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Transit Feasibility Study

Chesterfield County, VA

*A Professional Plan
Presented to
the Academic Faculty*

by

Taylor D. Jenkins

*In Partial Fulfillment
of the Requirements for the Master of Urban and Regional Planning in the
VCU Wilder School of Government and Public Affairs*

*Virginia Commonwealth University
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TRANSIT FEASIBILITY STUDY FOR CHESTERFIELD COUNTY, VIRGINIA

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CONTENTS

EXECUTIVE SUMMARY.....	7
CHAPTER 1: INTRODUCTION.....	10
1.1 TRANSIT SYSTEM INTRODUCTION.....	10
1.2 TRANSIT CURRENT INITIATIVES.....	11
1.3 CHESTERFIELD COUNTY INTRODUCTION.....	12
CHAPTER 2: EXISTING CONDITIONS.....	14
2.1 LAND USE.....	14
2.2 DEMOGRAPHICS.....	15
CHAPTER 3: METHODOLOGY AND FINDINGS.....	21
3.1 TRANSIT PROPENSITY INDEX	21
3.2 EXISTING ECONOMIC CONDITIONS.....	23
3.3 COMMUTER ANALYSIS	25
3.4 MAJOR TRIP ATTRACTORS.....	28
3.5 ACTIVITY DENSITY.....	27
CHAPTER 4: PREVIOUS PLANS AND STUDIES.....	30
CHAPTER 5: RECOMMENDATIONS.....	33
5.1 PLAN GOALS AND OBJECTIVES.....	33
5.2 PROPOSED ROUTES.....	35
5.3 FINANCIAL AND IMPLEMENTATION PLAN.....	37
REFERENCES.....	40

LIST OF FIGURES

Figure 1: Chesterfield County Proposed Transit Routes.....	9
Figure 2: Existing Transit Routes.....	10
Figure 3: Chesterfield County Location.....	12
Figure 4: Chesterfield County Existing Land Use.....	14
Figure 5: Total Population by Census Tract, 2017.....	16
Figure 6: Richmond, Chesterfield, and Henrico Population Projections.....	16
Figure 7: Number of Individuals Aged 25-54 by Census Tract, 2017.....	17
Figure 8: Number of Individuals Aged 15-24 by Census Tract, 2017.....	17
Figure 9: Elderly Individuals (65+) by Census Tract, 2017.....	18
Figure 10: Number of Individuals with a Disability by Census Tract, 2017.....	18
Figure 11: Minority Population by Census Tract, 2017.....	19
Figure 12: No Vehicle Households by Census Tract, 2017.....	19
Figure 13: Individuals Below the Poverty Line, 2017.....	20
Figure 14: Transit Propensity by Census Tract.....	22
Figure 15: Median Household Income by Census Tract, 2017.....	23
Figure 16: Average Employment in 2017 for Richmond, Chesterfield, and Henrico by Census Tract.....	24
Figure 17: Total Trips from Origin Census Tracts in Chesterfield County.....	25
Figure 18: Total Trips to Destination Census Tracts.....	26
Figure 19: Top 15 Census Tracts with Highest Commuter Origins.....	27
Figure 20: Major Trip Attractors.....	28
Figure 21: Activity Density by Census Tract.....	29
Figure 22: Greater Richmond Transit Vision Plan Network.....	32
Figure 23: Existing GRTC Transit Network.....	35
Figure 24: Proposed Chesterfield County Transit Routes.....	35

LIST OF TABLES

<i>Table 1: Richmond Region Major Employers</i>	7
<i>Table 2: Proposed Service Cost Estimations</i>	35



EXECUTIVE SUMMARY

With support from the Virginia Department of Rail and Public Transportation, the Greater Richmond Transit Vision Plan was completed in 2016. While it outlined a cohesive vision for future transit development in the region, deeper analysis would complement and support its recommendations with locality-specific research. This plan assesses transit feasibility in Chesterfield County and provides recommendations for the implementation of transit service. It also reveals key segments for candidacy of high-frequency transit service and future BRT development to build ridership prior to making large investments in BRT infrastructure. The document concludes with an implementation plan and an exploration of potential funding opportunities to support service expansion.

Since transit planning is heavily based on the location of people, such plans are often data-heavy and require access to demographic and employment information. The U.S. Census Bureau, the Weldon Cooper Center, the Virginia Economic Development Partnership, and local government websites were key in obtaining such information on area population and employment. Geographic Information Systems (GIS) spatial data is also a necessity for this type of plan, and can typically be obtained from the jurisdictions that they are sought for. Existing transit service and the most recently completed comprehensive or transportation plans for the service area in question are also paramount.

To determine transit feasibility, the plan relied on the following research questions:

Where is the transit need in Chesterfield County?

Where are the greatest employment and population densities in the county?

What commuter patterns exist among the county's workforce?

The plan produced a transit propensity index to measure likelihood of transit use by census tract. It identified activity density (population and employment combined) by census tract. Then, it observed commuter patterns for the county's workforce using the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) dataset to identify key origins and destinations of residents. A brief review of previously completed studies related to transportation in the county additionally informed recommendations.

Major Findings

Chesterfield County “exports” approximately 67% of its workforce. If transit were to be implemented, it must be with regional consideration of employment to be most efficient.

Major employers are located across the Richmond region. They are present in Downtown Richmond, Chesterfield's Government Center, and various portions of western Henrico. Select major employers are presented in Table 1, which notably does not include employers with multiple locations such as Target, Walmart, Kroger, and area banks.

Major Trip Attractors are present throughout the northern half of Chesterfield County, on both the eastern and western sides. The southern half of the County does not have many trip attractors.

Chesterfield County is projected to have continued population growth through 2040. It will have the highest population between itself, Richmond, and Henrico.

According to the transit propensity index, the highest levels of transit dependency exist in the northwestern area of the county along Midlothian Turnpike, a portion of Hull Street, and along Route 1. Route 1 notably has a high minority presence.

Table 1: Richmond Region Major Employers

Richmond Region Major Employers		
Name	Address	Locality
Altria Group, Inc.	6601 West Broad Street	Henrico
Amazon Fulfillment Services, Inc.	1901 Meadowville Technology Parkway	Chesterfield
Amazon Fulfillment Services, Inc.	4949 Commerce Road	Richmond
Atlantic Constructors	1401 Battery Brooke Parkway	Richmond
Capital One Financial Corporation	15000 Capital One Drive	Henrico
Dominion Virginia Power	600 East Canal Street	Richmond
DuPont Specialty Products	5401 Jefferson Davis Highway	Richmond
HCA Virginia Health System	7101 Jahnke Road	Richmond
Hill Phoenix	1925 Ruffin Mill Road	Chesterfield
Integrity Staffing Solutions	9827 Chester Road	Chesterfield
Interspan	3908 Meadowdale Boulevard	Chesterfield
Maximus Services	701 Liberty Way	Chesterfield
Old Dominion Insulation	12764 Oak Lake Court	Chesterfield
Results Customer Solution	100 Gateway Center Parkway	Richmond
Virginia Commonwealth University Health System	57 North 11th Street	Richmond
Xerox State Healthcare	7545 Midlothian Turnpike	Richmond

Plan Vision and Goals

The Greater Richmond Transit Vision Plan established a collective vision statement for the Richmond region's future transit development, and the completion of this plan intends to follow the same direction.

By 2040, transit will connect the Richmond region through an efficient, reliable, seamless and sustainably-funded system that benefits everyone by enabling economic growth, promoting livable and walkable transit-oriented development, expanding access to jobs and services, and strengthening multimodal access within and beyond our region.

The following goals and objectives were developed during the completion of this plan:

Goal 1: Connect residents to major transportation corridors and employment centers

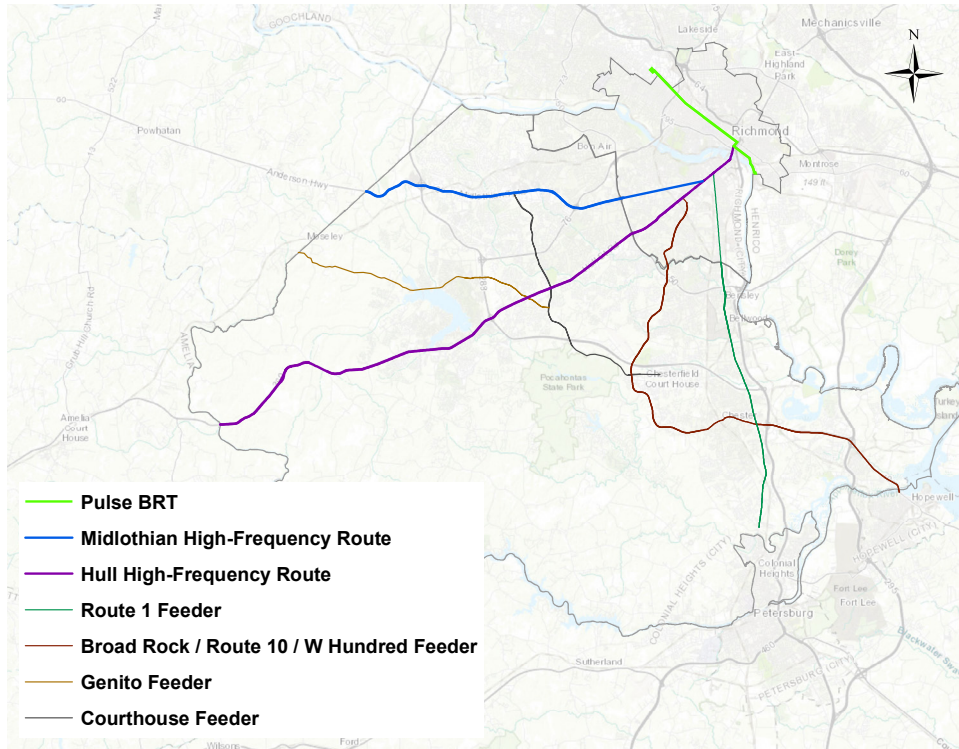
Goal 2: Provide useful, attractive transit options to potential riders

Goal 3: Integrate with the existing transit network where possible

Detailed objectives are included in the **Recommendations** Chapter.

Proposed Routes

Figure 1: Chesterfield County Proposed Transit Routes



Route recommendations were framed around planning for future BRT service along the county's highest-potential corridors -- Midlothian Turnpike and Hull Street. Those routes are proposed to run at enhanced frequencies of 15-minute headways, offering high-frequency transit service to build ridership prior to investments in major capital infrastructure for BRT.

A handful of feeder routes are proposed, including along Route 1, Broad Rock Boulevard / Route 10 / West Hundred Road, Genito Road, and Courthouse Road.

CHAPTER 1: INTRODUCTION

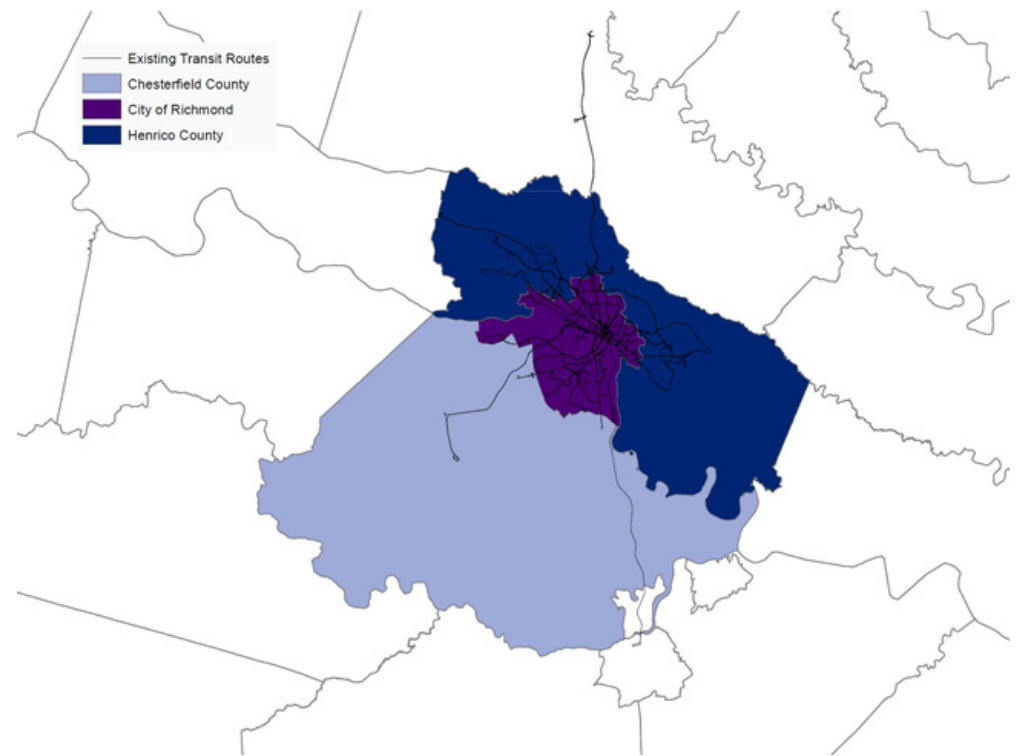
1.1 Transit System Introduction

GRTC Transit System (GRTC) is the primary public transportation operator for the Richmond region. It began as Richmond Railway in 1860 and is jointly owned by the City of Richmond and Chesterfield County. It operates a total of 43 routes and the service types include fixed-route bus service, paratransit, and bus rapid transit (BRT). While most of its service area is within city boundaries, it also operates routes that travel into Chesterfield, Henrico, and Hanover (Ashland) counties.

