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Transit Access Equity in Richmond, VA

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A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Urban and Regional Planning at Virginia Commonwealth University.

by

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ABSTRACT

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Major Director: Dr. Damian Pitt, Ph.D., Chair, Urban and Regional Studies

The purpose of this thesis is to analyze the extent of public transit access equity issues in Richmond, VA. The City of Richmond has an established public transportation network system, and the thesis explores the level of access for urban residents to use existing public transportation services. Technologies and programs have begun to emerge across the United States to help solve transit accessibility challenges. The thesis assesses the level of transit access equity that exists in Richmond and introduces technologies and services that could help improve accessibility and equity. The thesis uses a mixed methods approach that will consist of accessibility and equity measures, Geographic Information System (GIS), and key informant interviews.

CHAPTER 1

1.1 Introduction

Equitable transportation systems are necessary to ensure all people have equal opportunities and access to transportation. Although federal policies in the United States exist to safeguard transportation agencies' consideration of all members of society in transportation planning practices, competing priorities and budgets do no always create equal opportunity systems of transportation for all people. Equity issues in transportation date back at least to the Montgomery Bus Boycotts which took place from 1955 – 1956. The importance of transportation equity emerged with the Civil Rights Act of 1964, which enabled agencies to use resources in the most fair and nondiscriminatory way as possible (Colopy, 1994). Public transportation plays a critical role in mobility and commuting patterns. Multiple modes of transportation theoretically provide more opportunities to people commuting, but the location of such modes is only functional if they are implemented in locations that allow people to access them.

In many urban areas, especially in low-density urban environments, residents have difficulties accessing high-demand, high frequency public transit services such as public buses. The "first mile/last mile" (FMLM) problem is one such transit access equity issue. The term "last mile" was first used in the context of telecommunications, when referring to the final leg of the telecommunications network services delivery to customers (Stigo, 2017). It is now commonly used in transportation planning; the "first/last mile" is the first and last leg of an individual's commute. The "first/last mile" is a problem for several reasons: public transportation does not always start and end at target origins or destinations, parking may not be available at these two points, owning a vehicle may not be an option, and walking may not be the most convenient or possible way of getting around (King, 2016). The FMLM problem exists in the context of transportation availability, and trending solutions to FMLM and transit accessibility in general include demand-responsive transit systems, bikesharing systems, rideshare services, scooter-shares, walkable streets, smart cities, and effective urban design. Demand-responsive transit systems are user-oriented and rely on flexible routing and schedules; Dial-a-Ride is a common example of demand-responsive transit. Bikeshares, electric scooter, mopeds, and the like have begun emerging as fashionable solutions that are designed to be as attractive and fun to use as they are functional. Physical infrastructure improvements through urban design include better streets and sidewalks for people who choose to travel by other modes besides automobile use.

Public transportation in Richmond has evolved from originally a street-car system to one that is dominated by a bus transit network system. Greater Richmond Transit Company (GRTC) was founded in 1860 and its mission is "to provide clean, safe, and reliable transportation and to improve mobility and access throughout Central Virginia" (GRTC). GRTC provides a range of services including fixed route and express route bus service, specialized services such as CARE and C-VAN, and RideFinders (GRTC). In 2018, GRTC launched the city's first bus rapid transit service: the Pulse. The existing socioeconomic conditions and public transit services conclude that improvements can be made to the city's transportation network system to ensure equal access.

This thesis aims to address transit access equity issues in Richmond, Virginia. A methodological framework is presented to guide how research questions around the issue can be answered. The key objective of the thesis is to determine if, and to what extent, transit access equity is a problem in Richmond neighborhoods. This mixed methods study includes a Geographic Information System (GIS)-focused approach which will be the primary means of the quantitative analysis, and key informant interviews constituting the qualitative portion. Reviewing the literature and examining existing conditions introduce several research questions. The first question relates to determining if transit access inequity exists in the city: 1) To what extent is transit access inequity a problem for Richmond neighborhoods? Because it is assumed that the existing public transportation system can be improved, then the proposed methods will identify which neighborhoods experience higher levels of transit access equity/inequity based on certain criteria. Addressing the first research question leads to the question: 2) How can transit accessibility challenges can be solved in Richmond? This question is addressed through several methods: the GIS component identifies where transit access can be improved, which depending on spatial distance will influence what types of service will be appropriate for that specific area. Determining accessibility in these areas was an important step in this process. The last research question is: 3) How are new and existing transportation technologies and services addressing transit access equity? Qualitative analysis from key informant interviews influence the identification of transit access equity services that could be implemented in Richmond.

1.2 Emerging Technologies that Address Transportation Equity

Influential research has framed social exclusion as an equity problem that hurts economic growth, and it is therefore imperative that cities overcome economic and social exclusion (Piketty 2014). Recent studies show that vulnerable populations (low-income, minority race, transit dependent) are disproportionately affected by transportation infrastructure (Greene, et al., 2016). Some attribute social exclusion to targeted investment, policies and legislation, or the lack of equity initiatives in transportation planning. A 2018 report on mass transit ridership by the mobile ticketing software firm Masabi analyzed the key factors of ridership (Gooch, 2018). The report found that ⅓ of the US population is taking multimodal transportation trips for most of their regular trips, and multi-mobility increases public transit ridership which indicates a trend in multimodal transportation systems.

1.2.1 *Automobile Technologies*

Have A Go (2018), a company dedicated to promoting the use of electric vehicles and scooters, compared the ability of new urban technologies for developed countries to "cord cut", or to cut unnecessary expenses that are usually bundled into larger transportation systems. New mobility technologies allow cities to maximize transportation trips and cut operating costs. Multiple mobilities of transportation should not be viewed as competing against the more traditional forms of public transportation but should instead be integrated into a homogeneous network system as a service to fill the gaps.

A study conducted at MIT analyzed the impacts of rideshare adoption on traffic congestion in Boston, Massachusetts using mobile phone data (Alexander, 2015). The study measured the change in the number of vehicles, number of vehicle miles traveled, vehicle hours traveled, and congested travel time. Findings from this study show that ridesharing services can reduce the number of vehicles on the road without impacting travel time; this point leads to the fact that ridesharing is more efficient in smaller urban areas due to smaller geographic service area. One of the analyses included a 50% increase in rideshare adoption measures; this running of the model showed a decrease in congested travel time (37%) and nearly double the decrease in vehicles (19%). Findings from this study indicate that ridesharing services can positively impact traffic congestion and can be applied to urban areas of varying sizes and densities (such as Richmond, VA).

1.2.2 *Alternatives to Automobile Technologies*

Technologies such as electric bikeshares, dockless bikeshares, scooter shares, Segway, and public infrastructure such as adequate sidewalks, complete streets, linear parks, and bike parking are implementable designs that can be incorporated into existing public transportation infrastructure systems. A 2013 Transportation Research Record study in Washington, D.C. showed that bike share users were different from cyclists who commute regularly by bicycle. In this case, bike share riders were more likely to be women, to be younger, and to have lower incomes, and they were less likely to own bicycles or automobiles (Bryce, 2016). Non-automobile technologies play an important function in solving FMLM/accessibility problems while reducing gas emissions, increasing physical health, and livening communities.

1.2.3 *Technologies for Elderly, Individuals with Disabilities, and Mobility-Challenged*

Transportation equity also addresses accessibility for individuals with disabilities, the elderly, or other mobility-challenged populations that could benefit from public transit services. Technologies and services have evolved to specifically address accessibility issues for this portion of the population. Paratransit is typically known as a door-to-door minibus service provided as a supplement to fixed route public transportation services. Demand-responsive transit is a type of shared transport that provides door-to-door services using minibuses that are designed to accommodate wheelchairs. Public transportation is an important service to aging populations because it allows access to complete necessary household errands, doctor trips, and other daily trips. Findings show that adequate public transportation is also effective in preventing social isolation (Lucas, 2012; Mackett, 2015).

1.3 Existing Conditions in the United States

Public transportation has evolved in form, function, and ridership trends since the first use of such services. Public transportation was originally designed for utilitarian purposes: the transport of goods and services. It then evolved into a system for moving people as urban development grew across the US. Now, public transportation is heavily influenced by technology as cities strive to create the fastest, most efficient- if not trendy- modes of travel whilst keeping up with population and commuting trends. Along with these factors, transportation processes are also increasingly planning for aging adults, individuals with disabilities, and mobility-challenged.

1.3.1 *Existing Public Transportation Infrastructure in the US*

Public transportation systems in the US have evolved along with technological innovations and urbanization; public transportation today includes systems of buses, ferries, trolleys, and trains, including rapid transit (metros, subways, underground rail, etc.), light rail, and commuter rail. Some standout cities for having high-performing public transportation systems includes Portland, OR, New York City, NY, Seattle, WA, and San Francisco, CA (Bliss, 2018).

1.3.2 *Ridership Trends*

Public transportation provides an important linkage for low-income, elderly, and disabled populations to necessary services such as employment, grocery stores, and other necessary activities. The 2009 National Household Travel Survey shows that overall, households who make $30,000 or less annually take 21% fewer trips than other households (NHTC, 2009). The authors make the point that the discrepancy in trips traveled is not out of preference but largely due to the lack of transit services.

According to data from the American Public Transportation Association, overall public transportation ridership decreased by 3% between 2014 and 2016 (American Public Transportation Association, 2016). However, the longer-term trend shows overall ridership increasing from the last decade into the foreseeable future. Nationally, buses accounted for more than half of all public transportation trips in 2016 (American Public Transportation Association, 2016). One trend worth noting that affects national ridership is a decrease in the amount of drivers licenses in younger age groups due to federal policies promoting graduated licensing and an increase in shared-use mobility, such as bikesharing, carsharing, and ridesourcing (Sivak, 2016).

1.3.3 *Elderly, Individuals with Disabilities, and Mobility-Challenged*

Planning for accessibility for the elderly population is important and generally considers elderly and older adults as having varied functional behaviors, reduced way-finding and walking abilities, and other physical functional limitations. Research by AARP shows that nearly 20 percent of survey respondents ages 75 to 79 used ride sharing as their primary means of travel (AARP, 2011), so improving access to such services is important. Regarding access to transit services, there is a need for more complete and ADA-compliant sidewalks, ADA-accessible ramps, bike lanes, bike parking, and complete streets in Richmond. By 2030, it is projected that 8.7 million Americans will be age 85 and over, and a substantial portion of them will no longer drive (Transportation for America, 2015). In an AARP study (2011), 60 percent of people aged 50 and older reported that they did not have public transportation within a 10-minute walk from their homes.

Planning for aging adults is important because it is a sociological and psychological process in addition to a biological one. The aging process influences changes in daily patterns, activities, and obligations. A national trend is the continuing involvement of older people in the workforce after the retirement age (BLS, 2017). However, there are several age-related changes that affect driving abilities: sensory reception, neural processing and transmission, and motor response (Meyer, 2004; Hakamies-Blomqvist 1996). According to a 2016 TransitCenter report, older urban residents want fast, frequent, and reliable transit service, and they value ease of use and comfort. Planning public transportation for these changing demographics will not only make urban transit and paratransit more accessible for older residents, but the public transportation system will be more useful for residents of all ages.

In the United States, 12.6% of the population are individuals who have disabilities (Sze, 2017). "Disability" refers to an impairment and is a characteristic of an individual (Shakespeare, 2006) and includes vision-impaired, hearing-impaired, mental health conditions, intellectual disability, and physical disabilities. There are several factors that can prove to be accessibility barriers to people with a disability. For instance, a broken handrail at a bus stop could be dangerous for someone who is blind, and no designated pedestrian crossings make bus stops difficult to access for those with mobility challenges. Before-and-after studies on individuals with disabilities' access to public transit found improved perception of quality of bus services, improved social inclusion, and overall improved quality of life. Further evidence shows improved accessibility and universal design lead to an increase in ridership numbers (Aarhaug & Elvebakk, 2015; Fearnley, Hauge, 2010).

