience either minor increases in delay or slight reductions in delay, with no intersection experiencing more than 15 seconds of additional delay. All intersections are expected to continue operating within acceptable performance thresholds.
- **Under 2045 Build conditions, all intersections continue to operate with overall tolerable delays. The traffic volumes associated with the Duke Street Land Use Plan result in slightly fewer vehicles moving through these intersections during peak hours (due to the differences in trip-making from office, residential, and retail land uses). This means the corridor essentially has the same operations between the No-Build and Build conditions.**

AFTERNOON PEAK HOUR FINDINGS

The spot analyses reveal the following key findings during the **afternoon peak hour** of travel:

- **Under existing conditions, nearly all intersections operate with overall tolerable delays, except for the intersection of Duke Street and Cambridge Road.**
  - Notably, the intersection of Duke Street and Cambridge Road is capacity-constrained today, with a V/C ratio of 1.79.
- **Under 2045 No-Build conditions, all intersections operate with overall tolerable delays, though some intersections and turning movements experience moderate increases in delay compared to existing conditions. Notably, the planned Duke Street Transitway improvements at the intersection of Duke Street and Cambridge Road result in a 175-second reduction of delay for the intersection.**
  - Overall, the intersections at Duke Street and N Quaker Lane, Duke Street and Sweeley Street/Alexandria Commons, and Duke Street and Cambridge Road are projected to experience modest changes in delay under future No-Build conditions. While some increases in delay are anticipated at the intersections of N Quaker Lane and Sweeley Street/Alexandria Commons, all intersections are expected to continue operating within acceptable performance thresholds. The Cambridge Road intersection remains capacity-constrained under No-Build conditions but demonstrates improved operational performance compared to existing conditions.
- **Under 2045 Build conditions, all intersections continue to operate with overall tolerable delays, except at the intersection of Duke Street and Cambridge Road.**
  - While the traffic volumes associated with the Duke Street Land Use Plan result in slightly fewer vehicles moving through intersections during peak hours, the total volume of traffic using the Duke Street and Cambridge Road intersection contribute to higher delays and capacity-constrained operations.
  - The corridor otherwise essentially has the same operations between No-Build and Build conditions.

KEY TAKEAWAYS

Overall, the spot analyses confirm that the corridor prioritizes the east–west movements and that side street traffic volumes are proportionally smaller than mainline volumes and can experience significant delays at the various study intersections. Despite the changes to development density along the corridor as proposed in the Duke Street Land Use Plan, delays are not anticipated to significantly grow between existing and No-Build conditions or between No-Build and Build conditions. The Duke Street corridor is already serving a significant portion of regional travelers, and only minimal increases in regional traffic are projected by 2045.

Because this analysis found that the development scenarios proposed in the Duke Street Land Use Plan do not result in a significant increase in local trips or traffic volumes, **the traffic challenges that need to be addressed along Duke Street in the future are comparable to today's challenges**. Those challenges mostly center on how to make traffic volumes, traffic speeds, and accessibility for people walking, biking, and using transit more aligned through improvements that center local travel needs over regional travel.

Conclusions

Together, the three levels of analysis conducted for this study reinforce a consistent conclusion: Duke Street will continue to serve both local and regional travel needs, but the City has an opportunity to shape how the corridor functions in the future as growth and development occurs over time to prioritize local trips for all modes.

At the regional level, broader travel trends—including population and employment growth, persistent congestion on major highways, changing commute patterns, and increasing cut-through traffic—will continue to place pressure on Duke Street. Because Duke Street is closely connected to I-395, I-495, Telegraph Road, N Quaker Lane, and other regional routes, it will remain attractive to travelers seeking alternatives to congested regional facilities. The Macro-Transportation Assessment and peer case studies show how these pressures can be managed through coordinated land use, transit priority, multimodal infrastructure, and operational strategies that make local corridors safer, more reliable, and less oriented toward regional pass-through traffic. By supporting more local trips through a broader range of travel options, the City can use land use and transportation investments to better prioritize local access, even as regional traffic pressures persist.

At the corridor level, the Transportation Conditions Analysis demonstrates that planned land use changes along Duke Street are not expected to meaningfully increase traffic volumes. In fact, the shift from more vehicle-intensive commercial and service uses to primarily mixed-use residential development is projected to result in a slight net decrease in daily vehicle trips generated within the study area compared to a future without the proposed Duke Street Land Use Plan development. Future Build traffic volumes are expected to be nearly the same as, and in some locations slightly lower than, No-Build traffic volumes. Most segments of Duke Street are projected to operate within capacity in 2045; however, the segment between N Quaker Lane and Telegraph Road remains the corridor's most constrained location and is expected to operate near or above capacity regardless of whether planned development occurs or not. This finding is important because it indicates that the corridor's most significant future traffic challenges are not exacerbated by introducing the Duke Street Land Use Plan, but by existing and ongoing regional travel demand that uses Duke Street as part of the broader commuting network.

At the intersection and block level, the Spot Analyses further confirm that the conditions the corridor must address in the future are largely represented by today's challenges. While some individual turning movements and intersections experience delay, the Build and No-Build scenarios produce generally comparable operating conditions, with planned Duke Street Transitway improvements helping to address many existing challenges to multimodal travel. The analysis highlights that the City's focus should be on targeted, location-specific improvements that improve safety, manage delay, support transit operations, and make Duke Street easier to travel along and across for people walking, biking, riding transit, and driving. These improvements can help ensure that the corridor's limited capacity is used in a way that better supports local access, corridor livability, and multimodal mobility.

Ultimately, the study shows that future growth along Duke Street can be accommodated without the consequence of worsening corridor traffic conditions, provided that land use and transportation investments continue to work together. The Duke Street Land Use Plan's emphasis on more local-serving, residential, and mixed-use development can help reduce auto dependence and rebalance the corridor toward shorter, more locally oriented trips. At the same time,

continued implementation of the Duke Street Transitway, intersection-level safety improvements, demand management strategies, and policies that discourage inappropriate cut-through travel will be critical to ensure that Duke Street evolves into a safer, more reliable, and more locally focused corridor.

As development occurs throughout the life of the Plan, it may generate new opportunities to further build out dedicated transit infrastructure, as envisioned in the Duke Street Transitway plan. The conclusion of this study is therefore not that Duke Street can be made free of congestion, but that the City can manage growth and regional traffic pressures in a way that better aligns the corridor with Alexandria's long-term goals for safety, access, mobility choice, and better quality of life for all.