The Richmond region is experiencing a spur of transit-related momentum with the implementation of the area's first Bus Rapid Transit (BRT) line and a systemwide route redesign that has increased ridership. "The Pulse" is a multijurisdictional route traveling along Broad Street and Main Street, and spans two localities: the City of Richmond and Henrico County. Bus Rapid Transit (BRT) is high-quality bus service that includes accessible boarding platforms, high-frequency service, and a combination of dedicated bus lanes or transit signal priority. It differs from traditional bus service by rivaling travel times of traditional single-vehicle travel, and is most often found in urban cores. The service has been exceptionally successful since its debut. Public officials and a number of residents speculate a Pulse extension further into Henrico County to Short Pump is forthcoming. A systemwide redesign accompanied the Pulse launch, however, and local feedback encouraged the transit agency to consider other avenues for transit expansion. This plan seeks to explore transit expansion options for Chesterfield County, Virginia.

GRTC is funded through a combination of federal, state, and local sources. The federal body for public transportation in the United States is the Federal Transit Administration, and the state body that supports public transportation is the Virginia Department of Rail and Public Transportation.

Figure 2: Existing Transit Routes



GRTC receives local contributions from the City of Richmond and Henrico County. The difference in revenue is accounted for in farebox recovery (ticket sales) and revenues from bus wrap advertisements.

1.2 Transit System Current Initiatives

In 2016, the Virginia Department of Rail and Public Transportation published the Greater Richmond Transit Vision Plan outlining recommendations for future transit development in the Richmond region. The plan assumes that GRTC will be the operator for the region's future transit service, and it identifies five corridors for future BRT development. One of these corridors, Midlothian Turnpike, is within Chesterfield County. While the Pulse has been wildly successful within the City of Richmond and Henrico County, Chesterfield lacks existing transit routes to justify an immediate consideration of BRT infrastructure development. A number of recommendations from the Transit Vision Plan will be revisited and integrated within this plan where appropriate. Several of the corridors with future BRT potential would also be great candidates for high-frequency transit service, for example. A Transit Vision Plan – Phase II is currently in development for the Richmond region under the guidance of the Virginia Department of Rail and Public Transportation.

GRTC completed its most recent transit development plan (TDP) in July 2018. A TDP is a planning document mandated by state statute as a condition of receiving state operating and capital support. It includes a full transit system overview, examining services provided, route structure and performance, operational and capital costs, data collection methods, and areas for improvement. Since the plan's adoption, the Pulse has begun service and many conditions have changed across localities. As with the Transit Vision Plan, a number of recommendations for service improvement from the 2018 TDP will be considered within this planning document.

In 2019, Chesterfield County was awarded a Demonstration Grant from the Virginia Department of Rail and Public Transportation to pilot new fixed-route bus service along Jefferson Davis Highway (Route 1). Service began in March 2020, and the line operates on half-hour headways.

In addition to service expansion, the Richmond region is seeing a rise in Transportation Network Companies (or ridesharing services) and the availability of transportation mobility innovations like microtransit and bikeshare.

Virginia Commonwealth University (VCU) and GRTC piloted a contractual agreement in 2018 for the provision of transit services for university affiliates. It was renewed in a multi-year agreement in 2019 where VCU pre-pays for its affiliates to ride the entire system. Following its adoption, VCU discontinued its "campus connector" service that operated between its Monroe Park and MCV campuses.

The Commonwealth of Virginia's 2020 General Assembly session passed a number of laws related to transportation. House Bill 1541 (HB1541) created the Central Virginia Transportation Authority (CVTA), which will administer transportation funding to localities within Planning District 15. The bill collects funding through the imposition of the following taxes:

- 0.7% sales tax
- 7.6 cent per gallon gas tax
- 7.7 cent per gallon diesel fuel tax

The tax rates would be tied to inflation, and fluctuate as the economy grows or retracts. Fifteen percent of funds collected will be allocated to GRTC for the provision of transit and mobility services within the planning district, and the remainder of the funds will return proportionally to the localities for general transportation use. The creation of the CVTA provides an opportunity for more stabilized funding sources for the transit system, as transit funding will not have to compete as aggressively with locality priorities within general funds. This alleviates some degree of uncertainty from fiscal year to fiscal year.

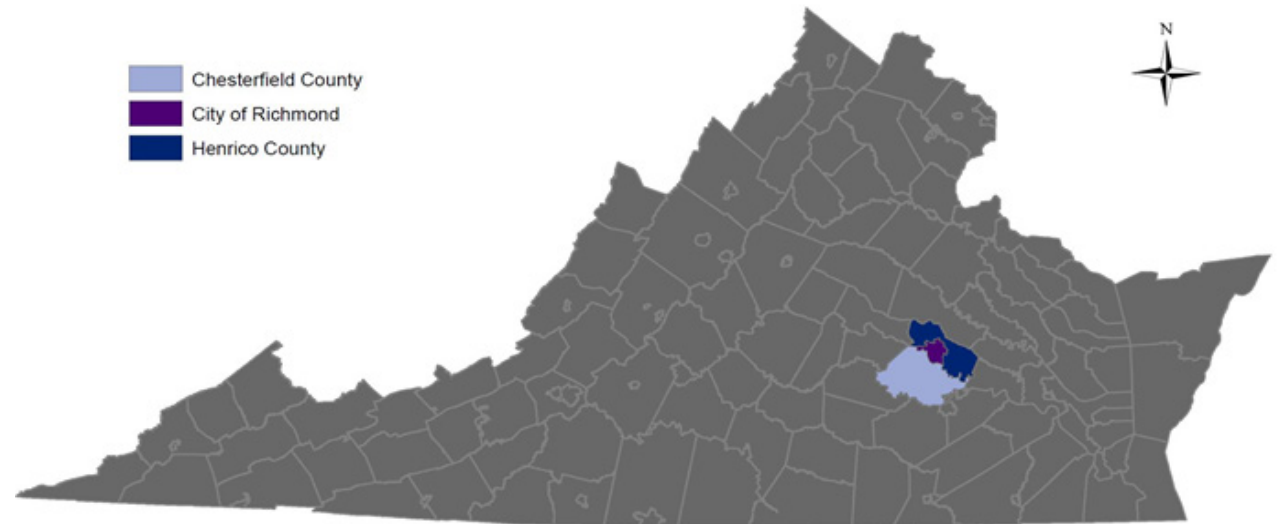
1.3 Chesterfield County Introduction

Chesterfield County is located in central Virginia just south of the city of Richmond. It is within the Richmond metropolitan statistical area (MSA) and was formed in 1749 from portions of Henrico County. It is bordered by the James and Appomattox rivers, and assumed its present-day boundary following the final annexation by the city of Richmond in 1970. Its dominant land use is agricultural, with approximately 52% of land zoned with that designation. Much of the agricultural land is within southern and south-western portions of the county, which are the most rural areas.

Major interstates, highways, and roads travel throughout Chesterfield County. These include I-95, Chippenham Parkway, Route 1 (Jefferson Davis Highway), and State Route 288. As previously mentioned, the majority of existing public transit routes operate within the City of Richmond. According to GRTC's Transit Development Plan, the Chesterfield County Board of Supervisors terminated the last route financially supported within county boundaries with the exception of the 82X Commonwealth Express in March 2016.

Chesterfield has tried a multitude of demand-response public transportation services throughout the years. Some of the county's transit initiatives include: Access Chesterfield, the county's existing contracted demand-

Figure 3: Chesterfield County Location



response service for low-income, elderly, or disabled individuals; a Goodwill-Uber pilot for individuals receiving services through Chesterfield Mental Health Support Services; and a previous Human Service route that traveled between the County Government Complex and Jefferson Davis Highway.

The county's current initiative, "Access Chesterfield," costs \$6 for a one-way voucher. This is costly in comparison to what residents could pay to utilize bus service through GRTC should it be available. GRTC fare for local routes is \$1.50 and \$0.75 for senior or disabled individuals. CARE, GRTC's form of paratransit service, costs \$3.00 for a one-way trip.

Also of importance to note is the Richmond region's historic theoretical frameworks that influence how planning is done and the assumptions under which transportation decisions are made. In the Richmond region, rational planning theory continues to affect the state of public transportation.

In Urban Planning Theory Since 1945, Taylor describes the rational process of planning as having roots in decision theory . It prioritizes “expert” knowledge by renewing faith in the application of science in decision-making, and applies value to all that can be quantified. That which cannot be quantified (beauty, opinion, or perception) was not considered to be scientific and had no place in the planning process.

In Richmond, rational planning theory guided the construction of the interstate highway system and downtown expressway. These actions devastated Black neighborhoods of the city, but Richmond was not the only place that suffered at the hands of rational planning. In Racialization of Space and the Spatialization of Race, Lipsitz estimates that approximately 1600 Black neighborhoods were destroyed across the country during Urban Renewal . The interstate and highway planning intervention relied on “expert” knowledge and minimized resident inclusion. This contributes to the historical distrust and straining of the relationship between residents and city or county planners. Rational planning legitimized the construction of the interstates as the best solution to commuter innovation, and furthered its agenda through the establishment of the Richmond Metropolitan Transportation Authority. A similar “transit authority” was never created, leaving GRTC Transit System only able to implement service that each locality is willing to pay for.

Rational planning theory also initiated a lasting legacy of car-centric planning in the region. While advocacy planning is not a champion of citizen input, it prioritizes outcomes for all and attempts to further causes that support disadvantaged individuals. In Advocacy and Pluralism in Planning, Paul Davidoff asserts that the advocate planner would be responsible to the client and their views. Much of the work within an advocacy planning framework is educational – the planner would educate other bodies and organizations of the issues at hand and causes they stand for.

CHAPTER 2: EXISTING CONDITIONS

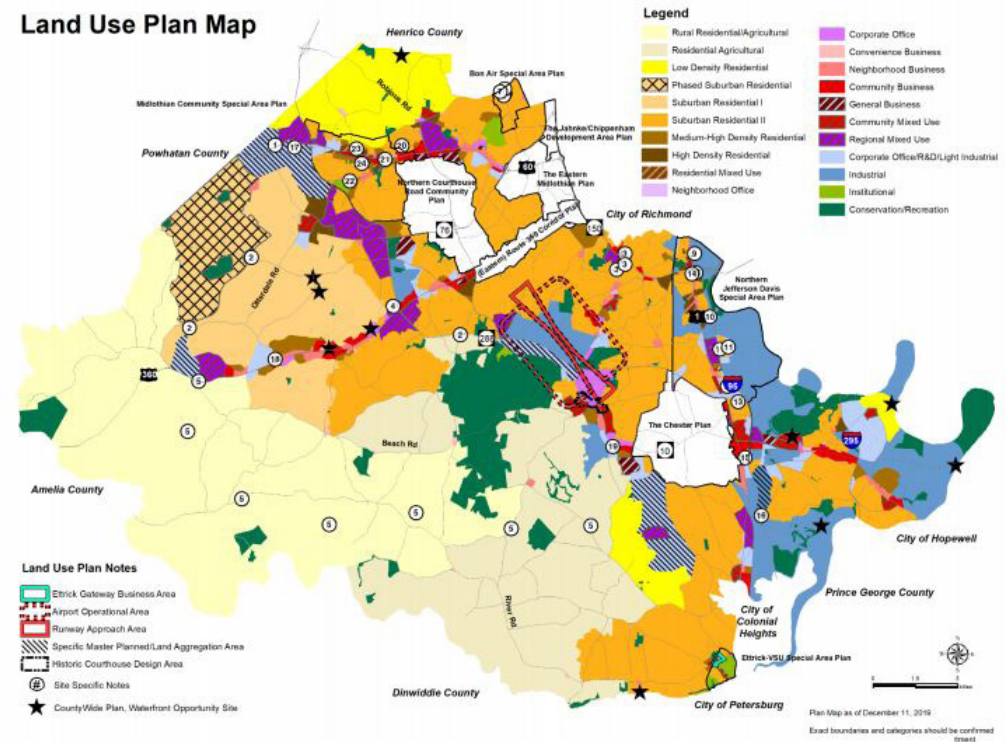
2.1 Land Use

A critical consideration when assessing existing conditions is land use, as transportation and land use are intrinsically linked. Where people live, work, and go for entertainment shapes their lives and their commutes. The distribution and density of each of those land uses will not only determine how they move, but also how efficiently they move and how easily connected they can be through public transportation. The concentration of people and jobs located within proximity to transit access will determine what kind of public transportation will be best.

The majority of Chesterfield County's existing land use is agricultural, with 52% of land classified with that designation. Following behind is residential, with 36% of available acreage classified as such. Most of the vacant land within the County resides in these two categories. According to the County's most recently completed comprehensive plan, approximately 36% of available acreage is vacant. Chesterfield also has Office, Industrial, and Commercial land uses. According to the comprehensive plan, the county has indicated its desire to preserve much of the agricultural land for the benefit of future generations. This further encourages densification of existing residential areas as the county's population grows. Additional density would support future transit expansion.