1.4 Cities' Models

Other cities' efforts to dealing with mobility technologies have led to political and regulatory struggles. In New York City, Mayor De Blasio recently put a limit on the number of new hires per month that ridesharing companies can employ, and several cities are following this example (Honan, 2018). The idea behind this is to control two things: the number of vehicles allowed in certain neighborhoods, and to prevent the agglomeration of mobility systems coverage in a geographic location to avoid monopolies of large service-providing companies. As we discover, the latter reason should not be weighed as heavily, as equitable multi-mobile transit services will complement, not inhibit, existing public transportation.

1.4.1 *Automobile Transportation Models*

In 2013, Dallas Area Rapid Transit (DART) launched D-Link, a micro-transit, on-demand free bus service serving the downtown Dallas area. The service is provided by DART, Downtown Dallas Inc., and the City of Dallas. In 2015, DART began partnering with ZipCar, Uber, and Lyft which can be accessed through DART's GoPass app. In 2016, DART received funding from the Federal Transit Administration's Mobility On Demand Sandbox Program. By providing a one-source, easy-to-use mobile platform, riders can access carsharing, bikesharing, and other ridesharing services (DART, 2017).

Chicago's commuter rail METRA addresses transit accessibility issues by prioritizing suburban employment centers. Partnerships with Pace and the Transportation Management Association of Lake Cook (TMA) which created the Shuttlebug program. Shuttlebug provides last-mile connections at Chicago Transit Authority (CTA) stations and employment centers along Pace's bus routes. Besides Pace's regular routes, Pace provides a "Call-n-Ride" service in ten designated areas and is seen as Chicago's area major provider of first-and-last mile connections. Pace also offers "Metra Feeder", a van carpool service. The service model introduced by Metra has led private employers to catch on by providing their own private shuttles to solve the FMLM problem and improve the area's transit accessibility (National Center for Mobility Management, 2013).

1.4.2 *Alternative Forms of Automotive Transportation Models*

Within the past decade, cities have seen the emergence of new, innovative mobile technologies pop up across the US. Washington, D.C. launched the nation's first bikeshare program in 2008. A 2011 study of the Washington, D.C. Capital Bikeshare program found that membership and daily trips were dramatically lower in seven African American neighborhoods than in wealthier neighborhoods (Davis, 2011). By 2016, the number of African American bike share members had only grown from 4% to 5% of all Capital Bikeshare users (LDA Consulting, 2016), despite African Americans making up about 50% of the Washington, D.C. population (US Census Bureau, 2013).

Some cities have brought attention to the issue of equity in bikeshare placements and are implementing ways to tackle it. For example, Honolulu's Biki launched in July 2017 and quickly became one of the eight most heavily used bike share systems in the US (NACTO 2017, p. 6); their approach to station location included consideration of demand densities and Honolulu Authority for Rapid Transportation (HART) stations (City and County of Honolulu 2014). Philadelphia's Indego launched in 2015 with the primary goal of tackling equity issues; Waffiyyah Murray, the bike share program manager, says, "When outsiders make decisions without community engagement, the battle for equity is well on its way to being lost" (Goffman

2018). Philadelphia's bike share system has provided monthly low-income plans, cash-payment options, and lessons on bike safety, as well as adding innovative community classes that build bicycle and digital skills together (Goffman 2018).

A report on the Bed Stuyvesant community's response to Citi Bike (New York City's bikeshare program), (NACTO, 2017) analyzed the way Bedford Stuyvesant Restoration Corporation conducted their community outreach program. The Bedford Stuyvesant neighborhood of Brooklyn is one of primarily a low-income, African-Caribbean population. In 2013, Citi Bike launched in New York City, which saw quick success in riders, but ridership was extremely low in Bed Stuyvesant. Restoration Corporation used Citi Bike's platform to promote bikeshare as a valuable health activity and mobility opportunities. To address perceptions that bikeshare was "not intended for" low-income and people of color, the partnership developed key strategies to engage the community: weekly health events, Citi Bike demonstration events, pop-up workshops, Citi Bike for Youth and Citi Bike to School programs, an ad campaign, a data dashboard, and surveys of Bed Stuyvesant residents about Citi Bike. Since the partnership's work, single day trips in Bedford Stuyvesant have reached record highs (even at the national level) and seem to be progressing faster than the rest of New York City. This indicates that the targeted approach in this specific neighborhood is having a direct impact.

Carpooling and vanpooling services are technologies that can help improve older populations' and mobility-challenged individuals' access to public transit; demand-responsive transit, route-deviation services, and feeder services also contribute to public transit accessibility. Local transportation agencies' partnerships with non-profit organizations collaborate to provide services that supplement existing public and paratransit services. TriMet in Portland, Oregon partners with Ride Connection, a local non-profit organization that coordinates multiple ride services. Ride Connection offers a community shuttle in designated communities that provide rides to grocery stores, local shopping, and activity centers; some shuttles also feed into the fixed-route transit stops (Weiner, 2008 pages 24-27). The community shuttles operate on a route-deviated schedule and provide off-route pick-up and drop-off service to residents within ½ mile of transit stops.

1.5 Existing Conditions in Richmond, VA

Transportation goals in the Richmond region have changed over time to reflect changing demographics and ridership trends. The Richmond region has seen an increase in the elderly population, individuals with disabilities, and the low-income population since 1990. Transportation services currently in existence are primarily used for access to employment. However, socially disadvantaged populations (elderly, low-income, individuals with disabilities, mobility-challenged, households with no vehicle access, etc.) face barriers in access to employment, mobility, and opportunity when they cannot access transit services. There are currently spatial gaps in transit accessibility for a large percent of the Richmond population.

1.5.1 *Demographics*

In 2017, the population of Richmond, VA was 227,032 and 25.5% of the population was living below the poverty level (US Census Bureau, 2017). Since 2010, the population has increased by 11.1%. The percentage of white city residents was 46%; African American was 49%; 7% Hispanic or Latino; 2% Asian. The median household income, which is determined by the United States Census Bureau, was $41,187, although median household incomes vary greatly among the different neighborhoods in Richmond. According to the Needs and Gap Assessment report by the Richmond Regional Planning District Commission, 15% of Richmond's population was disabled and 11% was elderly (RRPDC, 2015).

Of the 25% of the population's households that are below the poverty level, 50% of households also do not have access to a vehicle. The total population estimated to not own a car is 7%. This data reflects that the lack of car-ownership is not primarily by choice, but is based on the inability to drive or financial barriers to purchase a vehicle (RRTPO, 2015).

1.5.2 *Existing Public Transportation Infrastructure*

While GRTC local routes and the Pulse provide necessary services for people to get around the city, it can be further analyzed to determine if they serve the people who need it the most, and if they can access transit services. Planning efforts should continue to be evaluated and assessed as they are implemented in order to: 1) ensure they are reaching their intended goals and 2) to determine opportunities to improve infrastructure and services. The existing public transportation network system, while moving in the right direction, has room for improvement, especially to serve the immediate needs of communities who rely on public transportation. A 2015 survey produced by GRTC found that 61 percent of GRTC riders' primary purpose for riding the bus is to get to work (Southeastern Institute of Research, 2015).

The Greater Richmond Transit Vision Plan was the plan created for the Bus Rapid Transit (the "Pulse"). Three concepts for the Pulse were developed during the planning stages. One concept values high frequency with fewer total lines running more frequently in the most heavily-used corridors. Another concept prioritizes coverage, with more lines reaching more areas but at a lower frequency. The final concept keeps things largely the same with tweaks for efficiency. Public meetings took place, and conceptual maps were drawn and redrawn. The service model that eventually won out was the higher frequency/less volume concept (DRPT, 2016).

The Pulse Corridor Plan (RRPDC, 2017) for Richmond, VA was finalized after community meetings took place, and three goals were created: to be "Compact and Mixed", "Connected", and "Thriving and Equitable". Development along the Pulse Corridor will follow these six guiding principles: mixed use, viable transportation options, dense, compact development, historic preservation, transit access, and connectivity.

The Richmond Regional Planning District Commission produced a report in 2015 called "Needs and Gap Assessment for the Transportation Disadvantaged" (RRPDC, 2015). This comprehensive plan addresses the need for improved mobility for seniors, persons with disabilities, and low-income people. The report provided a needs and gaps assessment of the region. This report focused on services to connect these populations to employment centers; however, one important recommendation made was to serve non-profit organizations who provide services that are not currently located along current routes.

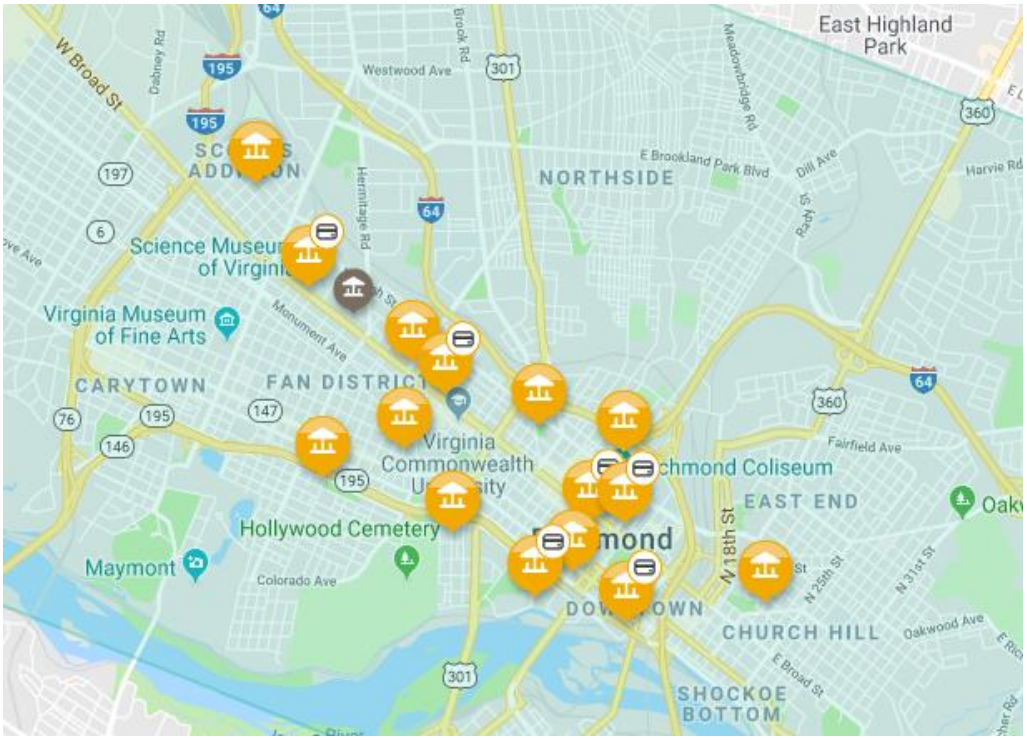
GRTC addresses accessibility for individuals with disabilities by providing paratransit services. GRTC's CARE service follows ADA guidelines for individuals who cannot reasonably use GRTC's fixed route bus service (GRTC). Eligibility to use the GRTC Paratransit service requires an eligibility process through the ADA website. The CARE Advisory Committee is the link between GRTC Paratransit service and individuals with disabilities.