To understand how existing land use will affect transit feasibility, the spatial distribution of land uses must be observed. Figure 4 is a map of existing land use for Chesterfield County, and it should be noted that most of the residential and commercial urban development is clustered in the northernmost portions of the locality. Most industrial uses are located within the eastern portion of the County, and agricultural to the south and southwestern parts. Some sprawl-like and fringe development patterns can be observed on the southern edge of the County.

Figure 4: Chesterfield County Existing Land Use



Most notable in the context of transit feasibility would be the presence medium-high and high density residential housing, illustrated by the brown color in Figure 4 above. Medium-high and high density housing can be observed along portions of Midlothian Turnpike, Hull Street Road, Old Hundred Road, and the Chippenham Parkway corridor.

2.2 Demographics

The American Public Transportation Association (APTA) is a nonprofit organization and internationally recognized voice within the transit industry. APTA advocates for additional public transportation funding, encourages pro-transit policy, and conducts research across various modes of transportation. Existing definitions vary in identifying populations who are *transit-dependent* – those who are likely to rely the most on the service. Some portions of existing literature plan for transit using only lack of vehicle ownership and income level as indicators of transit propensity, while others consider a multitude of variables.

According to a report released by APTA titled *Who Rides Public Transportation*, the following key demographics were found for individuals who currently use transit services:

- 78% of transit riders are employed
- 60% of transit riders are people of color
- 79% of transit riders are ages 25-54
- 46% of transit riders do not have a vehicle

In outlining methodology for assessing environmental justice in transportation, researchers Forkenbrock and Sheeley defined transportation-disadvantaged individuals as people facing unmet transportation needs due to several possible attributes: low income, disability, and those who simply choose not to drive. Those who use transit are individuals with the least mobility, and households adapt to limited mobility by making fewer and shorter trips. This means that in places where transit service is limited, access to opportunity is also limited due to the availability of fewer trips.

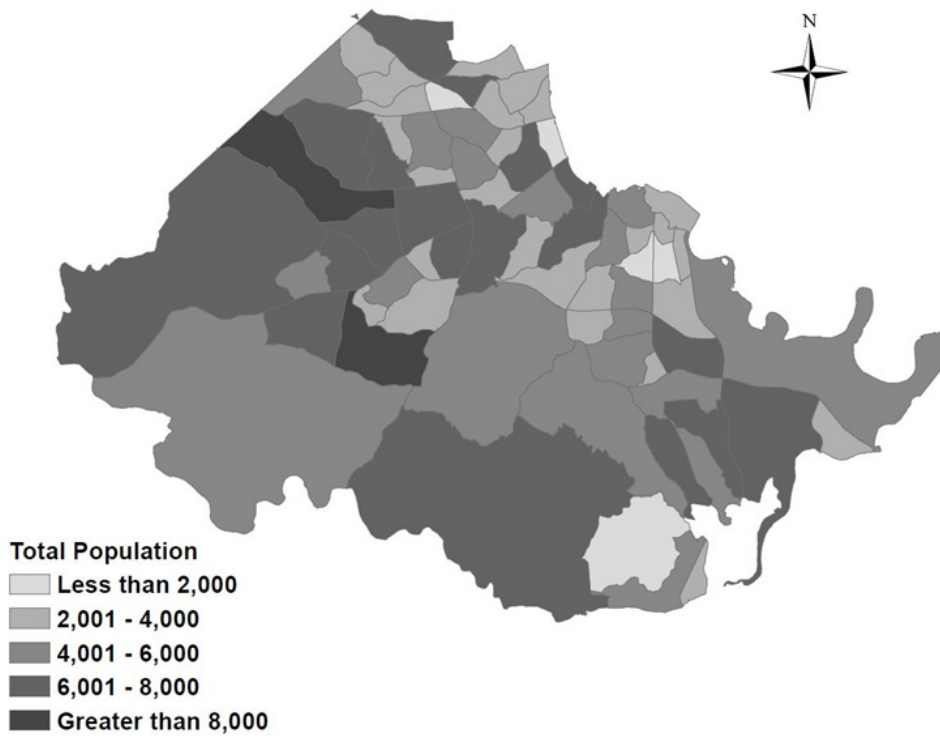
Even in 20th century literature, minority and low-income populations were more likely to use transit and less likely to own a car.

The following demographic variables were collected from the U.S. Census Bureau and used for this plan's analysis:

- Total population
- Youth (ages 15-24)
- Elderly (ages 65+)
- Economically active individuals (ages 25-54)
- No-vehicle households
- Individuals with a disability
- Minority population
- Individuals below the poverty line

Due to inconsistencies in the granularity of data available, each variable was collected at the tract-level. Unless otherwise noted, all data was collected from the U.S. Census Bureau for the year 2017. This was the latest year available across each of the demographic variables and employment data.

Figure 5: Total Population by Census Tract, 2017



Total population is an important consideration for transit planning. Low-density metropolitan areas consume a lot of land and reduce walking due to sprawl. Greater population densities support increased frequencies of service. While low-density areas are not particularly favorable for transit service, varying modes of public transportation exist. Where fixed-route transit is not appropriate, demand-response or deviated fixed route could be an option. Transit also has the potential to encourage higher-density regions through collaboration with appropriate land use regulation, commonly referred to as transit-oriented development (TOD).

In Figure 5 above, darker census tracts have greater populations. In a

subsequent section, the plan will address a finer measurement of transit propensity as it relates to population – activity density. Activity density measures the number of people and jobs per gross acre.

Yearly, the Weldon Cooper Center researchers develop and release official population estimates for Virginia. Figure 6 below provides population estimates and projections for Richmond, Chesterfield, and Henrico.

Chesterfield County had approximately 350,760 residents in 2019. According to the 2040 population projection, the county will continue to see the greatest total population with approximately 433,508 residents. As previously mentioned from the Land Use Plan, county administrators seek to preserve the majority of vacant agricultural land within its boundaries. Successful accommodation of over 80,000 new residents will require densification within existing residential areas and the conversion of more land to mixed use. Introducing transit service would support existing transportation infrastructure as higher volumes of people utilize major roadways.

Figure 6: Richmond, Chesterfield, and Henrico Population Projections



The next demographic of interest that contributes to transit propensity is age. Different age groups have different transportation needs. These can span school-related trips for children and teenagers, work commutes for young and middle-aged adults, or medical trips for the elderly. Observing the distribution of these age groups can support effective transit planning.

Economically active individuals aged 25-54 have a high likelihood of using transit. These are the years that individuals are most likely to be employed full time and making regular trips between home and work. Figure 7 presents this group by census tract.

Figure 7: Number of Individuals Aged 25-54 by Census Tract, 2017

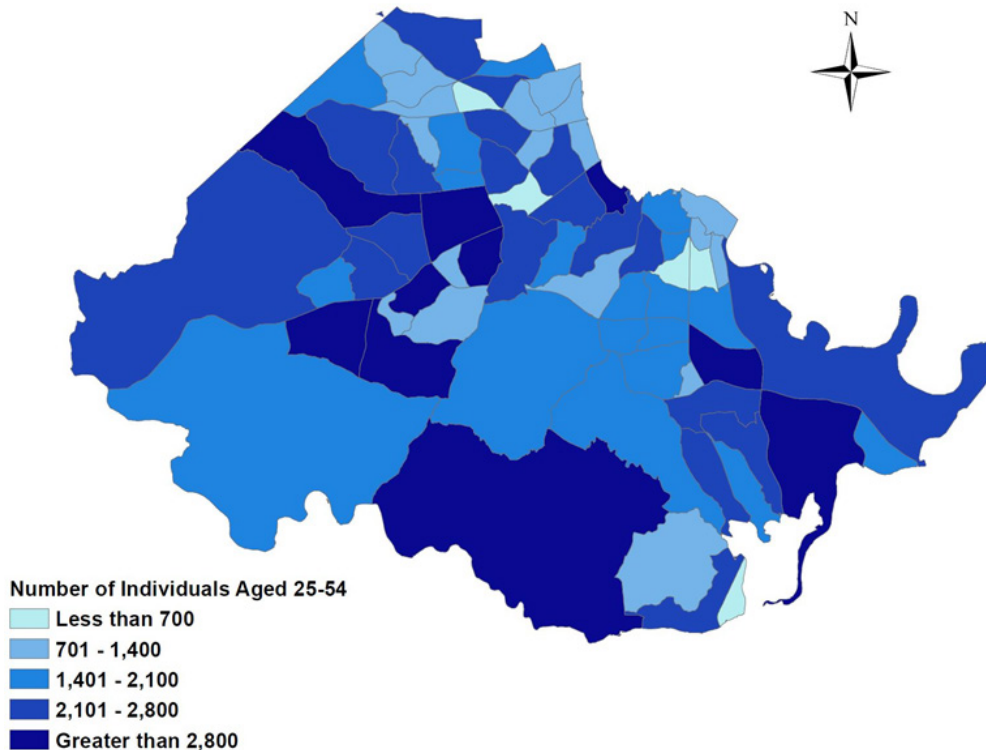
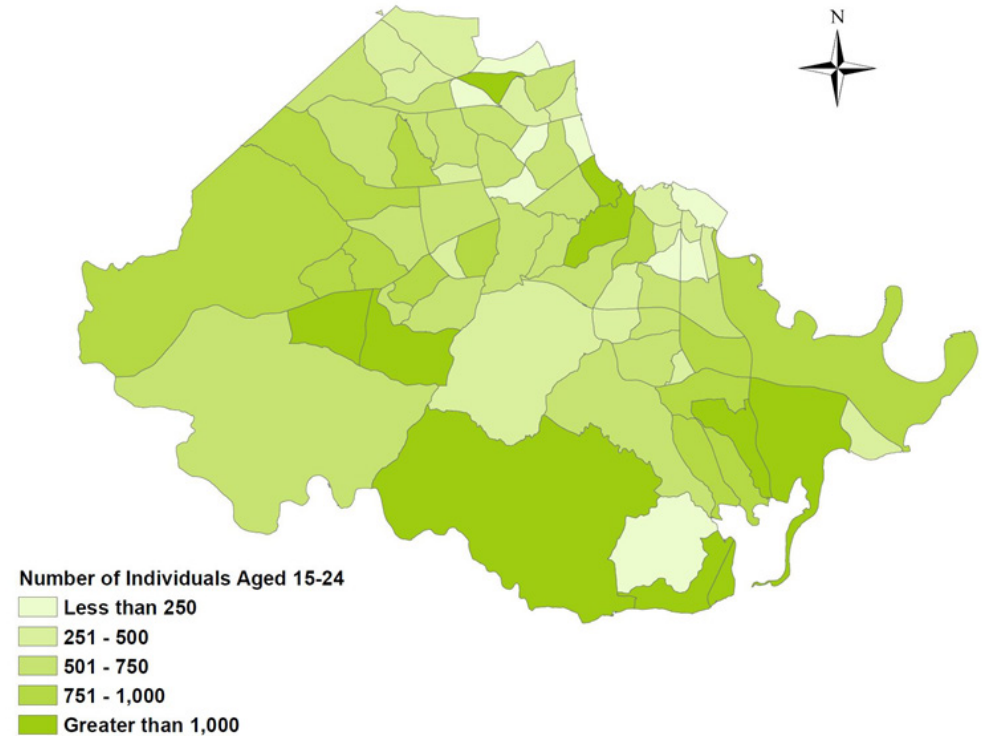
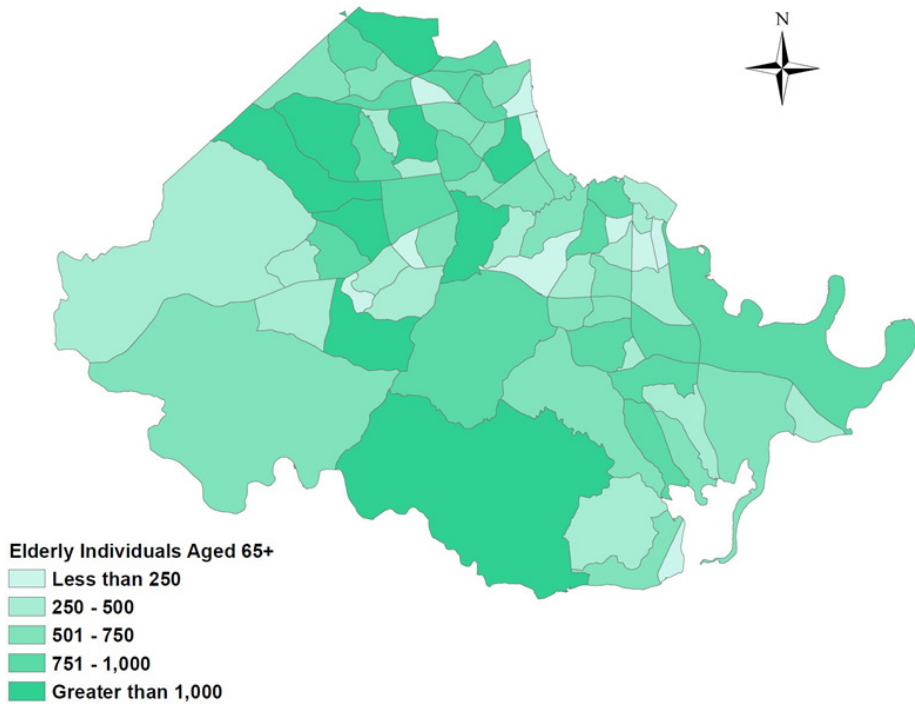


Figure 8: Number of Individuals Aged 15-24 by Census Tract, 2017



Individuals aged 15 to 24 also present an opportunity for transit ridership. A resident in this age group could potentially lack a driver's license, be a student, or not own a car. These traits do not alleviate the need for travel, however – individuals must still find means of accessing key destinations, and the availability of public transit could support that.

Figure 9: Elderly Individuals (65+) by Census Tract, 2017



The final age group for transit consideration is the elderly. Residents older than 65 years old are more likely to be retired, disabled, or unable to operate a vehicle. As individuals age, they may experience diminishing physical capacity.

Disabilities measured by the U.S. Census Bureau’s American Community Survey include difficulties related to vision, cognition, walking, self-care, or independent living. Individuals with disabilities also have a high propensity for transit use due to potential difficulties of operating a vehicle. Figure 10 to the right illustrates the number of individuals with a disability by census tract.

This variable could potentially intersect with the previous – the elderly. These populations likely make the most use of demand-response services for medical appointments or routine trips.

GRTC operates a nationally-certified Travel Training Program that teaches older adults, individuals with disabilities, and new riders how to use the system safely and effectively. This could provide expanded mobility options beyond demand-response service.

Figure 10: Number of Individuals with a Disability by Census Tract, 2017

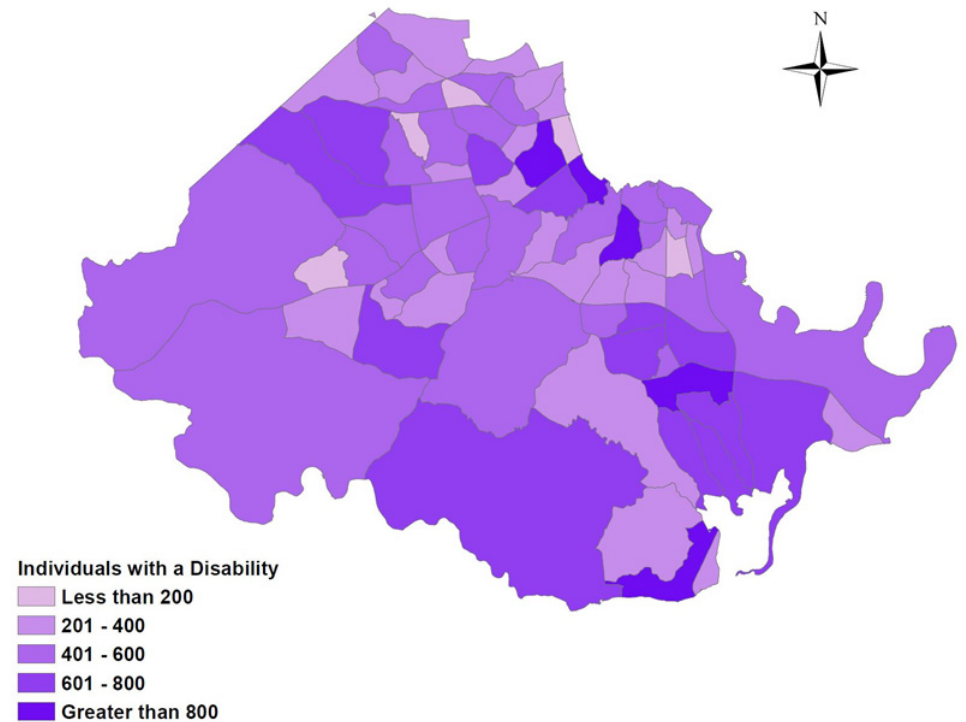
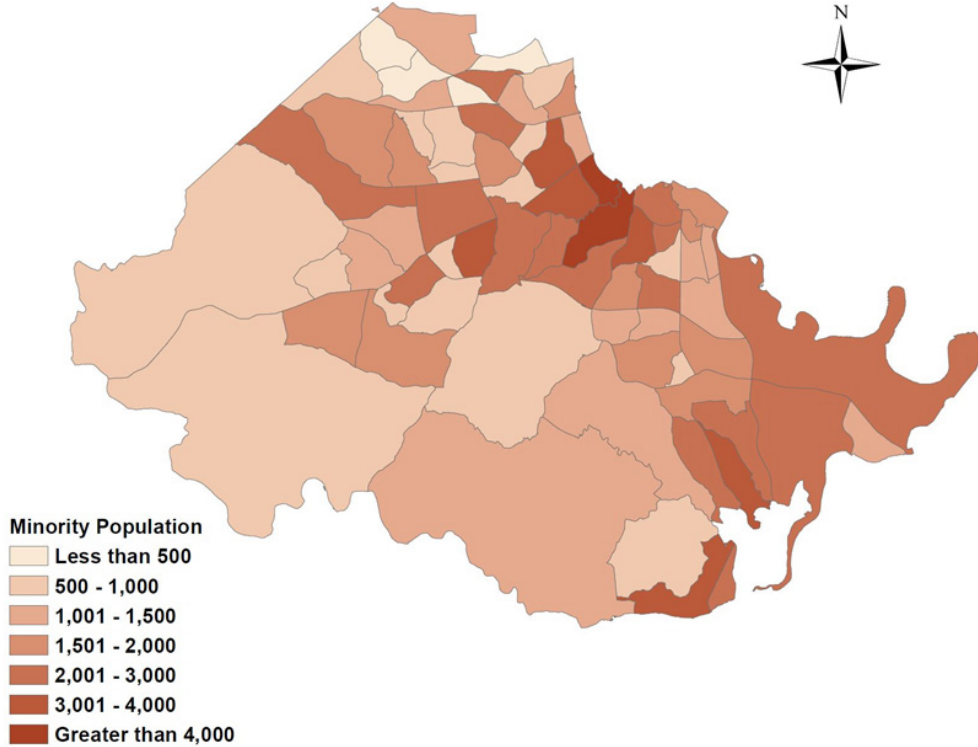


Figure 11: Minority Population by Census Tract, 2017



The minority population includes non-white residents of the following races: Black or African American, American Indian or Alaska Native, Asian, Hawaiian or Pacific Islander, and two or more races. In addition, Hispanic or Latino ethnicity is also included in this measurement. It appears that minority populations are concentration around the north and eastern tracts of the County.

Perhaps one of the most intuitive indicators of potential for transit use is the lack of a personal vehicle. According to Figure 12, households without a vehicle appear to be most concentrated in the northwestern-most portion of the county followed by areas along the outskirts of the county's eastern boundary.

Figure 12: No Vehicle Households by Census Tract, 2017

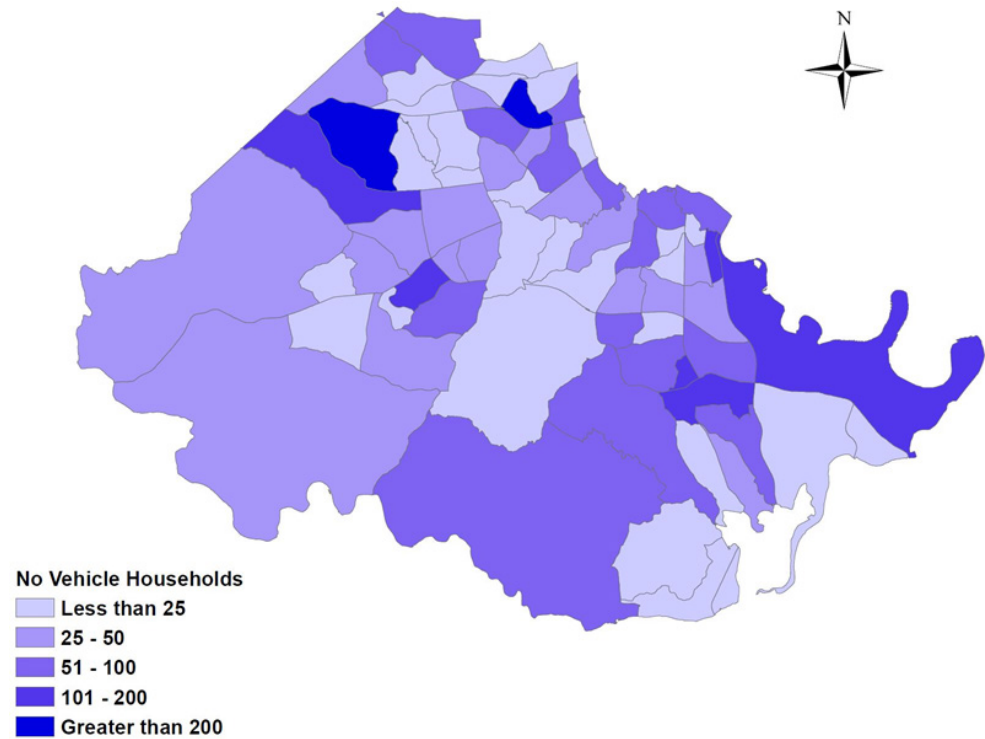
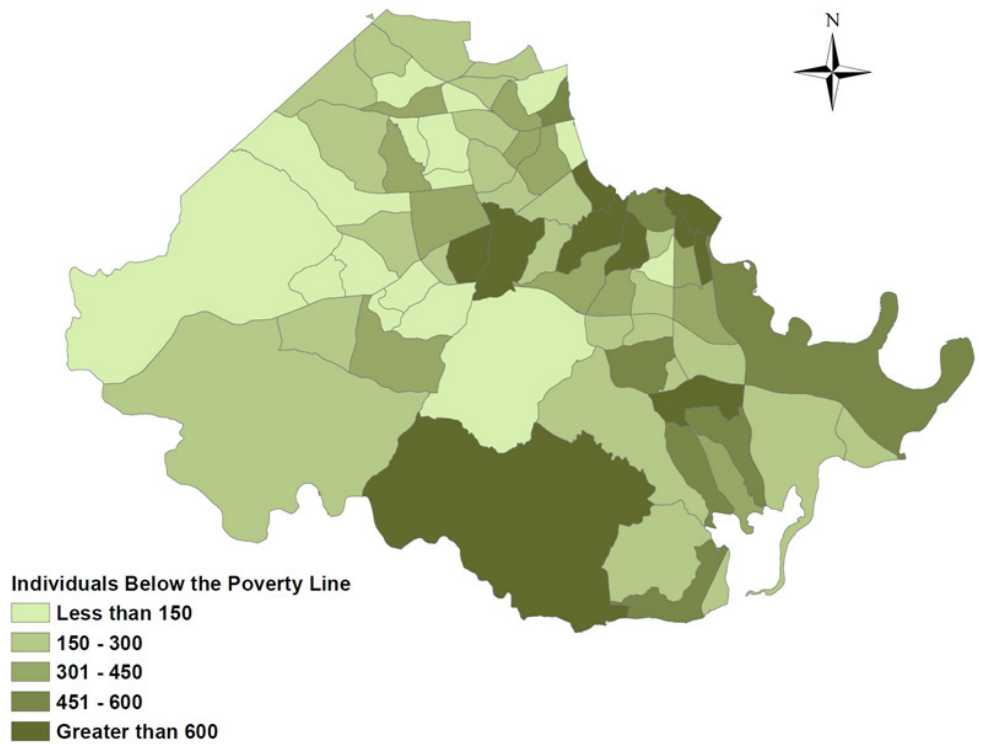


Figure 13: Individuals Below the Poverty Line, 2017



Finally, Figure 13 observes the number of individuals below the poverty line. Low-income residents are most likely to use transit based on dependency rather than choice, and are less likely to own a personal vehicle.

CHAPTER 3: METHODOLOGY AND FINDINGS

3.1 Transit Propensity Index

This chapter details the methodology under which this transit feasibility study was completed. It was guided by the following resesarch questions:

Where is the transit need in Chesterfield County?

Where are the greatest employment and population densities in the county?

What commuter patterns exist among the county's workforce?

Where is the transit need in Chesterfield County? To answer this research question, a transit propensity index was created. It measures the likelihood of using transit based on key demographic attributes of the county's population. Since each locality has unique demographic conditions, a transit propensity index measures the likelihood of using transit for each census tract *relative to the county as a whole*. The aforementioned demographics that were included in the analysis are:

While transit-dependent populations often overlap, the presence of higher concentrations of each variable indicates a higher demand for transit service. To calculate census tract "scores", each variable was weighted equally and each dataset normalized on a scale of 1-10 to enable accurate comparison and consolidation. The scores for each demographic were then averaged across census tracts to produce a final score for each. Figure 14 illustrates transit propensity across Chesterfield County. The darker the census tract, the higher propensity its residents have to use public transit if it were available.