1.5.3 *Emerging Technologies in Richmond*

Richmond, VA is among the cities that have started to see some of these mobility technologies; RVA Bikeshare was launched in 2017, and Bird electric scooters started popping up in 2018 which has led to political struggles among city administration. The first launch of RVA Bike Share station locations, shown in Figure 1, illustrates the locations are concentrated in the downtown area and along the main thoroughfare of Broad Street, not in many of the surrounding urban neighborhoods. When Bird scooters appeared on city sidewalks in September 2018, the administration of Mayor Levar Stoney originally banned them, reasoning they encroached on public rights of way. Since then, Mayor Stoney has announced a one-year pilot program and a scooter ordinance has been passed (Holley 2018).

Since 2014, Richmond has acquired extensive Uber and Lyft services which also were not without regulatory hang-ups (Thompson, 2014). While both mobility services – scooters and bikeshares – are still in infancy, the strategic location of multi-modal services leads to conclusions that they are not being equitably disbursed (see Figure 1 for bike share station locations). A characteristic of Richmond is that the dependence on the automotive vehicle remains the dominant form of transportation (Baker 2013). In 2016, American Community Survey data estimates 18% of households did not own a vehicle (US Census Bureau 2016). This discrepancy leads to conclusions that improvements can be made to transit access equity, and the FMLM problem.

Figure 1. RVA Bike Share Station Locations



Source: https://www.rvabikes.com/#full-map

CHAPTER 2

LITERATURE REVIEW

2. Theoretical Framework

This literature review provides a theoretical framework that encompasses planning theories, transit equity models, and conceptual models. The first section of the literature review explains how planning theories are related to transportation equity. The just city and advocacy planning are the two primary planning theories used to frame this thesis. Key transit access equity models emerged from the framework including: mobility equity, accessibility, and shared mobility/modality. The key conceptual models include the transit supply and demand model and the what if scenario analysis. Review of the framework influences the thesis approach to the research questions and methodology.

2.1 Planning Theories

Planning theories are used in the field of urban planning to determine the approach taken to a planning process. In this case, the process is transportation planning. Planning theories consider the intentions of projects, roles of power (McGuirk, 2001; Mitchell 2003), and roles of voice (Sandercock, 1998). Theories also consider members of the community and underlying assumptions (Davidoff, 1975; Fainstein, 2009; Rydin, 2007). Theories are used to form strategies recognizing the level of existing knowledge. This theoretical framework looks more deeply at transit access equity and how planning theories can be used to frame the research questions and form the analysis.

2.1.1 *The Just City*

Susan Fainstein's urban planning theory of the Just City (2009) emphasizes the role of the progressive planner's focus on equity and material well-being with three main concepts: justice, democracy, and equity. Cities that effectively work towards goals of equity will inevitably fall within the framework of the Just City. Christensen builds off of the equity frame and argues that both process and outcome are important to planning practices (Christensen, 2015).

The Just City is considered a normative planning theory, or one that utilizes intellectual knowledge to overcome social inequities and abuses of power in the realm of democracy. The "just city" is a measure of outcomes after planners and political leaders have taken democratic action; at the same time, vision of the just city calls for rectifying injustices in a world where control of investment resources by a small stratum constantly re-creates and reinforces subordination (Fainstein 2009). John Rawls's argument of justice concerning equal distribution of values includes "a framework of political and legal institutions that adjust the long-run trend of economic forces so as to prevent excessive concentrations of property and wealth, especially those likely to lead to political domination" (Rawls 2001, p. 44). The three key characteristics of the urban justice, according to Fainstein, are material equality, diversity, and democracy (Fainstein 2009). Transportation equity assumes mobility as a value and perceives that everyone should have a fair share.

2.1.2 *Advocacy Planning*

Paul Davidoff's advocacy planning theory (1965) asserts the importance of attitudes and values in a just democracy. The role of an advocacy planner "engages in the political process as advocates of the interests both of government and of such other groups, organizations, or individuals who are concerned with proposing policies for the future development of the community" (Davidoff 1965, p. 424). Pluralism means there are multiple groups of society for which must be planned, and advocacy is the means by which a planner considers all the needs by all groups. The premise of Davidoff's argument is that the government's role in planning for social welfare must account for the needs of minorities and specialized interests. Transportation equity involves planners, government agencies, and interest groups. When discussing transportation access it is assumed the "minority" are vulnerable populations: low-income, limited English proficiency, no vehicle availability, or minority race. The planner as an advocate takes on the responsibility as a proponent of justice for the client. In this case, the client is the vulnerable population without access to a transit service.

Campbell's work builds off of Davidoff's theory, in which she argues there is space in planning for "better" outcomes for cities in light of normative processes (Campbell 2014, p. 46). Campbell's work illustrates the interrelations of advocacy and equity planning, communicative and collaborative planning, and the "just city" approach. She highlights that the aforementioned approaches of just outcomes with just processes emphasize "material redistribution and substantive outcomes, over deliberation and inclusive participation" (Campbell 2013, p. 48). Works focused on outcomes tend to ask the *what* questions, where the process-focus asks the *how* and *why* questions. It is important in planning practice to consider both processes and outcomes.

2.1.3 *Connecting Planning Theory to Transit Access Equity*

Equity in transportation planning works to engage the public in ways that are not typical. That is, the more inclusive process of transportation planning focuses on the needs of specialized interest groups (i.e. vulnerable communities). The Just City as applied to the thesis seeks to address policy issues and planning techniques by utilizing innovative technologies and resources to ensure equal access by disadvantaged populations.

Transportation planning should not only involve the public in its processes, but the role of the planner as an advocate is necessary to ensure all members of society have equal "rights" to services. In this thesis, applying the just city and radical planning approaches, a different approach to transportation planning empowers the community and involves putting aside fears that have been central to everyday planning practice (Sandercock 2000). Radical planning is a means to achieve the end goal of equitable access that would not be possible without civic engagement. Transportation equity involves community engagement, diversity, inclusion, and voice to members of the public, specifically the ones leveraging community resources.

2.2 Transit Access Equity Models

2.2.1 *Transit Access Equity*

Transit accessibility research is important as it relates to equity issues. There will always be a portion of the population that have no access to a car and are reliant on public transportation. The relative vulnerability of the transit-reliant population – youth, elderly, marginalized – is important and leads to the reason for this research: the improvement of equitable accessibility to public transportation. The objective of this theoretical framework is to highlight certain characteristics of the aforementioned theories as they interact to inform transportation equity. This framework outlines transit access equity models, provides definitions of transportation equity, and includes the ways in which these models influence the methodology of this project.

The genesis of transit access equity began with the idea put forth by John Kain (1968) called the "spatial mismatch hypothesis". While Kain focuses on the socioeconomic issue of connecting jobs to housing for low-income workers (usually people of color), the concept of social inequity has been applied to many other types of social analysis, including transportation. Sanchez (2003) explains that US policymakers have attempted to address the issue of jobs accessibility and residential segregation by improving transportation mobility. Transportation analyses are moving towards the trend of incorporating social equity variables into their methods. However, existing literature on evaluating equity in urban mobility services leads to contradicting, and constantly changing, findings. Varying methods and definitions reveal that evaluating equity is complex and often leads to many technical problems. In order to effectively analyze the impacts of transportation on social equity, it is necessary to define "equity" as it relates to transportation.

As Sadik-Khan argues in "Bike Lanes and Their Discontents" (2017, page 151) relating to cities implementing bike infrastructure programs, cities "embark on a controversial policy: daring to take street space that for decades has been used exclusively by vehicles and do something else with it." At least in the respect of social equity and allowing spaces for everyone, multimodal services give the marginalized – the excluded, the socially isolated – a fighting chance to use cities' existing infrastructure.

2.2.2 *Mobility Equity*

Mobility equity is defined as "a transportation system that increases access to high quality mobile options, reduces air pollution, and enhances economic opportunity in low-income communities of color" (The Greenlining Institute, 2018). Carleton explains the importance of defining equity in order to effectively interpret transportation analyses (2018). Carleton argues that many aggregate definitions miss out on the many different levels of inequity among disadvantaged groups. Litman defines transportation equity as "fairness of the distribution of impacts (costs and benefits)"; his methods of measurement include mobility and accessibility variables (Litman, 2018). Manaugh explores how social equity is conceptualized, operationalized, and prioritized in US planning practices (Manaugh, 2015).

2.2.3 *Accessibility*

Litman (2017) provides useful definitions of factors assessing accessibility, transit level-of-service rating factors, nonmotor level-of-service factors, and the most common transit modes. The author compares factors of automobile dependency with multimodal transportation systems. Some of these factors include land use density, vehicle miles travel, road design, traffic speeds, planning practices, and social expectations. The main argument Litman puts forth is that transportation planning is shifting from traffic-based analysis to mobility-oriented analysis to accessibility-based analysis. Performance indicators of accessibility-based analysis is focused on total travel costs (time and money), and improvement strategies include better walking and cycling infrastructure, transportation demand management, and better transport network connectivity. Litman (2017) says accessibility-based analysis places people at the center of the transportation system.

Lisa Rayle (2014) came up with four hypotheses to explain the discrepancy between community opposition to TOD and the lack of empirical findings on displacement: methodological shortcomings in existing studies, insufficient attention to social and psychological forms of displacement, potential transportation cost savings, and use of TOD plans as a policy target. A concentration of transportation services can help offset some of the costs associated with development (construction, housing prices, household expenditures on services). The 2013 regional plan for the San Francisco Bay Area included priority development areas for TOD. Community opposition due to the fear of displacement – fueled by the current affordable housing crisis – formed the Six Wins for Social Equity (Urban Habitat). Six Wins agreed to support the transit-focused development strategy but demanded greater community control over planning processes, public investments in low-income neighborhoods, protections for existing renters, support for affordable housing, and guarantees for local worker benefits.

A report produced by the Federal Transit Administration compared accessibility among social groups across metropolitan regions across the US (FTA, 2013). For the purposes of their analysis, accessibility is defined as households' access to a private automobile. In terms of equity, a region is ranked more equitable than another if transit equity is high relative to automobile access. One unique factor included in this study is the measurement of housing and land use policies' (that restrict where people can live) impact on transportation equity. Results found that metropolitan areas that have higher transportation equity levels included more transit-dependent (automobile-less) households living in high transit accessibility zones. However, a critique of this literature is that their data reflected that most African Americans reside in urban cores of cities. However, first-ring suburbs in Richmond and other urban areas contain mostly minority and low-income households, and much of the existing literature does not cover in detail such areas.

2.2.4 *Shared Mobility & Multimodality*

Susan Shaheen (2016) explains that 'shared mobility' includes the modes of carsharing, personal vehicle sharing (peer-to-peer carsharing and fractional ownership), bikesharing, scooter sharing, traditional ridesharing, transportation network companies (or ridesourcing), and e-Hail (taxis) and are used to supplement public transportation systems.

McLeod's review of public transit networks and multimodal systems reveals several important themes (McLeod, 2017). Related to "multimodality", evidence shows that improvements in outer suburbs will have higher network benefits than focusing on the center of cities. "Integrating PT with Land Use Planning" explores the idea of multiple modes of transport into one system and how that could increase ridership and efficiency across the board. On the other hand, some studies show that TOD and increased development can threaten affordable housing and social equity, and rezoning areas to match development initiatives can exacerbate gentrification (Bliss, 2017; Chapple, et al., 2017; Mcardle, 2012).

2.2.5 *Framing the "First Mile/Last Mile" Problem*

The "first/last mile" (FMLM) problem is a transit access issue in many urban areas. FMLM is used to describe passenger travel in the context of getting to and from bus/transit stops. Cities have begun embracing new urban mobility technologies to combat the problem of FMLM. Perhaps because FMLM is limited to a short distance (one mile or less), cities and transit agencies are beginning to rely on ridesharing services to boost transit ridership, not take away from it (Levinson, 2016). A review of the existing literature reveals the pressing need for more information on the "First Mile/Last Mile" (FMLM) problem.