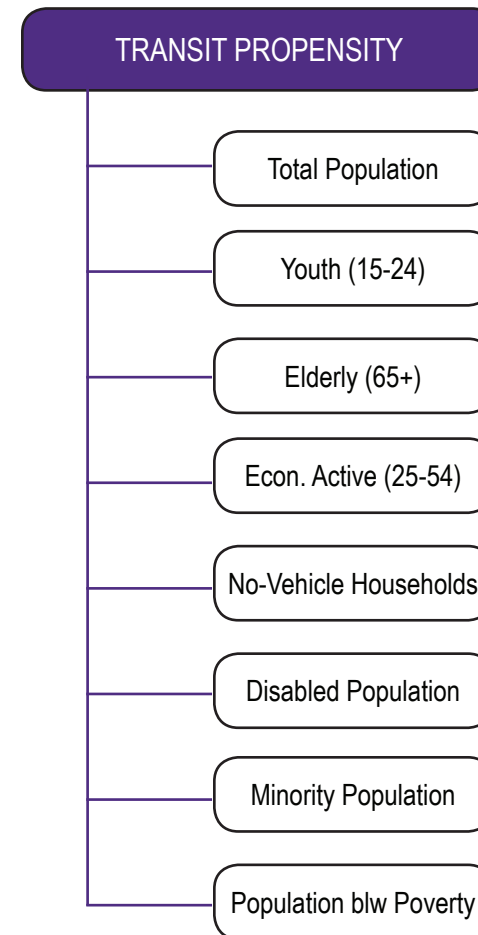
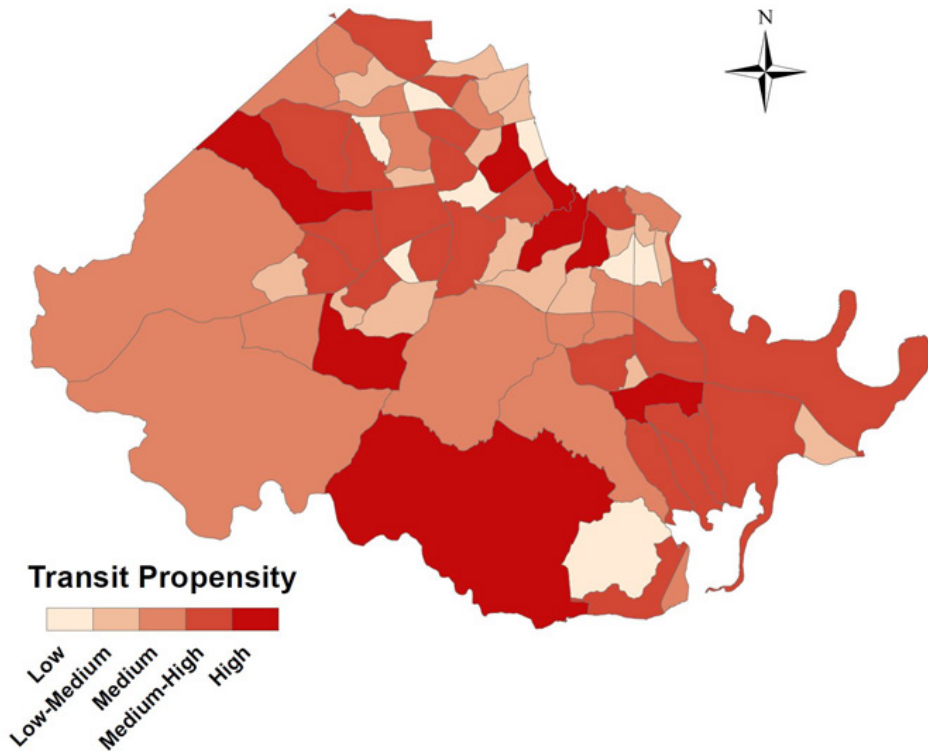


Figure 14: Transit Propensity by Census Tract



According to the transit propensity index, the highest levels of transit dependency exist in the northwestern area of the county along Midlothian Turnpike, a portion of Hull Street, and along Route 1. Route 1 notably has a high minority presence. Recommendations will focus on these areas.

3.2 Existing Economic Conditions

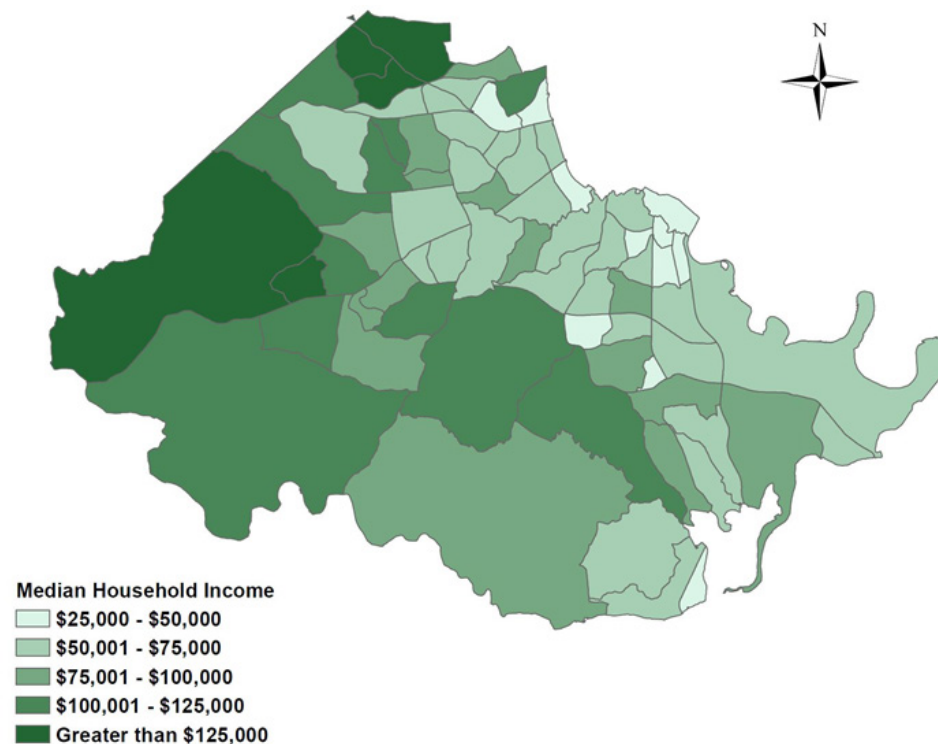
While Chesterfield's median income of \$76,969 would suggest overall locality wealth, closer observation at the census tract level would reveal median household incomes that range from \$25,000 to \$176,000. In Figure 15 below, the greatest clusters of median household income between \$25,000 and \$50,000 can be found along the Route 1 corridor. Individuals with lower incomes are less likely to own vehicles due to the costs of maintenance, gas, and property taxes and represent a portion of the market for transit ridership. Data for median household income was gathered at the census tract level.

Though transit-dependent populations rely on public transit, they are not the only group that comprise transit ridership. Workforce-aged individuals present an immense market for ridership, especially considering the clustering of business establishments and groups of workers who may have similar destinations multiple days per week. Total jobs per census tract were collected using data from the Virginia Employment Commission, attained through VCU's Center for Urban and Regional Analysis (CURA).

According to Census On The Map, Chesterfield "exports" approximately 67% of its workforce. Only about 33% of workers both live and work in the County. While economic activity within the county is specifically within focus, employment cannot be considered independently or only locality-wide. Individuals travel across jurisdictions for employment, and this can be observed in Chesterfield's workforce traveling patterns.

Figure 16 illustrates job counts for Chesterfield County and its neighboring localities of Richmond and Henrico in 2017. There must be an understanding of

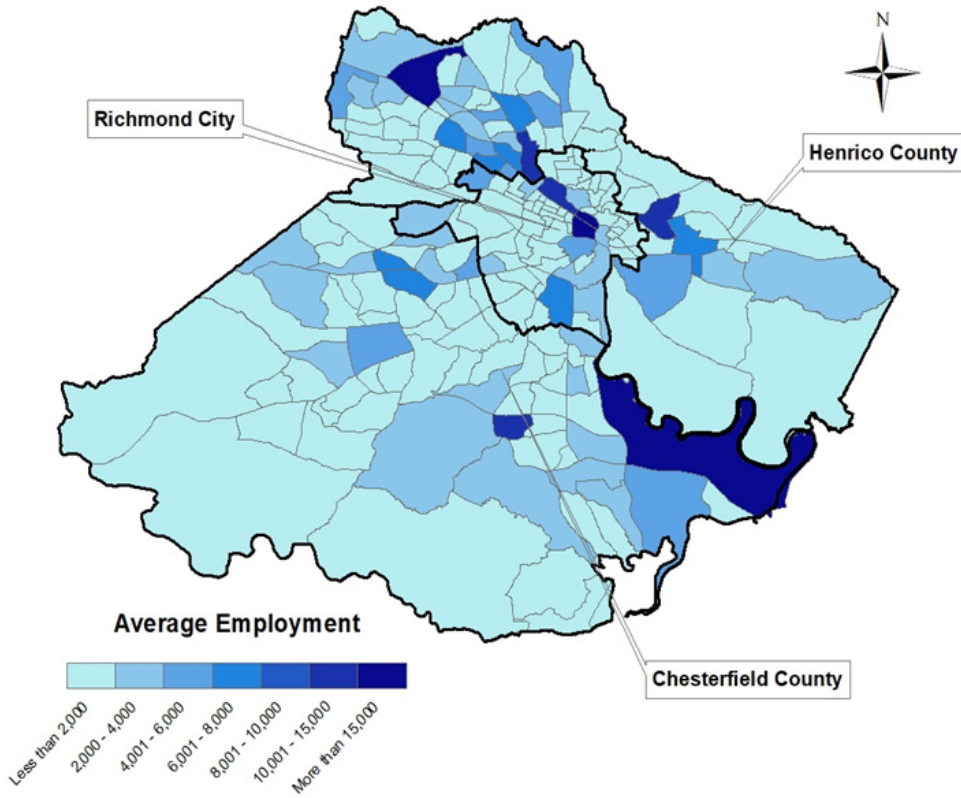
Figure 15: Median Household Income by Census Tract, 2017



where jobs are concentrated in the region to fully grasp the possibilities of where Chesterfield workers are going. These three localities are in focus due to their being within GRTC Transit System's existing service area.

Employment destinations are present in each of the localities. Downtown Richmond, Innsbrook in Henrico, and Chesterfield's government center specifically come into focus.

Figure 16: Average Employment in 2017 for Richmond, Chesterfield, and Henrico by Census Tract



Notably excluded from consideration for “major employers” are a number of large retail employers that have multiple locations. These include: WaWa, Kroger, Capital One banks, SunTrust banks, Food Lion, WalMart, Target, UPS, Bon Secours hospitals, and Home Depot.

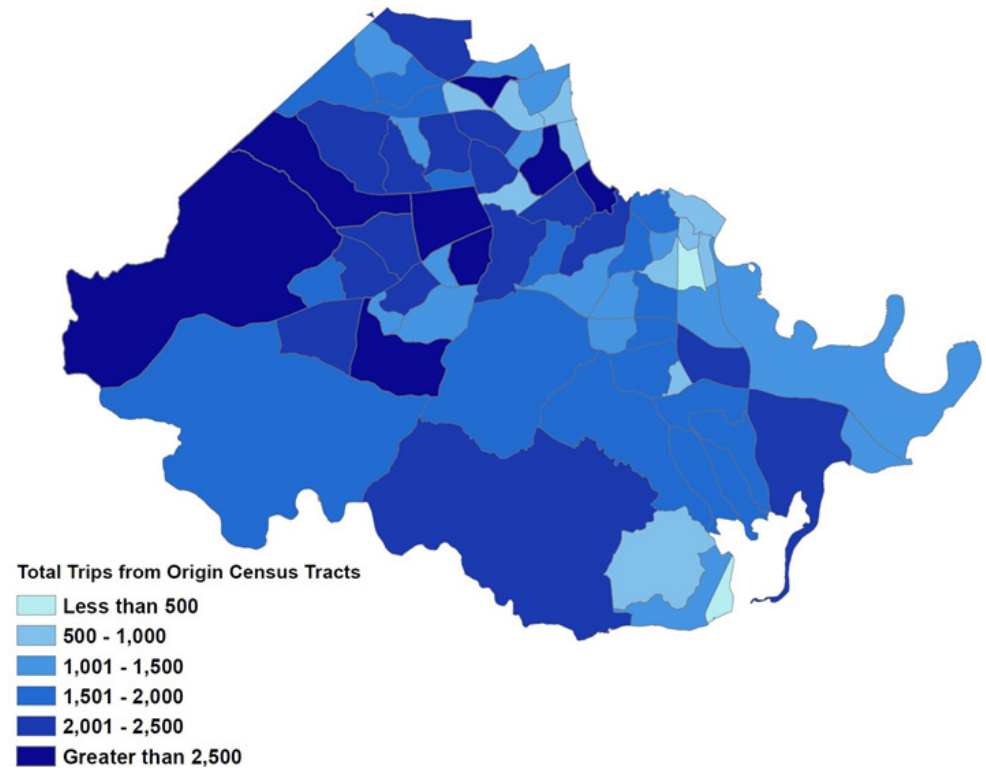
3.3 Commuter Analysis

What commuter patterns exist among the county's workforce? A “commute” is a work-related trip between home and work. Commuter data is specifically important to observe because it demonstrates movement, while general demographic data is static. Commuter origin and destination data were collected from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) dataset. It collects statewide origin-destination data for employment that is aggregated at the census block level. Total jobs include public and private sector jobs that are the primary job held by the individual. While this dataset is the most comprehensive of its kind, it has a few limitations:

- The dataset excludes self-employed individuals and those without employment insurance
- The 2017 dataset does not include federal workers due to data sharing restrictions
- Workplaces with multiple physical locations may not be reported, leading to inaccuracies in worker destinations
- The dataset offers a Euclidean distance understanding of commute trips, but cannot demonstrate the variations of routes that individuals can take to and from work

Trips that originated in Chesterfield County were extracted and sorted by locality. Trips with destination in Chesterfield, Richmond, and Henrico were utilized for this section's analysis because those are the primary localities of GRTC's existing service area.