Accessibility of low-income and minority households to transit services is an important facet of transportation planning that has significant social implications. Many existing reports focus on air pollution and noise as direct impacts of transportation systems (Dannenberg, 2003; Litman, 2006; Frank, 2006; Litman, 2009) which affects various social groups, but these impacts are still primarily mobility-based analyses. Shifting from a mobility-based approach to an accessibility-based approach is one way of improving transportation network systems. Defining "access" is another important factor: Litman (2011)'s definition of accessibility is the ability to meet desired goods, services, activities, and destinations. Access is commonly referred to as opportunities. For the purposes of this analysis, the presence of at least one ridesharing or multimodal transit service within ¼ mile of a bus stop will be considered as having adequate access.

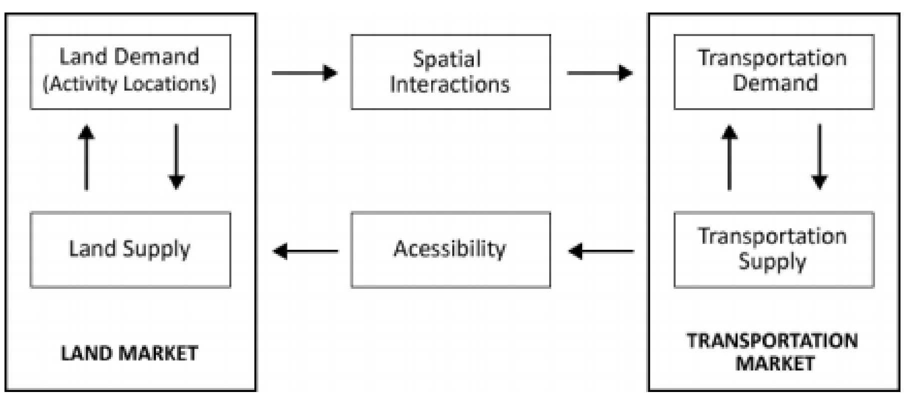
2.3 Conceptual Models

So far, key theoretical frames have included transit access equity, mobility, accessibility, and shared mobility/multimodality. The planning theories that shape the research issue include the just city and advocacy planning. Shaping transit access equity as a concept is also important. Measuring accessibility is key to measuring equity. A concept of transportation-related accessibility is the "needs gap" approach which is illustrated by the transit supply and demand model.

2.3.1 *Transit Supply and Demand*

An accessibility model was developed using a "needs gap" approach which assesses public transit services (the supply) with the spatial distribution of transit needs (Currie 2004). A later study conducted by Currie at al. (2007) introduced a model to measure the links between transport disadvantage (TD), social exclusion (SE), and well-being (WB). This thesis builds off of this research which is focused on horizontal equity of transit access using socioeconomic data. Figure 3 is a model that shows the relationship between supply (transit services) and demand (the recipients of transit services). Analysis measures the accessibility category between supply and demand.

Figure 2. Transit Supply and Demand Model



Source: Rosenbaum and Koenig, 1997

2.3.2 *Predictive Modelling Using Network Analyst*

Predictive modelling is generally used as a project management tool used to evaluate different scenarios and predict their effects on existing transportation systems. Network Analyst is an ArcGIS tool used to evaluate transportation and travel demand models. It uses previously collected GIS data to evaluate the likely implications – both positive and negative – of alternative policies or changes in service. The Network Analyst approach uses transportation data, traffic data, and population/social demographic data to plan routes, calculate drive times, locate facilities, and solve other network problems (Esri).

A report conducted by Blair et al. (2013) focused on the social impact of transportation network change using GIS. The research combines quantitative and qualitative methods along with geographic modelling; the research demonstrates how implementing a change in transportation network systems has differentiated impacts that have implications to policies. The quantitative phase of the analysis included the assessment of socioeconomic, demographic, and transit data using GIS where socioeconomic values were derived from GIS overlay maps. The indicators used in this study to determine socioeconomic values were car density, population density, and economic activity. Three case studies in Belfast, Ireland were identified and socio-spatial analysis was used to determine changes in low-income populations' access to public transportation with a network change. The results found that one study area experienced an improvement to transportation access while the two other study areas experienced a decline in accessibility.

2.4 Furthering the Existing Literature

The literature shows that there are multiple ways to approach transportation planning, and transportation equity specifically. The two planning theories informing the approach are the just city and advocacy planning, where the needs of disadvantaged populations are the focus to achieving equitable outcomes. Transportation planning as a process has evolved from traffic-based analysis to mobility and accessibility-based analysis. Existing literature reveals why transit accessibility is an equity issue; there will always be a portion of the population who does not have a car and therefore having a reliable transportation system is equitable and necessary. Transit access equity branches from Kain's term "spatial mismatch hypothesis" where the connection from jobs to housing for low-income workers is not equitable. The key concepts that determine how this thesis examines the research issues include the transit supply and demand model – where the transit service responds to the needs of the transit recipients – and the what if analysis – if multimodal transit services were implemented into existing public transportation systems.

Questions were left unanswered, or at least not explored to the fullest extent, after a review of the literature. Overarching, theoretical questions arose such as how does transportation access equity exist (where does it exist and what causes it to exist), and how can it be improved? Practical questions arose such as to what extent does transit access inequity exist in urban areas? How can improving access equity improve existing transportation systems? What tools can be used to implement equitable transit systems? How do measures of equity account for the costs and benefits for disadvantaged populations? To what extent do multimodal transit services help improve existing public transportation systems?

Most of the existing literature measures physical proximity to transit; some further the research by adding social factors, such as “low income”. However, much of the available research uses existing transportation network systems to perform their measurements – few studies focus on changes in transportation network systems. A limit to existing transportation analysis is data on social exclusion; this is often because the classic transportation modelling system measures the number and characteristics of trips served by public transit. Incorporating new and existing technologies such as bikeshare systems with GIS modelling is important because of the growing trends for such solutions in urban transportation systems. Further, there is a need for more research measuring multiple dimensions of socially disadvantaged populations’ exclusion from public transportation services. A key piece that can expand on the literature is an empirical study to measure social equity issues in relation to public transportation access. There is an opportunity for measurements of accessibility used in the Belfast study (Blair et al. 2013) to be applied to Richmond. The goal of answering these questions and limitations will ideally be achieved through the proposed methods presented in Chapter 3.

CHAPTER 3

3. Methodology

3.1 Research Questions

Reviewing the existing literature and considering the existing conditions of public transportation services in Richmond leads to questions about transit access equity different neighborhoods in Richmond experience. Therefore, the goal of the thesis is to determine the extent to which FMLM exists within the city in relation to public transit stops.

Thus far, we have referred to equal access to public transportation as “transportation equity”. However, the literature shows the need for a working definition, because “transportation equity” is beyond the scope of this study. For the purposes of this thesis, the term “transit access equity” will be used and is defined as having adequate access to public transit and the equal and fair distribution of its benefits and impacts. Adequate access will be measured in terms of accessibility and mobility opportunity. Review of the existing literature leads to the following research questions:

1. To what extent is transit access inequity a problem for Richmond neighborhoods?
2. To what extent can transportation technologies and services (i.e. GRTC, RVA Bike Share, etc.) improve the overall Richmond transportation network system?
3. What are the most promising (new and existing) transportation technologies that address transit access equity in Richmond?

Table 1 shows how the research questions will be addressed by the research methods:

Table 1. Research Questions & Methods

Research Question	*Data Analysis Used*	*Research Method*
1. To what extent is transit access inequity a problem for Richmond neighborhoods?	Quantitative Data	• Accessibility Index • Social Equity Index
2. To what extent can transportation technologies and services (i.e. GRTC, RVA Bike Share, etc.) improve the overall Richmond transportation network system?	Quantitative Data	• Network Analyst using GIS
3. What are the most promising (new and existing) transportation technologies that address transit access equity in Richmond?	Qualitative Data	• Key Informant Interviews

The purpose of this analysis will focus on the accessibility of individuals to public transportation through the availability of multimodal transit services. There is little research available on first and last mile transit services, so this analysis will explore options to improve households' direct access to such services as part of an overall transportation network. The scope of this thesis is focused on measuring accessibility to determine equity. This analysis will measure access equity across four dimensions: race, poverty, limited English proficiency, and transit dependence. Focusing on these criteria, levels of access equity will be determined by block group within the city. Answering the research questions will help identify determinants of an equitable transportation system and lead to policy recommendations and strategies to improve transit access equity.

The geographic unit of analysis used to measure the target population will be at the block group level. Socioeconomic data for block groups in the City of Richmond are available from the US Census Bureau. Transportation data and road network data were obtained from GRTC and TIGER line shapefiles from the US Census Bureau. ArcGIS software is used to conduct spatial analysis and perform functions based on the results from accessibility and equity measurements (explained in Sections 3.2 and 3.3).

3.2 Measuring Accessibility

3.2.1 *Access to Transit Stops*

Measuring the actual distance an individual is from a public transit stop is key to determining accessibility. Attempts to address errors in proxy calculations have included using smaller units (Furth et al., 2007), calculating the ratio of the population within the transit stop service area with different levels of access (Gutierrez and Garcia-Palomares, 2008), and measuring accessibility from dwelling units to bus stops (Biba et al., 2010; Kimpel et al., 2007; Zhao et al., 2003). Transit stop service areas have been calculated by both Euclidean buffers/distances and network buffers/distances. Network buffers/distances are the preferred method for calculation because Euclidean methods often overestimate the service area of a stop (El-Geneidy et al., 2009; Horner and Murray, 2004).

In this analysis, GIS is used to form buffer polygons ¼ mile around GRTC transit stops (TCQS analysis). Proximity access by for each block group is determined through network buffers/distances. For the purposes of this analysis, it is assumed that individuals located within ¼ mile of the buffer have adequate access to transit.

3.2.2 *Frequency of Transit*

Service frequency is an important function of accessibility and can vary greatly between peak and non-peak travel times. There are two general approaches to measuring transit service frequency. The first tool creates a minimum service standard frequency of 30 minutes or better during weekday inter-peak (Curtis and Scheurer 2010). The second approach includes all transit trips when measuring frequency. Currie (2010) uses the number of trips per week for each stop, whereas Mondou (2001) and Yigitcanlar et al. (2008) categorize transit service frequency by how often a bus/train arrives (e.g. at least every 15 min, at least every 30 min, and 30 min and more).

In summary, a comprehensive time-based assessment of transit accessibility must include the time it takes to get to a transit stop, travel times, and transit frequency. For the purposes of this analysis, the only public transportation system used is GRTC. The time-based measurements taken from route schedules will serve as proxies to measure accessibility.

3.2.3 *Creating an Accessibility Index*

The methods in this study build on existing public transportation accessibility research, primarily the Composite Index of Public Transit Accessibility which combines three different models of accessibility tools: Local Index of Transit Availability (LITA), Transit Capacity and Quality of Service (TCQS), and the Time-of-Day Tool which are focused on trip, spatial coverage, and temporal coverage (frequency). Measurements for the LITA (Rood 1998) include the transit service intensity of an area, which is helpful for property developers to determine where transit is most intense and to help develop land use plans. Accessibility is measured through TCQS (Kittelson 2003) which uses a service coverage model. Time-of-Day Tool (Polzin et al. 2002) uses time-of-day travel demand distribution and provides accessibility based on a specific time. LITA and TCQSM rely on transit data and census data; Time-of-Day tool requires specific hourly travel data in addition to transit and census data. Table 2 shows a common grading scale for LITA scores.