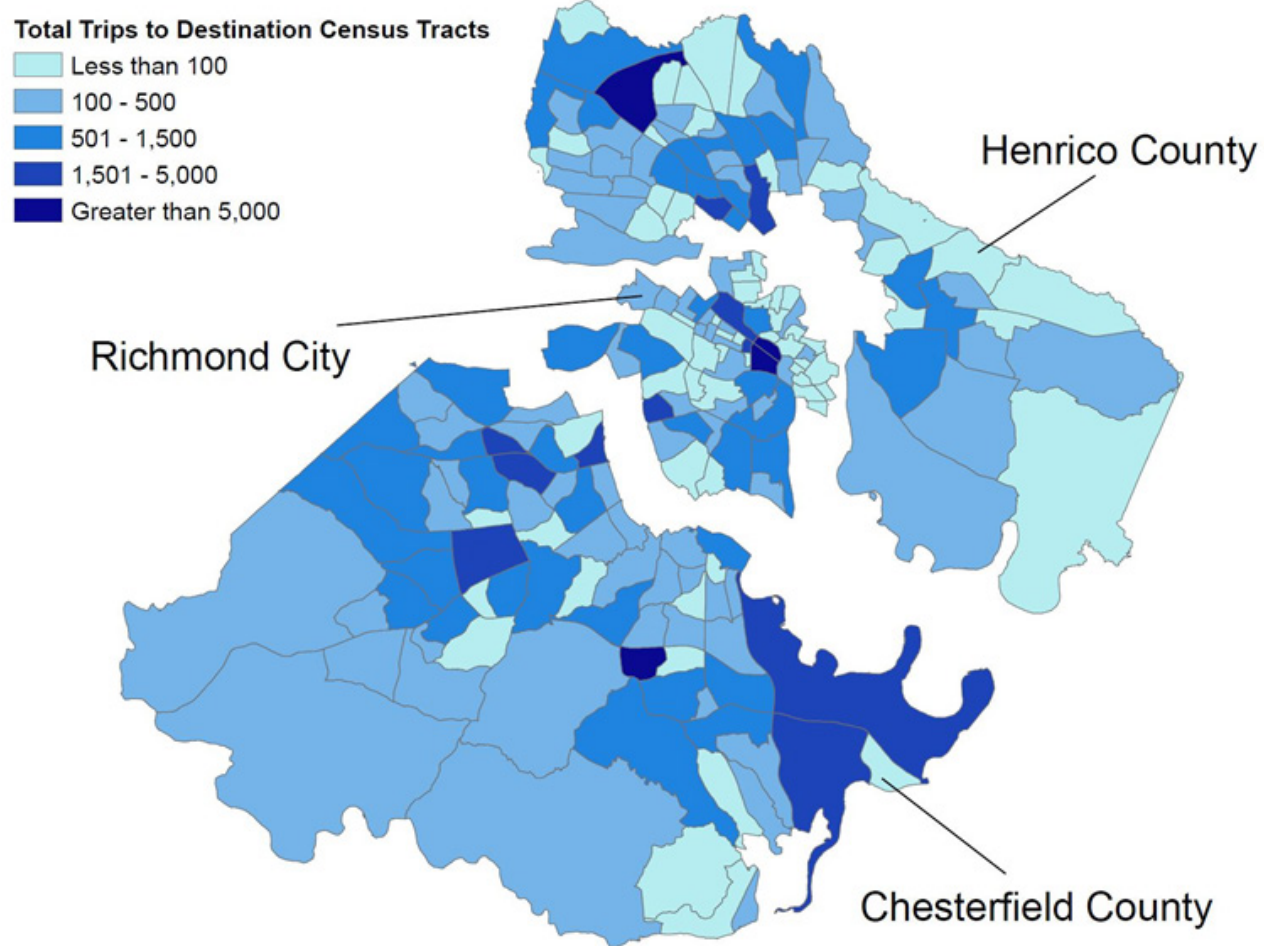
Figure 17: Total Trips from Origin Census Tracts in Chesterfield County



According to the LEHD data for 2017, the total number of trips originating in Chesterfield is 117,485. Figure 17 illustrates how many trips are originating from each census tract in the county.

Figure 18 shows the number of destination trips to each census tract. This distribution is relatively similar to the previously included map of employment density.

Figure 18: Total Trips to Destination Census Tracts



Additionally, the close relationship between land use and transportation planning cannot be overlooked with the observance of commuter habits. Where people live and work are key determinants of the trips that they make, and how they most efficiently get there.

Figure 19: Top 15 Census Tracts with Highest Commuter Origins

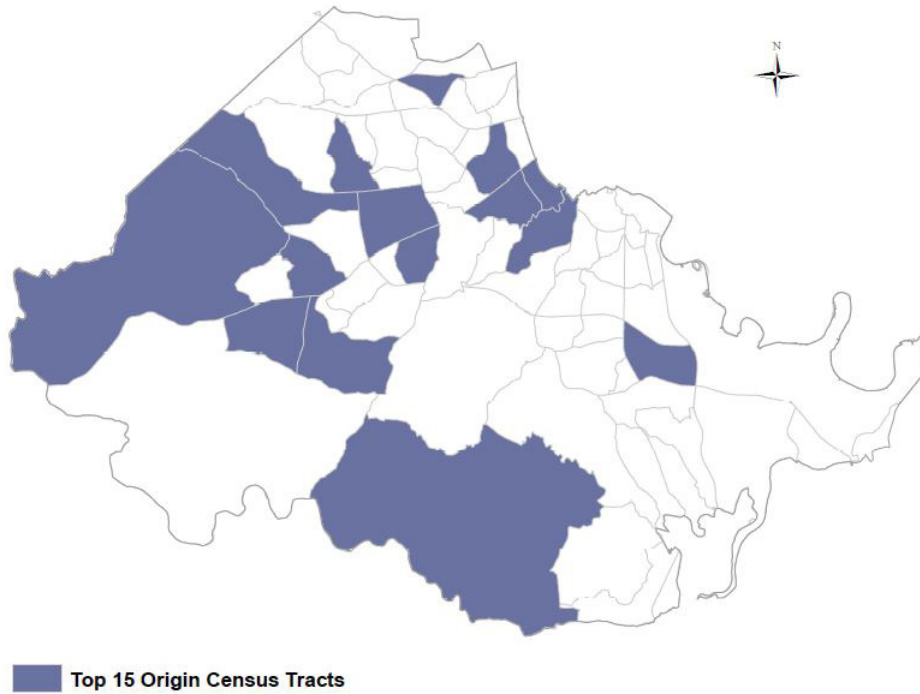
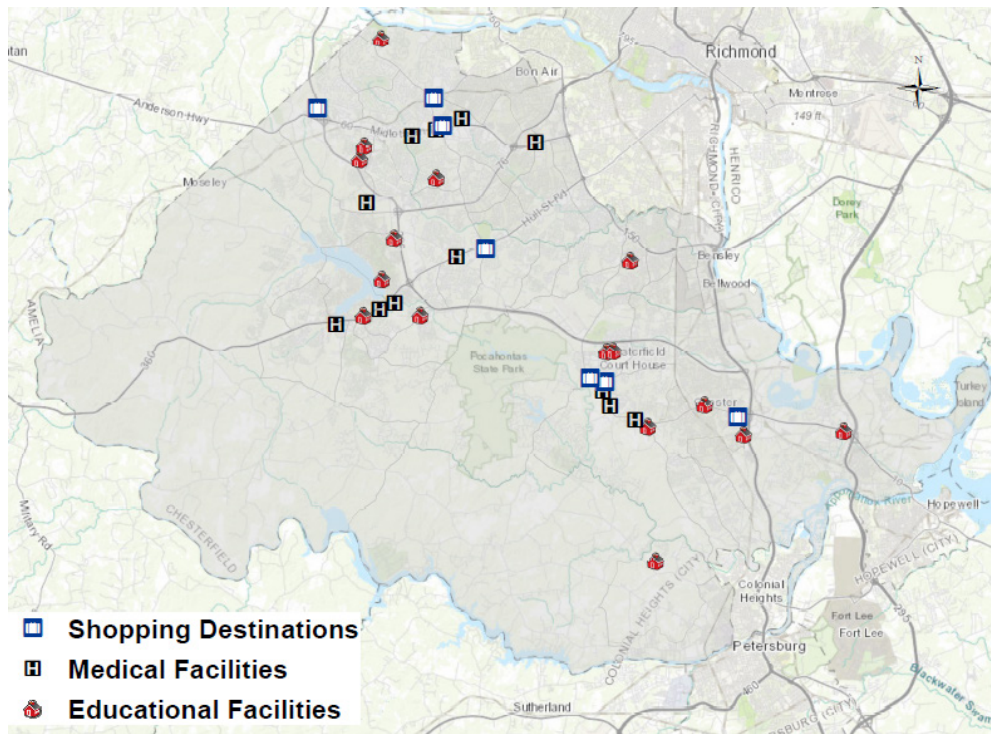


Figure 19 illustrates the census tracts with the highest commuter origins in Chesterfield County. The southernmost census tract that is highlighted should be noted -- transit service is unable to be provided there due to road network constraints that will be discussed further in the *Recommendations* chapter.

3.4 Major Trip Attractors

Aside from where people live and work, individuals also use critical resources and engage in leisurely activities. Trip attractors that have potential to generate varying levels of trips include educational facilities, medical facilities, commercial shopping destinations, and high-density housing.

Figure 20: Major Trip Attractors



Major Trip Attractors are present throughout the northern half of Chesterfield County, on both the eastern and western sides. The southern half of the County does not have many trip attractors.

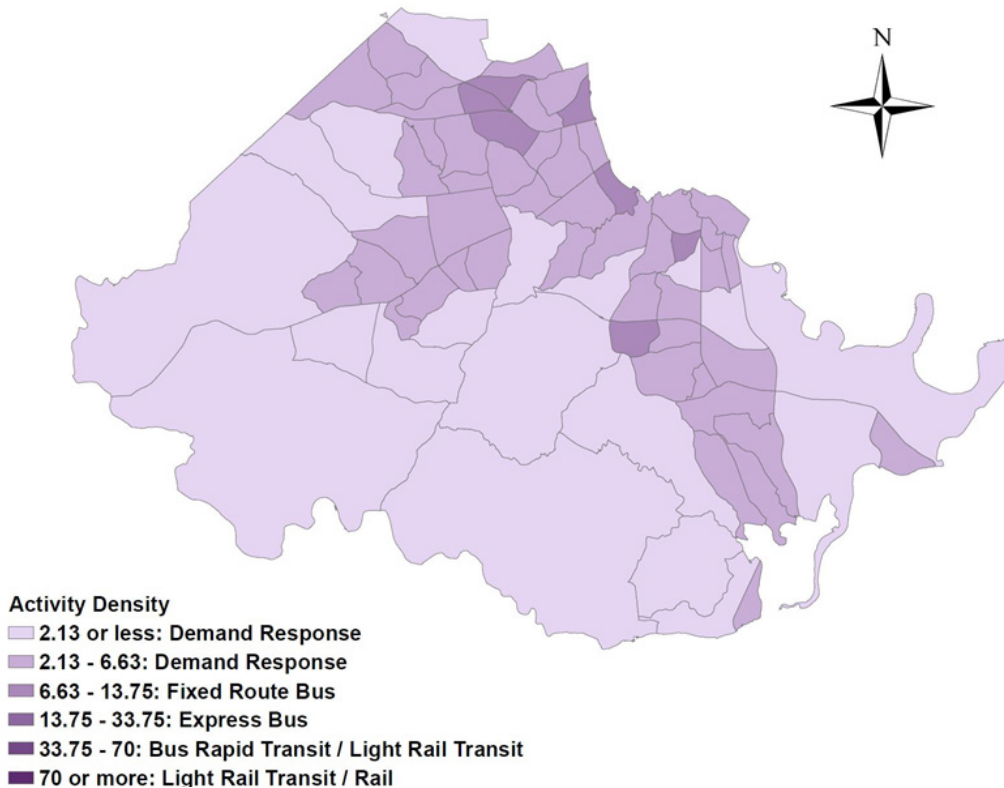
Many trip attractors are clustered along Midlothian Turnpike, Courthouse Road, and Hull Street. Preliminary opportunities for high-frequency routes along these major roadways can begin to be conceptualized from what is being observed.

3.5 Activity Density

Where are the greatest employment and population densities in the county?

Using data from the U.S. Census and Virginia Employment Commission, job density and population density were assessed per acre and combined to create a collective “activity density”. Population density refers to people per square acre, and total population was the demographic used from the U.S. Census Bureau. Job counts were attained from the Virginia Employment Commission by census tract, and calculated per square acre for each census tract. These two numbers were then combined to determine the collective “activity density” found below.

Figure 21: Activity Density by Census Tract



The legend below Figure 21 represents guidelines for transit investments supported by the Virginia Department of Rail and Public Transportation. Since most major transportation initiatives are supported by a combination of local, state, and federal funding, using pre-established benchmarks would be the logical decision.