Table 2. Common Grading Scale

LITA
-.90 - -0.62
-0.61 - -0.23
-0.22 - 0.22
0.23 - 0.97
0.98 - 3.06
3.07 - 9.00
9.01 - 32.80

3.3 Measuring Equity

To measure equity in transit access at the block group level, this thesis uses the accessibility index model described above. The purpose of measuring equity is to determine levels of transit equity affecting different communities in Richmond. Because this research builds off of the existing literature, combining socioeconomic data with transit data is important to determine where transit access inequity exists. Measuring equity at the block group level requires several steps. First, socioeconomic data and transit data are collected. The accessibility index is used to calculate equity for each of the following criteria at the block group level:

1. Individuals representing people of color (i.e. race or ethnicity)
2. Individuals below the poverty level
3. Individuals who are elderly (aged 65 years and older)
4. Individuals with limited English proficiency
5. Households with no vehicular access.

For the purposes of this analysis, as influenced by the existing literature, poverty is defined as individuals living on less than $25,000 per year. The same index for measuring accessibility will also be applied to measure social equity across each of the five criteria. To quantify race, indices will be measured by block group for the number of individuals who are non-white: Black or African American, Asian, and Hispanic or Latino. Demographic data were access through the US Census Bureau.

Once accessibility for each block group is determined, equity (using the five levels of socioeconomic data) for each block group meeting certain criteria (explained further in Chapter 4) is determined. The same units of measurement are used from the accessibility index, but looked at more specifically for each block group by the five specified criteria listed above. All results (accessibility and equity) are mapped in GIS; the overlay function is used to analyze overlaps of the five criteria in relation to the spatial geography already created (i.e. ¼ mile buffers, transit data, and socioeconomic data).

Table 3. Example Calculation for the Accessibility Index and LEP Equity Index Score

Block Group	**Coverage Score**	**Frequency Score**	**Capacity Score**	**LITA Score**	**LEP Equity Score**
	(# stops * # routes)/land area (in sq mi)	(Aggregated stop frequency * Aggregated route frequency)/1000	(Frequency Score * # stops * Routes per BG)/population per BG	coverage + frequency + capacity	Z-Score of LITA
	(2*7)/0.292438	(194.37*.60)/1000	(2*7*11.66)/1656	(47.87+11.66+.10) = 59.63	-0.52
	z-score of coverage scores	z-score of frequency scores	z-score of capacity scores	summation	(LEP z-score) - LITA
104011	-0.27	-0.15	-0.10	-0.52	.20 – (-.52) = 0.72

3.4 Geographic Information System (GIS)

3.4.5 *Creating a Multi-Modal Transit System*

ArcGIS 10.6 is used to create a multi-modal transit network system, using the existing GRTC routes and stops. It is assumed that Richmond City will not have a comprehensive, full-scale high-frequency public transit system in the near future, so creating a predictive modeling system will allow transportation planners to determine what services can improve the existing transportation system. Transit data from GRTC include existing transit stops, bus routes, and schedules to form the transit component of the network. VDOT road network data are also used to form the walking, cycling, and scooter components. Google Maps' average walking speed is adopted: 3.1 miles/hour; as well as the average cycling speed: 9.6 miles/hour to calculate distances using multiple modes from transit stops. Guidelines from the Institute for Transportation and Development Policy propose 10-30 bikes per 1,000 residents, and/or 36 stations per square mile (ITDP 2014).

The multi-modal transit system helps determine where additional GRTC transit stops, potential bikeshare locations, and scooters could help improve transit access equity challenges in Richmond. This method is influenced primarily by Movoa et al. (2012) and their use of a predictive modelling system using GIS. The What If scenario analysis will be used to determine possible improvements to access equity by adding additional services to the existing transit network system. The tools to perform this function include Excel and ArcGIS, primarily using the Network Analyst function.

3.5 Interviews

3.5.1 *Qualitative Research Frame*

The qualitative portion of this study comes from a policy-oriented perspective. The importance of the qualitative analysis was highlighted by studying advocacy planning theory (Davidoff 1965), which pointed out that long-range, allocative planning needed community participation (Dandekar 1986). The use of qualitative and quantitative perspectives in combination allows for a better understanding of the problems under research than adopting a single perspective (Clark and Creswell 2010). Further, a mixed methods approach collects key information from different methods to better understand the context of what is being measured. A 2011 study emphasized the importance of a mixed methods approach to analyzing city and community social capital (Xerez et al.). The study used methods including interviews, ethnographic observations, and archival data.

American Planning Association (APA) developed specific policy goals for surface transportation. Policy Goal #6.6 says that APA will support "meaningful and substantive public participation in the development of transportation plans and programs by engaging stakeholders, including the general public, interest groups, transportation providers, implementing agencies, and advocates early and throughout the planning process, and taking their input into consideration" (APA 2010). Effective public participation is necessary for building community consensus for transportation investments and strategies; forming lasting community relationships is a fundamental part of understanding the needs, concerns, and goals of neighborhoods when planning transportation projects and programs.

The interview portion of this project is adopted from a 2009 study that argued transportation policy since the 1990's needs to have a virtuous cycle between community participation and institutional development (Weir et al. 2009). This area of research furthers the ideal of radical planning, where Weir and the authors say that as new groups entered the transportation arena, new reform networks formed. In the study, the authors compared two regions: Los Angeles and Chicago, and conducted interviews with various community interest groups to influence transportation policies. Their model shows that when policy reforms do not provide immediate organizational or individual benefits, organizational intermediaries play a key role in knitting together and mobilizing supportive constituencies (Weir 2006).

3.5.2 *Case Selection*

The cities of Charlotte, North Carolina and Atlanta, Georgia were chosen for their similarities to Richmond. Charlotte's population size and population densities are most similar to Richmond; Atlanta is similar to Richmond socially via age composition, race, and transportation infrastructure. Google searches of these two cities indicate that they are both implementing strategies to solve the FMLM problem. Organizations in Atlanta include MARTA, Atlanta Regional Commission, the City of Atlanta, Livable Centers Initiative, and TransFormation

Alliance. Community organizations in Charlotte include Charlotte Transportation Department, Charlotte Area Transit System, Alta Planning & Design, and the Center for Advanced Multimodal Mobility Solutions and Education.

3.5.3 *Interview Protocol*

Interviews were conducted with transportation experts in Richmond and leaders in other cities who are creating strategies to improve transit access equity. Interviews with city officials and representatives were selected based on the results from Research Question #3. The interviewees, in some capacity, have been involved with the implementation of mobility technologies and will include transportation planners, advocates of equitable transportation, and leaders in non-profit organizations involved with transit accessibility projects. Specifically, in Richmond, leaders in the transportation industry will include representatives from VDOT, RRTPO, GRTC, RVA Rapid Transit, and the City of Richmond. Cities used in the comparison will be similar to Richmond in terms of population size and densities, social characteristics, and have a Bus Rapid Transit system.

The major component to the qualitative portion of the methods includes Key Informant Interviews (KII). Interviews with identified city leaders were conducted over the phone between January 15th and January 30th, 2019. Interview topics covered with practitioners from the City of Richmond, Charlotte, and Atlanta focused on policies and programs as they relate to multimodal transportation services and their accessibility. The interview protocol was formal and the interviews lasted approximately 30 minutes. KIIs contribute to Quality Improvement due to the institutional nature of the interviewees. While there is no clear-cut definition of Quality Improvement, it is commonly considered "A systematic pattern of actions that is constantly optimizing productivity, communication, and value within an organization in order to achieve the aim of measuring the attributes, properties, and characteristics of a product/service in the context of the expectations and needs of customers and users of that product" (VCU). Quality Improvement projects are used to improve a practice or process. Further, interviews can be used to compare policies and processes to established practices. The interview protocol is used to ensure the same basic lines of inquiry are pursued with each person interviewed and specific topics are addressed (see Appendix A for protocol). Qualitative analysis using Audacity and hand coding was performed after all interviews were complete to introduce which policy recommendations could be implemented in Richmond, VA.

3.6 Research Limitations

A limitation to keep in mind throughout this thesis is the lack of data available to the public such as Uber and Lyft, newer mobility technologies such as moped-sharing, and fixed route public transportation systems' ridership data. Some results on ridership have been published in annual reports by private companies, so some of the results may be biased towards one type of transit service. Data available includes results and methodologies from cities that have implemented pilot studies for technology services, and therefore are not ultimately conclusive of evidence. For the purposes of this research, comparative analysis will be limited to systems that can feasibly be implemented for the population size and population density of Richmond, VA. For example, this thesis will not propose a metro rail because the citywide population would not support such a system. The spatial geography of Richmond City is worth distinguishing from other cities: several low-density neighborhoods are tangential to or part of first-ring suburbs such as the East End neighborhood, so there will likely be greater variations in accessibility in these areas. Migration and population patterns show a greater number of people live in the central downtown area and fan out into neighborhoods established as the city-wide population grew (first- and second- ring suburbs). Within the past ten years, first-ring suburbs have experienced higher density populations. Accessibility will vary because first-ring suburbs, while still included in the city boundary, have varying densities compared to other neighborhoods, making transit services in these areas more elusive.

Research and analysis on elderly, disabled, and mobility-challenged populations are limited in this study. Public transportation accessibility largely focuses on physical disabilities. Within the scope of this research, the elderly population is considered aged 65 and older living within the urban boundaries of Richmond City. While there is a definite need for more research in the field of improving transportation access to individuals with different types of disabilities (vision and hearing-impaired, mental health conditions, intellectual and cognitive disabilities, etc.), this thesis is not considered a comprehensive analysis of all disability types. The extent of this research study is examining what types of transit services could likely improve transit accessibility for people with physical disabilities and the elderly population in general within the existing transportation system in Richmond.

It is also important to note that this research study is focused on origin-based transportation trips where origins can be location-based measures or people-based measures (Karou & Hull, 2012). In other words, this thesis aims to measure accessibility and equity at the beginning of transit trips – or what it takes for an individual to reach the transit stop (i.e. the connection between people and public transit). For this study, measurements begin and end at the same physical location. However, one should consider that because this is a citywide study, some trips could be considered origin-destination trips if a route begins in one area of the city and ends in another area still within city boundaries.

CHAPTER 4

4 Findings

This thesis was focused on determining accessibility to public transit as an equity issue in transportation planning. Four key findings identify Richmond as having moderate accessibility for all block groups with room for improvement to the existing system. First, in terms of physical coverage, most Richmond residents at the block group level have adequate access to public transit. Second, Richmond accessibility varies across different social dimensions. Third, adding bus stops, routes, and services can improve the existing Richmond transportation system. Fourth, when transportation planning takes a holistic approach, equity issues are more likely to be addressed. Intentional community engagement is one of the leading tools to improve social equity, and creative regional programs can help address the first mile/last mile problem and connectivity.