Findings indicate that Chesterfield County is not as dense as an urban core, thus most rail investments will be excluded from consideration as recommendations are developed. As was expected, much of the rural portions of the county have densities conducive to demand response service. Some tracts, however, are suitable for fixed route and express bus according to this measure.

Just as the positions of major trip attractors demonstrated, the southernmost portions of the County would not be extremely conducive to transit service.

CHAPTER 4: PREVIOUS PLANS AND STUDIES

Public engagement is important because it shows planners what numbers can't explain. Where do people want to go, and how do they typically get there? Are there alternative routes that residents typically travel due to traffic volume, constant maintenance, or other inconveniences? How could transit support the existing roadway network?

Due to time and resource constraints, public engagement was unable to be included in the development of this plan. Multiple planning studies have been completed within the last five years, however, and some included extensive engagement efforts. This chapter summarizes relevant feedback and recommendations from prior plans that relate to expanding transit service in Chesterfield County.

Midlothian Community Special Area Plan, 2019

The Midlothian Special Area Plan was adopted in December 2019 by the county board. Two recommendations are particularly critical:

- Bus rapid transit extension from the Pulse station downtown to Westchester Commons, traveling along Route 60 (Midlothian Turnpike)
- Commuter and light rail along the existing Norfolk Southern Railroad corridor, from Main Street Station in Richmond to Otterdale Road

Additionally, numerous public comments gathered following the draft plan's release specifically identified traffic congestion along Routes 288 and 60 (Midlothian Turnpike) as major issues. High-capacity transit service along these routes could support alleviating high traffic volumes without the expense of adding and maintaining additional roadway capacity.

Chesterfield Millennial Visioning Project Report, 2019

In 2019, county administrators assembled a steering committee of citizens and stakeholders to administer an electronic survey about millennial preferences in the Richmond region. The survey was administered in May 2019 and a workshop was hosted in July. The report revealed a few key findings that will inform the recommendations of this plan:

- 67% of respondents travel to the City of Richmond for socialization because of the clustering of venues and the ability to move between them without a car
- 60% of respondents would prefer to live in a dense development centered around a rapid transit stop with retail, restaurants, offices, and residences in walkable proximity
- 66% of respondents would not like to live where retail, restaurants, offices, and residences are all kept separate and accessible only by car
- Over half of respondents said that a regional bus network in the Richmond metro area is important to them
- Attendees of the workshop indicated that additional transit would help them feel more connected to Richmond City and its amenities
- Over 60% of respondents said that sidewalks and bike lanes are more important to them than cars

As indicated by results of the survey, the region's millennial population has a propensity and preference for living in dense, walkable places with mixed uses and access to transit.

Chesterfield County Comprehensive Plan, 2019

Chesterfield County's most recent Comprehensive Plan was completed and adopted by the Board of Supervisors in May 2019. Chapter 13: Transportation describes current and future transportation initiatives for the County's consideration, including detail about the Greater Richmond Transit Vision Plan. Broad concepts from the vision plan that are included in the Comprehensive Plan include:

- BRT along Midlothian Turnpike to Westchester Commons
- BRT along Hull Street to Magnolia Green
- Express service along 288

These concepts will be explored further in depth in the Recommendations section of this plan. Comprehensive Plans generally contain extensive public engagement periods, but raw documentation of public comments wasn't able to be located.

GRTC Transit Development Plan, 2018

GRTC's most recent Transit Development Plan (TDP) was completed and adopted by its Board in 2018. A TDP is a planning document that provides a broad overview of the transit system, its services offered, and potential improvements. This document informs short- and long-term planning efforts for the system over six to ten years, and is required by the Virginia Department of Rail and Public Transportation.

The TDP recommended that potential connections between the City of Richmond and surrounding county corridors be considered for transit enhancement. Within Chesterfield County, key improvement concepts included:

- Extend Route 82x to Chesterfield Career and Technical Center
- Extend Route 2b to Arboretum Place
- Extend Route a to Chesterfield Towne Center, Old Buckingham/Woolride, and Westchester Commons incrementally
- Extend Route 1c to Genito Road and Woodlake Shopping Center incrementally, via Hull Street Road
- Extend and branch Route 86 along Route 10 to connect with Chesterfield Government Center and John Tyler Community College
- New express service from Cogbill and Chippenham Park and Ride to downtown Richmond
- New local route with hourly service forming a loop along Dundas, Meadowdale, Hopkins, Cogbill, and Route 1 that would connect with 3b/c

Greater Richmond Transit Vision Plan, 2016

In 2016, the Virginia Department of Rail and Public Transportation (DRPT) released the Greater Richmond Transit Vision Plan for the Richmond region. It established a multimodal vision for the future of public transportation in the Richmond region, and identified five candidate corridors for future BRT service. Two of those corridors are located at least partially in Chesterfield County: Midlothian Turnpike and Hull Street Road. Both will be integral to the recommendations outlined in this plan. A Transit Vision Plan Phase II is currently underway.

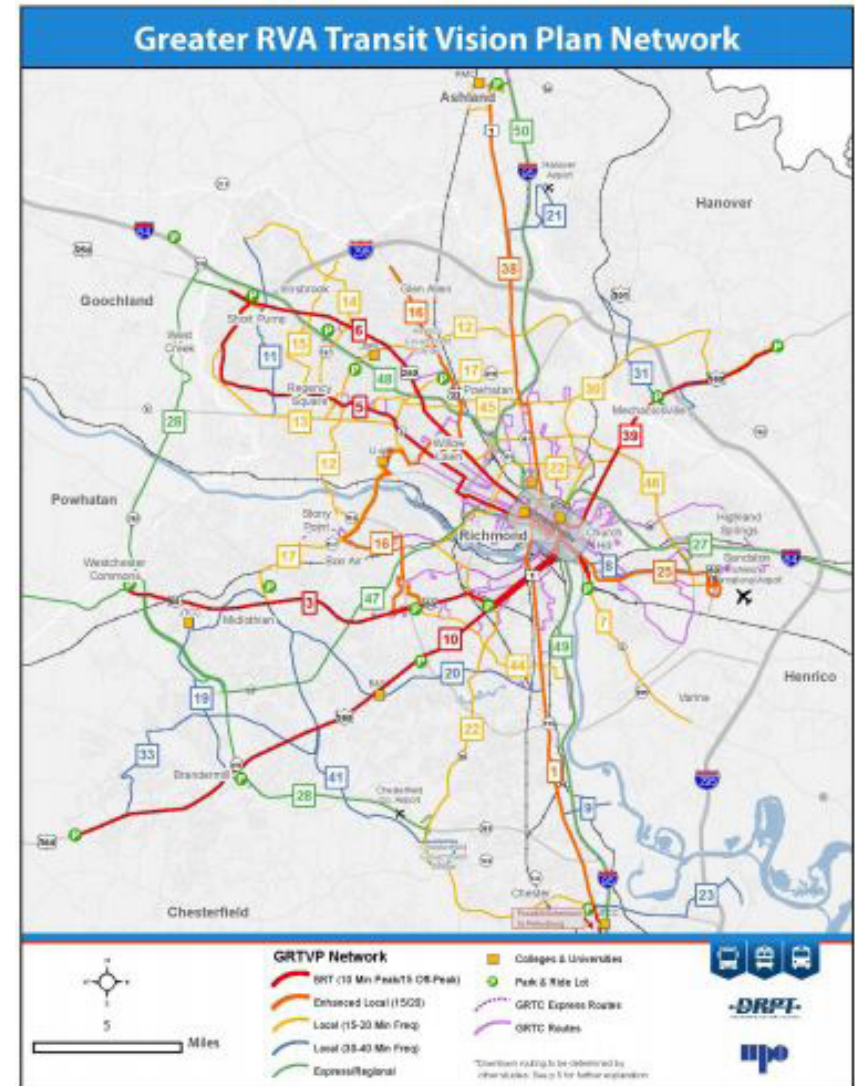
While key corridors may appear to support BRT service, the introduction of traditional transit service is the first step prior to making large infrastructure investments. This will establish resident familiarity with bus service and build preliminary ridership. High-frequency transit service with headways of at least

20 minutes are attractive “starting points”. Recommendations specific to Chesterfield County identified by the Transit Vision Plan include:

- Develop a comprehensive vision plan for transit-oriented development at key focus areas on the Midlothian Turnpike corridor (Spring Rock Green Shopping Center, Chesterfield Town Center, Midlothian Village)
- Establish a vision for transit-supportive development nodes on the Hull Street corridor
- Continue progress on small area / corridor planning for Jefferson Davis Highway, and include recommendations to support transit-supportive development nodes along the corridor
- Introduce local service along Old Buckingham Road, Woolridge Road, and Charter Colony Parkway from Courthouse Road to Brandermill
- Introduce local service along W Hundred Rd, Rivers Bend Blvd, and Meadowville Technology Pkwy from John Tyler Community College to Amazon
- Introduce local service along Fox Club Pkwy, Woolridge Rd, Genito Rd, and Courthouse Rd from Rockwood Park/360 to Moseley
- Introduce local service along Courthouse Rd from Rockwood Park/360 to Chesterfield Government Center

Figure 22 to the right illustrates the regional transit network developed by the Transit Vision Plan.

Figure 22: Greater Richmond Transit Vision Plan Network



CHAPTER 5: RECOMMENDATIONS

5.1 Plan Goals and Objectives

As previously mentioned, this plan was preceded by the completion of the Greater Richmond Transit Vision Plan in 2016. It identified a unified direction for future transit development in the region, and this plan's goals and objectives will support it. Two subsequent plans (The Richmond Network Redesign and GRTC Transit Development Plan) also utilized this vision. Below is the statement developed for the Transit Vision Plan.

By 2040, transit will connect the Richmond region through an efficient, reliable, seamless and sustainably-funded system that benefits everyone by enabling economic growth, promoting livable and walkable transit-oriented development, expanding access to jobs and services, and strengthening multimodal access within and beyond our region.

Additionally, the goals and objectives presented in this chapter were informed by the findings in previous chapters. They intend to address challenges and opportunities in the most succinct, efficient ways.

Goal 1: Connect residents to major transportation corridors and employment centers

- Objective 1.1: Introduce transit service along Midlothian Turnpike
- Objective 1.2: Introduce transit service along Hull Street Road
- Objective 1.3: Introduce routes that travel to employment-dense areas in each of the three localities: Chesterfield, Richmond, and Henrico

Goal 2: Provide useful, attractive transit options to potential riders

- Objective 2.1: Routes will minimally operate at half-hour headways
- Objective 2.2: Bus stops will be spaced approximately ¼ mile apart
- Objective 2.3: Bus stops will be in compliance with ADA requirements
- Objective 2.4: Bus stops will be well-lit and safe

Goal 3: Integrate with the existing transit network where possible

- Objective 3.1: Reconfigure or extend routes that travel to downtown Richmond
- Objective 3.2: Utilize existing transportation infrastructure to support commuter routes, such as park-and-ride lots

Goal 4: Improve public image

- Objective 4.1: Conduct additional public outreach within Chesterfield County
- Objective 4.2: Launch marketing campaigns with each new route

Goal 5: Integrate transit-supportive initiatives into county planning processes, such as comprehensive plans, small area plans, and yearly budget processes

- Objective 5.1: Identify opportunities for additional mixed land uses
- Objective 5.2: Conduct a countywide sidewalk inventory and prioritize the construction of pedestrian infrastructure
- Objective 5.3: Identify opportunities for infill development and redevelopment to support higher densities

5.2 Proposed Routes

Figure 23: Existing GRTC Transit Network

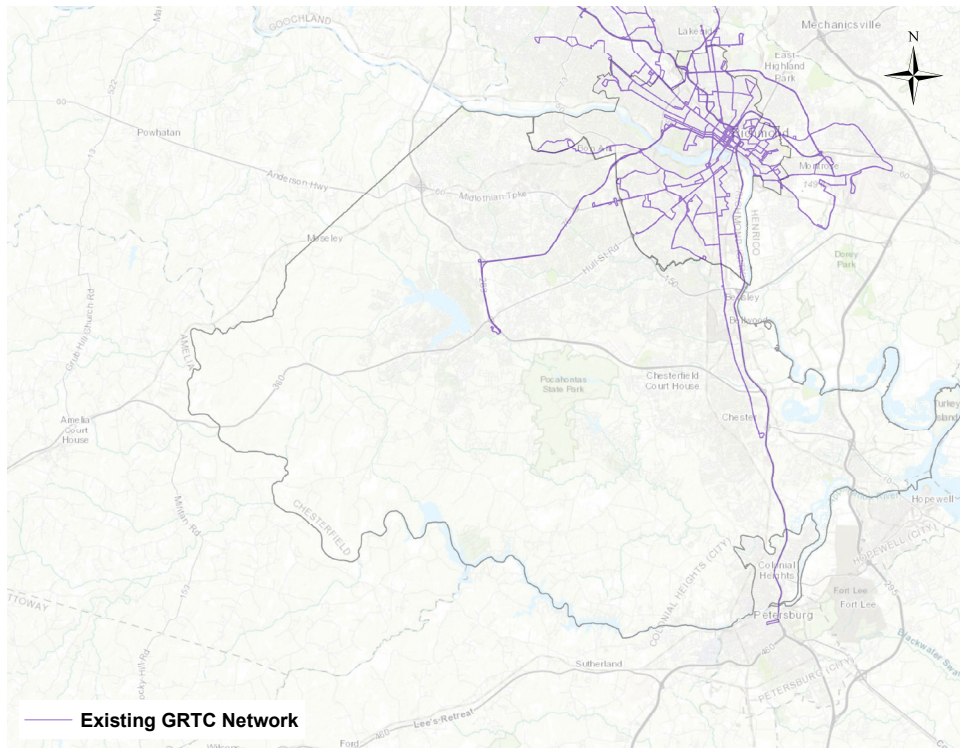
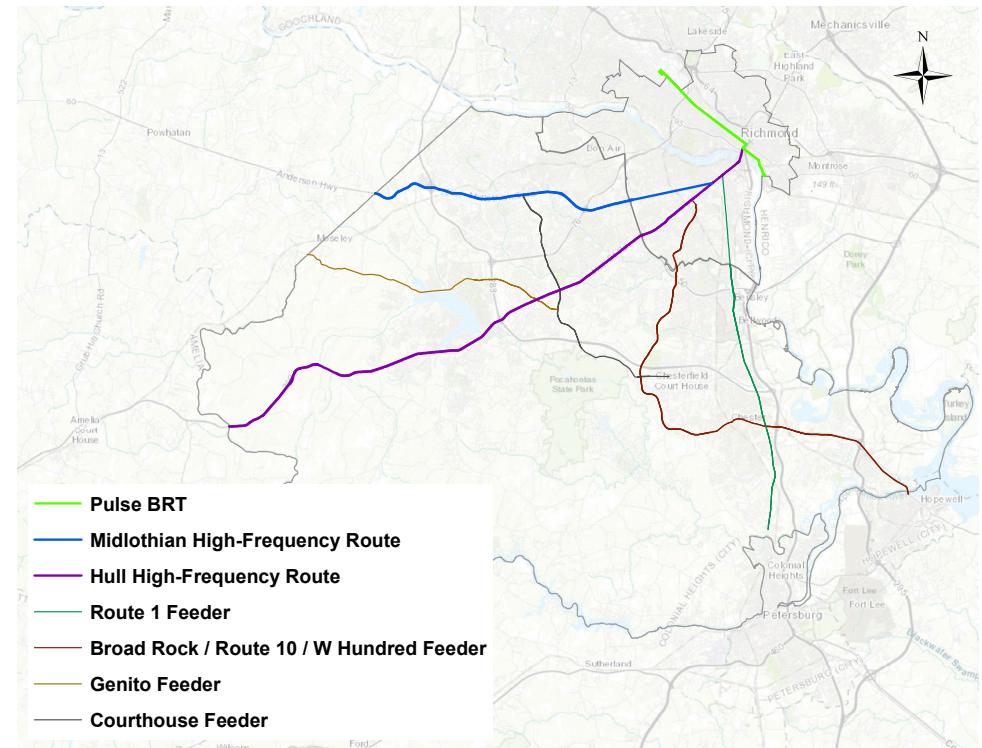


Figure 24: Proposed Chesterfield County Transit Routes



Route recommendations are primarily framed around future BRT service along the county's highest-potential corridors and identified Goals and Objectives from the previous section. **Goal 1: Connect residents to major transportation corridors and employment centers** can be achieved through the implementation of high-frequency transit routes that will be the backbone of service. These include Midlothian Turnpike and Hull Street Road. High-frequency transit for the two corridors would begin at the VCU Medical Center Pulse station in downtown Richmond, and utilize 14th Street to access Hull Street. At Clopton, the routes would branch. One would continue along Hull and the other along Midlothian Turnpike. Each route would have 15-minute frequencies.

Figures 23 and 24 illustrate GRTC's existing transit network and proposed routes for Chesterfield. Feeder routes would travel and intersect the high-frequency routes and support the achievement of **Goal 2: Provide useful, attractive transit options to potential riders**. This includes the following route concepts:

- Seamless Route 1 feeder between the county and city, operating at half-hour headways
- Genito Road feeder, operating at half-hour headways
- Broad Rock Boulevard / Route 10 / West Hundred Road feeder, operating at half-hour headways
- Courthouse Road feeder, operating at half-hour headways

Though the transit propensity index compiled in Chapter 3 identified one high-potential census tract in the southern portion of the county, there were no trip attractors identified in close proximity. Additionally, the roadway network within that census tract is limited and not particularly conducive to transit vehicles. To alleviate similar issues across less-dense portions of the county, a series of park-and-rides should be investigated.

5.3 Financial and Implementation Plan

Prior to the 2020 Virginia General Assembly session, one of the greatest barriers to public transportation expansion in the Richmond region was the lack of dedicated funding for transit operations and capital needs. The Richmond Metropolitan Transportation authority was created by the Virginia General Assembly in 1966 for the construction and maintenance of the downtown expressway . A similar “transit authority” had not been created, leaving GRTC Transit System only able to implement service that each locality is willing to pay for. It could not levy taxes or use similar means to raise funds and had to look elsewhere to fund initiatives.

The 2020 General Assembly session passed a number of laws related to transportation reform. House Bill 1541 (HB1541) created the Central Virginia Transportation Authority (CVTA), which will administer transportation funding to localities within Planning District 15 . The bill collects funding through the imposition of the following taxes:

- 0.7% sales tax
- 7.6 cent per gallon gas tax
- 7.7 cent per gallon diesel fuel tax

The gas tax rates are tied to inflation, and will fluctuate as the economy grows or retracts. Fifteen percent of funds collected will be allocated to GRTC for the provision of transit and mobility services within the planning district, and the remainder of the funds will return proportionally to the localities for general transportation use. The creation of the CVTA provides an opportunity for more stabilized funding sources for the transit system, as transit funding will not have to compete as aggressively with locality priorities for their general fund revenues. This alleviates some degree of uncertainty from fiscal year to fiscal year.

Funding from the CVTA likely wouldn’t cover the entirety of the transit system’s operating budget. Cross-jurisdictional routes would be great candidates for funding out of this stream, such as those that travel along Midlothian Turnpike, Hull Street, and Route 1.

Sources of financial support for transit operating and capital expenses are available through the Federal Transit Administration (FTA) and the Virginia Department of Rail and Public Transportation (DRPT). Each source is accompanied by different levels of funding and local match requirements, which are further detailed in this portion of the plan.

Service Costs

To develop cost projections for each proposed service recommendation, GRTC’s average operating expense per vehicle revenue hour (VRH) was gathered from the National Transit Database. In 2018, the transit agency’s **cost per VRH** was \$114.19 for fixed-route services and \$107.24 for bus rapid transit. This measures the cost of providing transit service alone and excludes operator training, maintenance testing, and deadhead hours.

Costs for service improvements in Table 2 are costs of service only, and do not include capital needs that may be associated with expanded or new service. The following formula was used to calculate annual operating costs:

$$\text{Annual Operating Cost} = [\text{COST/VRH FOR MODE}] * [\text{TOTAL SERVICE HOURS}] * [\text{ROUTE FREQUENCY}] * [\text{DAYS OF SERVICE IN ONE WEEK}] * [\text{52 WEEKS IN A YEAR}]$$

These costs are intended to serve as ballpark-estimates only, and do not consider additional factors like schedules or reduction of service duplication. There could be cost benefits for transitioning transit service along Route 1 to a seamless route, for example. Costs assume that each route will run from approximately 6:00 AM to 1:00 at their respective headways for seven days a week.

Table 2: Proposed Service Cost Estimations

Route	Headway	Annual Operating Cost
Midlothian Turnpike	15 mins	\$3,153,696
Hull Street	15 mins	\$3,153,696
Broad Rock Boulevard / Route 10 / W Hundred Road	30 mins	\$1,576,848
Genito Road	30 mins	\$1,576,848
Courthouse Road	30 mins	\$1,576,848

State Funding Opportunities

Transit funding often comes from a variety of sources. These could include individual localities, sales or lodging taxes, state sources, or federal support. Locality resources are typically exhausted and limited, and will not be further explored within this plan due to the creation of the Central Virginia Transit Authority. Relevant state and local funding opportunities are presented below.

The Virginia Department of Rail and Public Transportation (DRPT) is the state body that supports Virginia’s public transportation providers. Pursuant to policy set forth by the Commonwealth Transportation Board (CTB) and Virginia statute, it allocates operating assistance using a performance-based methodology that considers both agency size and performance. This formula is “fixed” and cannot be manipulated or changed.

DRPT offers grants to transportation agencies with varying levels of local match requirements and conditions that could support new transit service. One of which, the **Demonstration Grant**, has already been acquired by Chesterfield County to launch their Route 1 service. This could be a future funding source as new service is decided upon in the county. This grant provides 80% of state funding and requires a 20% local match should it be awarded.

The DRPT **Technical Assistance grant program** supports studies, research, plans, and data collection that help improve or evaluate public transportation services. A wide range of studies potentially qualify for this funding opportunity, and GRTC could utilize it for studying specific corridors in depth prior to launching new service. Studies like this Transit Feasibility Plan, for example, would qualify for support under this umbrella. This grant provides 50% of state funding and requires a 50% local match.

SMART SCALE is Virginia’s competitive prioritization process to evaluate applications for state transportation funding. While transit projects qualify for funding under existing guidelines, agencies and localities must ensure that projects submitted for SMART SCALE are the best fit. SMART SCALE funds projects at 100% and could be an attractive option for future BRT expansion should GRTC and the county pursue those routes.

Federal Funding Opportunities

The Federal Transit Administration (FTA) is the federal body supporting local transit systems of varying modes nationwide. It has a number of competitive grant programs, some of which could be pursued for introducing new transit service or supporting capital costs. Two federal grant programs are particularly

notable: the **Better Utilizing Investments to Leverage Development (BUILD)** transportation grants program and the **Capital Investment Grants (CIG)** program. The BUILD program (formerly known as TIGER) was one of the funding sources leveraged by GRTC, Henrico, and Richmond for the completion of the Pulse. Unlike BUILD, however, the CIG program is exclusively for transit capital investments. It is a multi-year process and thus an investment, but a worthwhile endeavor for federal financial support.

Smaller federal grant opportunities include FTA's **Bus and Bus Facilities** program and **Low or No Emission Vehicle** program. Both support the replacement, rehabilitation, and purchase of transit vehicles. The Low/No Emission Vehicle program specifically provides funding for the purchase of zero- and low-emission transit buses and necessary facilities.

REFERENCES

- About. (n.d.). Retrieved from <https://www.rmtaonline.org/about/>
- Black, A. (1995). *Urban mass transportation planning*. New York, NY: McGraw-Hill, Inc.
- Forkenbrock, D. J., & Sheeley, J. (2004). Effective methods for environmental justice assessment. *The National Academics of Sciences, Engineering, and Medicine*.
- Chesterfield County, Virginia. (2018). *Moving forward: The comprehensive plan for Chesterfield County*.
- Davidoff, P. (1965). Advocacy and pluralism in planning. In S. Feinstein (Ed.) & J. DeFilippis (Ed.), *Readings in planning theory* (pp. 427-442). West Sussex, UK: John Wiley & Sons.
- GRTC Transit System (2018). *Transit development plan*.
- Issues in bus rapid transit. (n.d.). Retrieved from <https://www.transit.dot.gov/sites/fta.dot.gov/files/issues.pdf>
- Jiao, J. (2017). Identifying transit deserts in major Texas cities where the supplies missed the demands. *Journal of Transport and Land Use*, 10(1).
- Jiao, J., & Dillivan, M. (2013). Transit deserts: The gap between demand and supply. *Journal of Public Transportation*, 16(3), 23-39.
- Levinson, H. S., Zimmerman, S., Clinger, J., Gast, J., Rutherford, S., & Bruhn, E. (2003). Bus rapid transit volume 2: Implementation guidelines. Retrieved from https://nacto.org/docs/usdg/tcrp_rpt_90_implementation_guidelines_volume_2_levinson.pdf
- Lipsitz, G. (2007). The racialization of space and the spatialization of race: Theorizing the hidden architecture of landscape. *Landscape Journal*, 26(1), 10-23.
- Milam, R. T., Birnbaum, M., Ganson, C., Handy, S., & Walters, J. (2017). Closing the induced travel gap between research and practice. *Transportation Research Record*, 2653, 10-16.
- Mcleod, S., Scheurer, J., & Curtis, C. (2017). Urban public transport: Planning principles and emerging practice. *Journal of Planning Literature*, 32, 223-239.
- National transit database (NTD) glossary. (2019). Retrieved from <https://www.transit.dot.gov/ntd/national-transit-database-ntd-glossary>
- Our history. (n.d.). Retrieved from <http://ridegrtc.com/about-us/our-history>
- Taylor, N. (1998). *Urban planning theory since 1945*. London: Sage.

REFERENCES

University of Virginia Weldon Cooper Center, Demographics Research Group. (2019). Virginia Population Estimates. Retrieved from <https://demographics.coopercenter.org/virginia-population-estimates>.

University of Virginia Weldon Cooper Center, Demographics Research Group. (2019). Virginia Population Projections. Retrieved from <https://demographics.coopercenter.org/virginia-population-projections>

Weisbrod, G., Cutler, D., & Duncan, D. (2014). *Economic impacts of public transportation investment*.