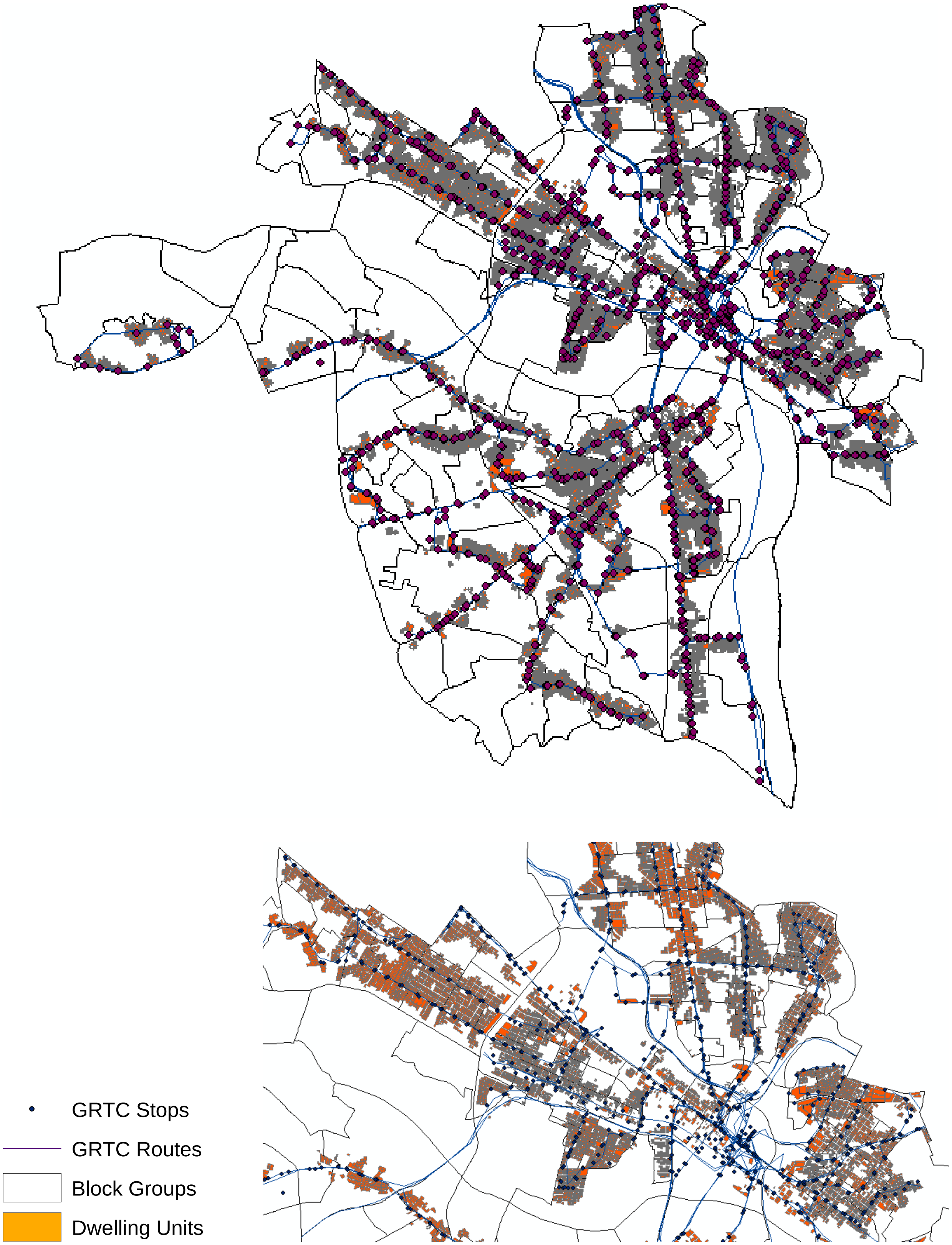
4.1 Spatial Distribution and Availability of GRTC Stops and Routes in RVA Block Groups

Results from quantitative analysis reveal that transit accessibility, when measured alone, is adequate for most block groups. Block groups received scores for spatial availability (TCQS). The Local Index of Transit Accessibility (LITA) provides a composite score for each block group measuring transit intensity and accessibility by three aspects: spatial coverage, frequency, and capacity). The Time of Day tool allows analysis of spatial and temporal coverage for bus routes based on traffic and ridership data city-wide.

4.1.1 *Transit Capacity and Quality of Service*

The physical coverage of GRTC bus stops and routes is important in determining the proximity and availability of transit services for individuals in city block groups. The Transit Capacity and Quality of Service (TCQS) metric was used to determine the spatial coverage of public transit in each block group city-wide. The TCQS used a quarter-mile buffer analysis to calculate Richmond block group accessibility. At the block group level, graphically it seems the entire city is adequately covered by transit services. However, it was necessary to consider total populations within each block group; this is important for spatial coverage because not all block groups have residents, so the absence of stops or routes does not necessarily mean inadequate accessibility. This consideration was examined by calculating the number of dwelling units served within one quarter mile across the entire city (Figure 3, top) and dwelling units located in the downtown area (Figure 3, bottom) using the same quarter mile buffer distance as used with the block groups. As the maps clearly show, there is a denser concentration of dwelling units served within one quarter mile of transit stops in the downtown, near west end, and east end neighborhoods of the city due to the greater number of bus stops and routes located in these areas. The total number of dwelling units served within one quarter mile of transit stops is 33,668 dwelling units.

Figure 3. Dwelling Units Served within One Quarter Mile of GRTC Stops



4.1.2 Local Index of Transit Accessibility

The LITA measures service coverage, service frequency, and capacity. Service coverage per block group was calculated as the number of bus stops and routes in each block group divided by the total land area (in square miles) for each block group. In other words, each block group was given a score based on the number of stops and routes for the land area within each block group, as shown in the formula below:

$$\textit{Coverage Score} = \frac{\textit{Number of Stops per Block Group x Number of Routes per Block Group}}{\textit{Land area (in square miles) per Block Group}}$$

Frequency scores are considered the total number of daily trips per block group and are based on bus stop and route frequencies. Scores were calculated using transit data (frequencies for each bus stop and route) which were then aggregated (summed) for each block group: the aggregated total of stop frequencies was multiplied by the sum of route frequencies per block group. The frequency scores were divided by 1,000 to get a common score, as shown in the formula below:

$$\textit{Frequency Score} = \frac{\textit{(Aggregated Stop Frequencies x Sum of Route Frequencies per Block Group) x 100}}{\textit{1,000}}$$

Service capacity is defined as the level of transit service per capita. Capacity scores were determined as the number of routes and stops per block group multiplied by frequency scores divided by block group population totals.

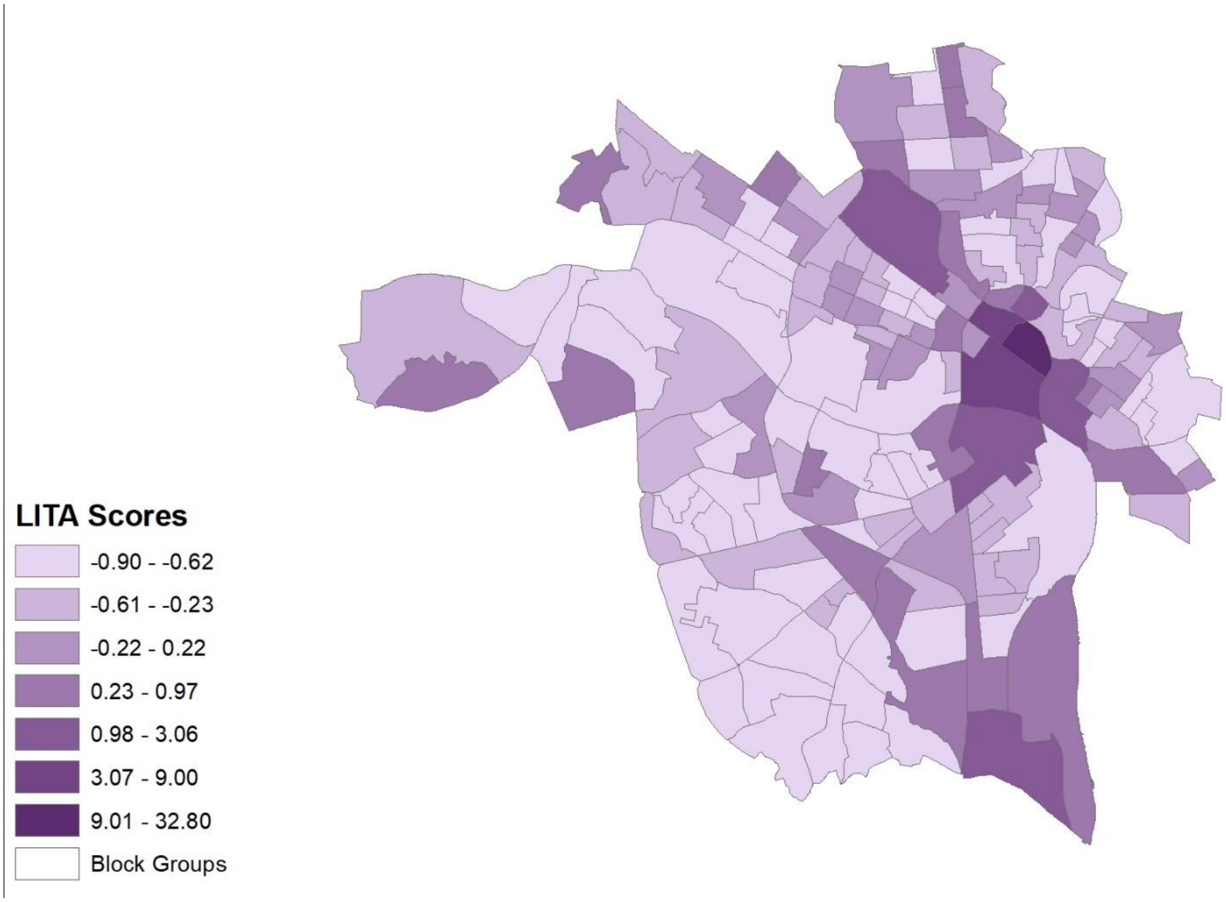
$$\textit{Capacity Scores} = \frac{\textit{Number of Vehicles per Day x Route Miles per Day x Number of Stops per BG}}{\textit{BG Population}}$$

Once all individual accessibility measures were determined, the z-score for each was calculated to convert the range of data on to a common grading scale:

$$\textit{Z-score} = \textit{(Individual score - Mean of data) / Standard Deviation}$$

Figure 4 shows the result LITA scores for each block group. For the purposes of this study, it is important to note that block groups receiving a LITA index score of zero or below indicates poor access. The higher the LITA score, the better the accessibility. To elaborate, if two block groups have identical land area, the block group that has more bus stops will receive a higher score in the coverage measurement. Ensuring all scores are calculated on a common grading scale prevents unnecessary divergence from the individual scores.

Figure 4. Local Index of Transit Accessibility (LITA) Scores



The LITA index is a composite score, so the above measurements were aggregated to get the final score (the z-score for each accessibility measure was calculated first and then all were aggregated for the composite score). Based on LITA scores, the downtown area of Richmond has the highest levels of accessibility- the block groups located in downtown received the highest LITA scores. Several block groups in the north side of Richmond and in the Southside also received relatively high LITA scores, indicating adequate transit access in those particular areas. Appendix B provides the LITA scores for each block group.

LITA Composite = Coverage Score + Frequency Score + Capacity Score

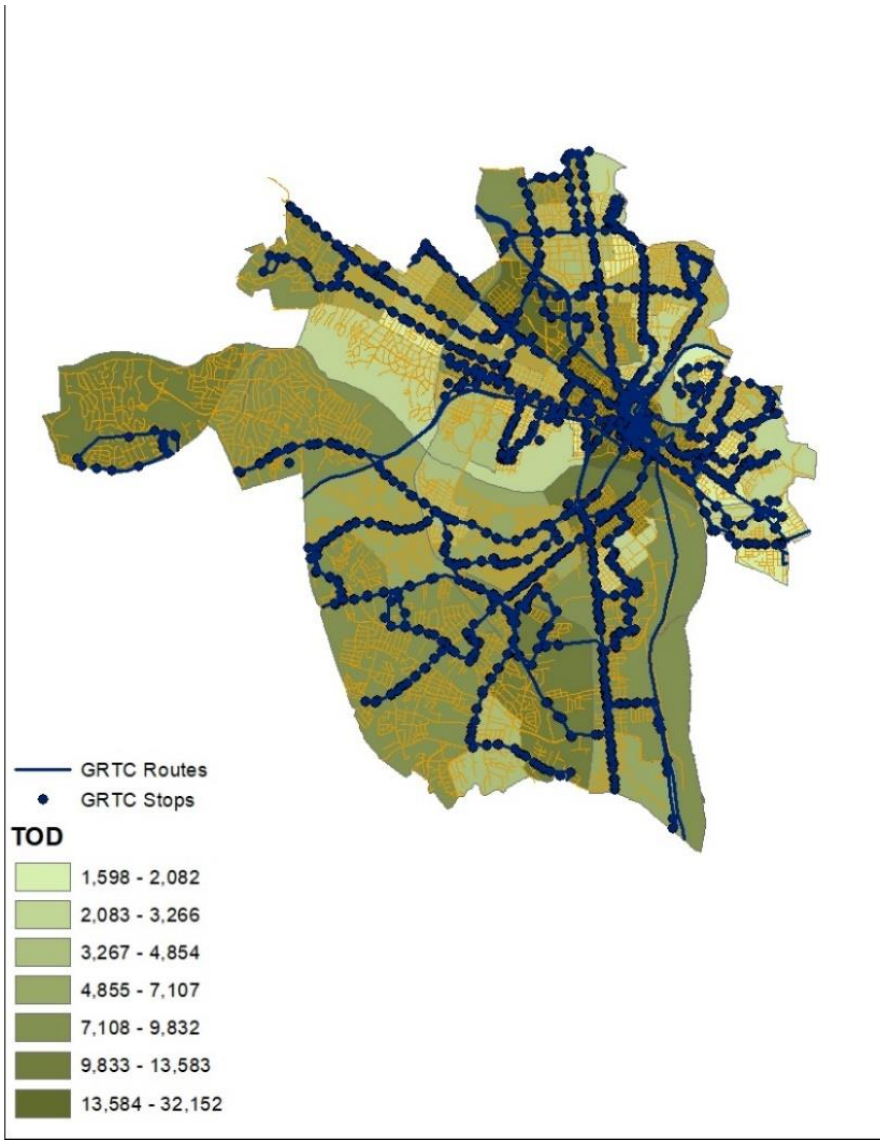
For the purposes of this thesis, LITA scores were used to calculate access equity index scores across the five social demographic categories. Equity index scores are used later in this analysis (Section 4.2). The mathematical calculation for equity index scores is as follows:

Equity Index Score = Social Demographic Category (i.e. Individuals in Poverty) – LITA

4.1.3 Time of Day Analysis

An important finding resulting from Time of Day Analysis (TODA) analysis is that most travel trips occur in the downtown area and along major arterials. Figure 5 shows the results from Time of Day analysis. The Time of Day (TODA) Tool was used to measure traffic trips within Traffic Analysis Zones (TAZ), which are similar in terms of land area (size) as city block groups. StreetLight traffic data were used to form the analysis. Figure 8 shows the results of the Time of Day scores. Block groups were scored based on three different times of day on an average day (Monday through Sunday): Peak AM (6 AM – 10 AM), Mid-Day (10 AM – 3 PM), and Peak PM (3 PM – 7 PM). Peak times were chosen because this is the time network demand is the highest. Individual scores for TODA during peak times were aggregated to get a total score for the total average day.

Figure 5. Time of Day Analysis Scores

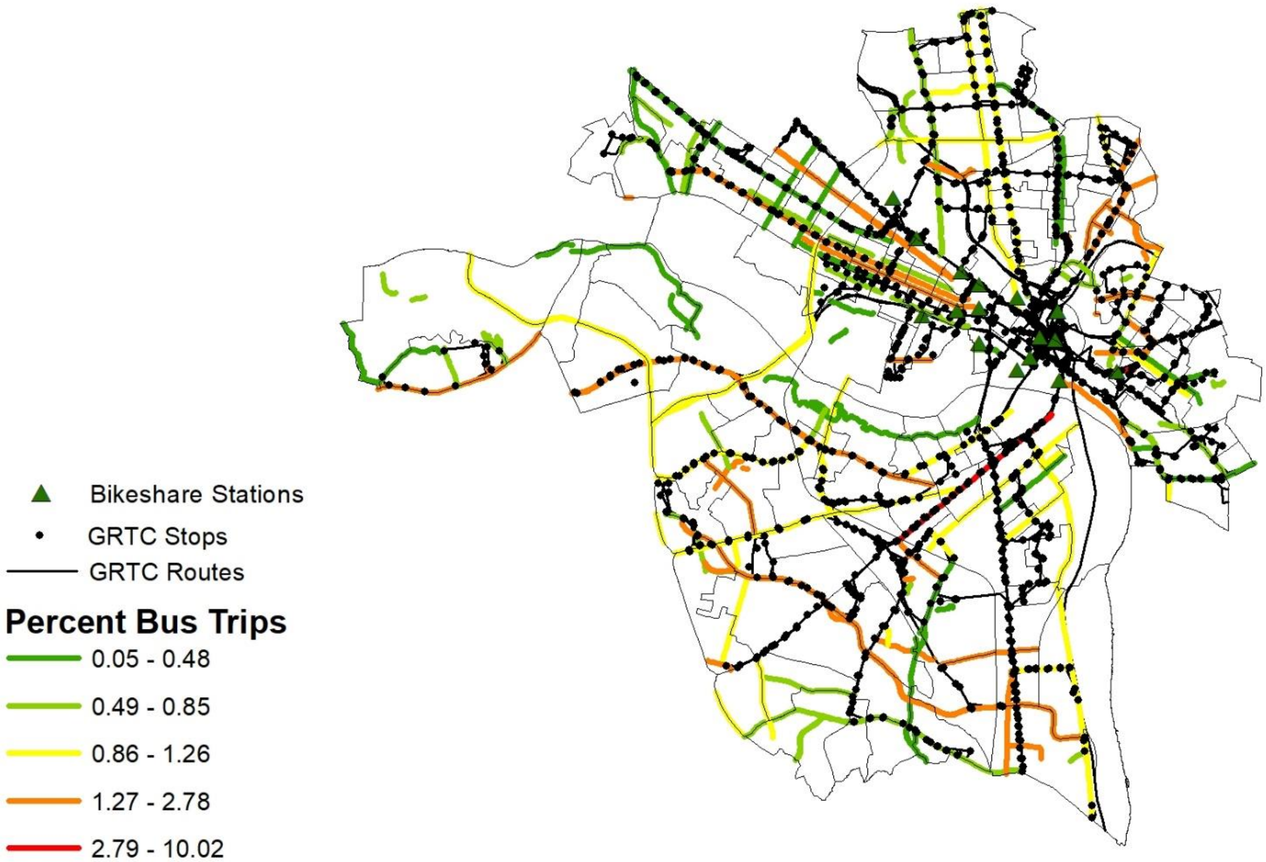


Darker shades of green indicate higher TODA scores (more heavily trafficked) zones. The downtown area received the highest TODA scores; a few block groups located in the north side and south side of the city also received high scores. The current bus routes serve the east-west corridor (Broad Street), the southern corridor (Jefferson Davis), as well as the North Avenue/Forest Hill Avenue route that runs along the southern route just south of the James River based on where the most traffic trips are taken.

Average Annual Daily Traffic Volume data (2016) from VDOT provided annual daily traffic volume (ADT) data and annual average daily traffic (AADT) data for all VDOT routes. AADT indicates the total volume of traffic per year which is necessary to understand in transportation planning to account for demand. An assumption with traffic volume data is that where there is more traffic, there is more demand for public transit services; however, this is not always the case. The AADT traffic data was used to determine total daily traffic compared to the percent of bus trips (see Figure 6). Results from the analysis show that average annual daily traffic (AADT) volume is skewed heavily toward interstate highway use. Bus routes that run adjacent or parallel to highways have higher traffic trips, so it is important for more bus stops and higher route frequencies to be located along these roads. Content analysis determined that block groups that intersected such routes received higher accessibility scores, regardless of social dimensions.

The most trafficked bus routes include Jefferson Avenue in the East End, Hull Street, Warwick Road, and Forest Hill Avenue on the south side, Hermitage Road and Chamberlayne Avenue in northside, and Broad Street, W Huguenot Road, and Grove Avenue in the West End.

Figure 6. Average Annual Daily Traffic Volume



Comparing LITA scores with the Time of Day Analysis, some similarities were concluded: the downtown area receives the highest accessibility scores (meaning better access) and has the highest number of aggregated travel trips. On the other hand, some block groups receive lower accessibility scores (less accessibility) yet have higher aggregated traffic trips; this gap is an area where improvements to the existing transportation system could benefit disadvantaged individuals.

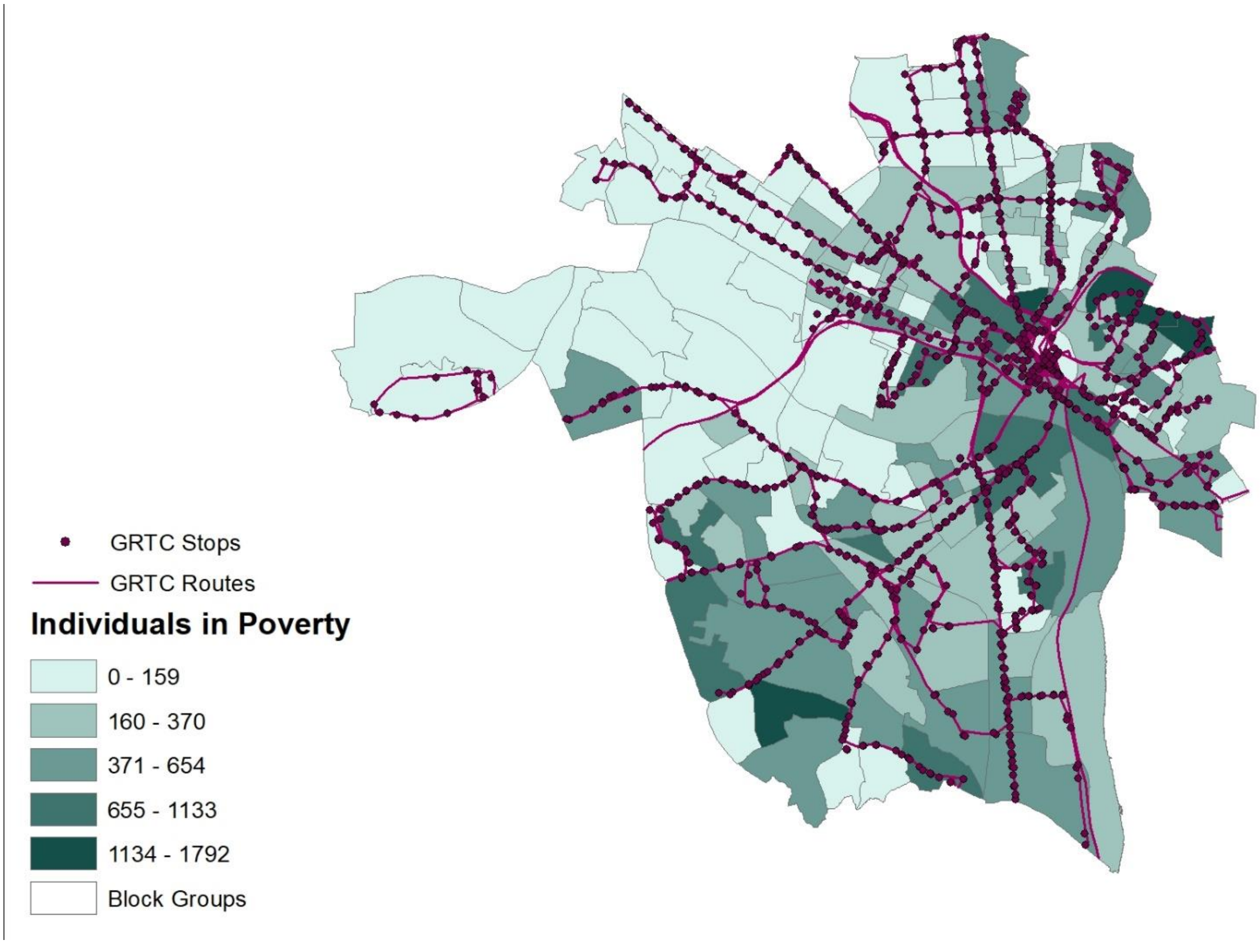
An explanation for this gap indicates that GRTC prioritizes better accessibility in more heavily trafficked neighborhoods and arterials. This is understandable for fiscal reasons because areas with higher traffic volumes usually indicates there is a higher demand density (higher volumes of people) who will use public transit. However, this explanation leads to the conclusion that current transportation planning in Richmond prioritizes automobiles and traffic over individuals' ability to access transit services. Furthermore, planning primarily for financial cost cuts leaves out a large part of the population who are not located physically close to transit stops yet still rely on public transit services. Transportation planning with an equity focus would work to close this gap.

4.2 Social Equity Variability

Accessibility is an important measure of access equity, and the purpose of this thesis was to determine access equity for disadvantaged populations in Richmond City: individuals living in poverty, Limited English Proficiency, elderly (ages 65 and older), no vehicular access, and non-white populations. The LITA index is a composite index that measures coverage, frequency, and capacity. LITA scores were calculated by subtracting the LITA scores from the scores for each social demographic for each block group.

In this analysis, poverty access equity varies greatly across the city with the most equitable service located in the northside and Southside neighborhoods. Poverty access equity scores were calculated in relation to the LITA scores and the number of individuals living in poverty in each block group. To calculate the poverty score for each block group, the z-scores were calculated for the range of data for the number of individuals living in poverty. Then, the LITA score was subtracted from the poverty z-score to produce an equity index score.

Figure 7. Individuals in Poverty

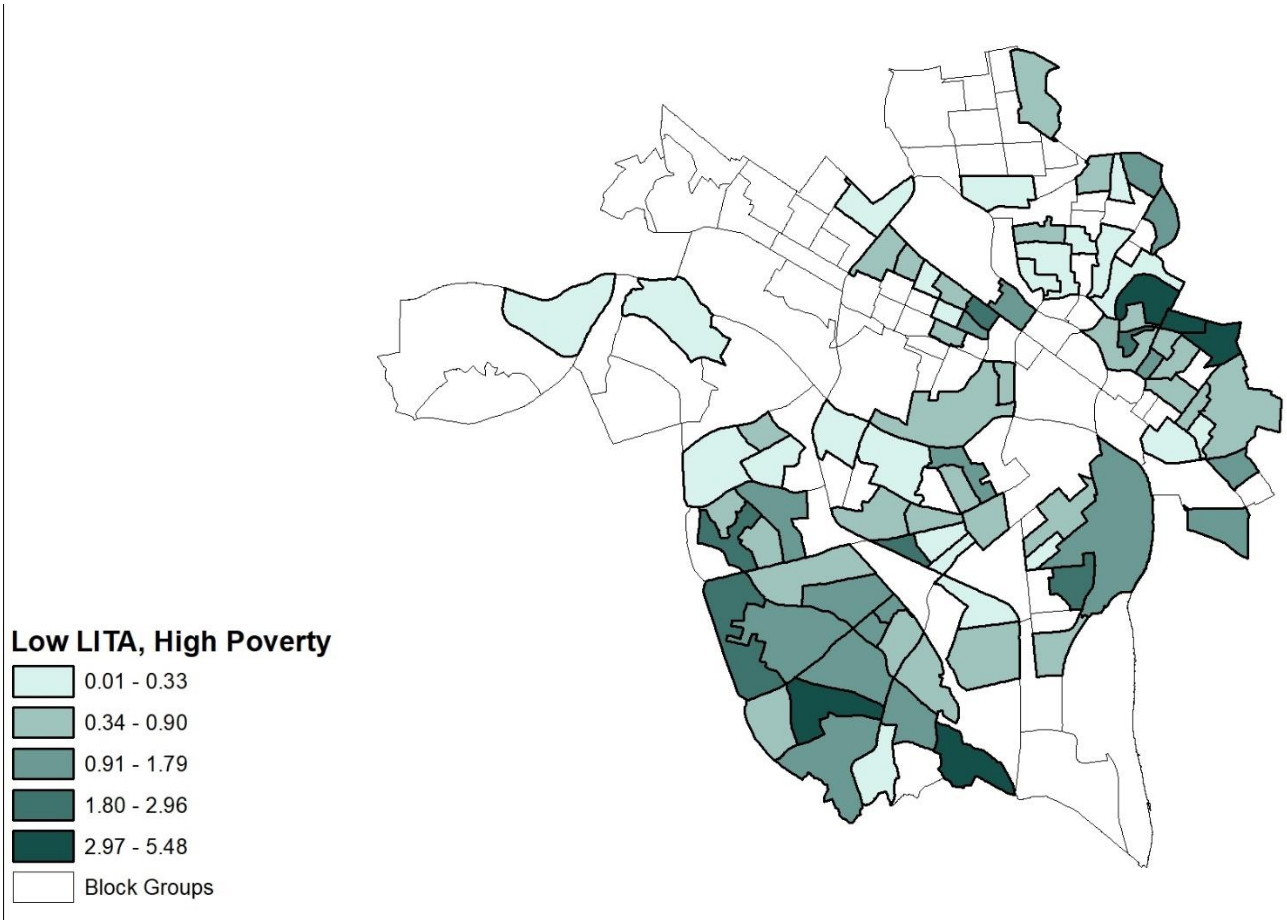


As you will notice in Figure 7, several block groups are shaded darker, indicating there is a higher concentration of individuals living in poverty in that particular block group. It is important to note that block groups receiving high LITA scores (see Figure 4) did not always correspond with good access equity scores, and vice versa. The greatest concentration of individuals in poverty is located in the downtown, East End, and northside neighborhoods, and the neighborhoods with the highest equity scores for individuals in poverty are located in the north side and Southside neighborhoods.

A category was created for analysis purposes identifying the gaps in where accessibility is the worst and where the greatest number of individuals in disadvantaged populations are living. This category is called "LH", for "Low LITA scores, High Population". The criteria for block groups meeting the LH definition include LITA scores less than zero and equity scores greater than zero. The equity index scores for block groups meeting "LH" criteria were calculated as the poverty z-score minus the LITA score. A negative LITA score indicates poor accessibility, and positive z-score indicates there is a higher concentration of that population in a block group. By subtracting the LITA score from the population z-score, the resulting calculation will show the variation in equity scores; the higher the equity score means a more serious equity issue.

The results of calculating LH scores for each social demographic show variations in access equity, where higher index values indicate more serious equity issues, and lower index values indicate less serious issues. Figure 8 displays the results of Low LITA, High Poverty Population. Appendix D includes "LH" scores for all categories.

Figure 8. Block Groups with Low LITA, High Poverty Scores



The next series of figures show the map results of block groups meeting "LH" criteria for the Elderly, LEP, No Vehicle Access, and Non-White populations. Generally, a darker shaded block group indicates higher equity scores (e.g. worse accessibility for disadvantaged populations). It is worth noting that equity score ranges varied for each social demographic, but generally the scores range from around 0.01 to 5.48.

The "Low LITA, High Disadvantaged Population" scores indicate where (which block groups) in the city there is a need for improved access equity. The higher the score and the darker the shade indicates more severe inequity scores. Several social demographic categories through this analysis identified many block groups considered the least equitable based on this criterion.

"LH" scores consider the variation in equitability, where higher index scores mean more serious equity issues, and lower index scores mean less serious.

Figure 9. Low LITA, High Elderly Population

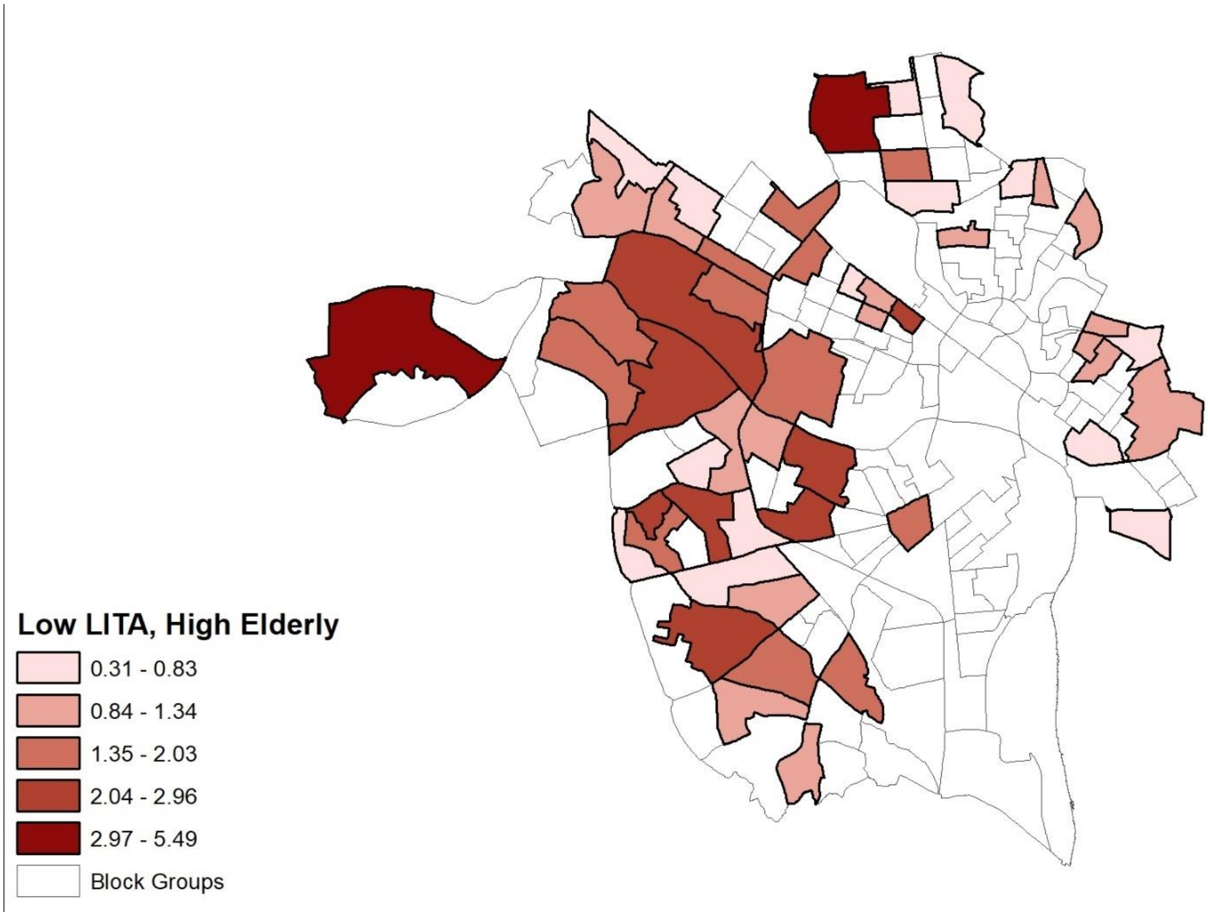


Figure 10. Low LITA, High LEP Population

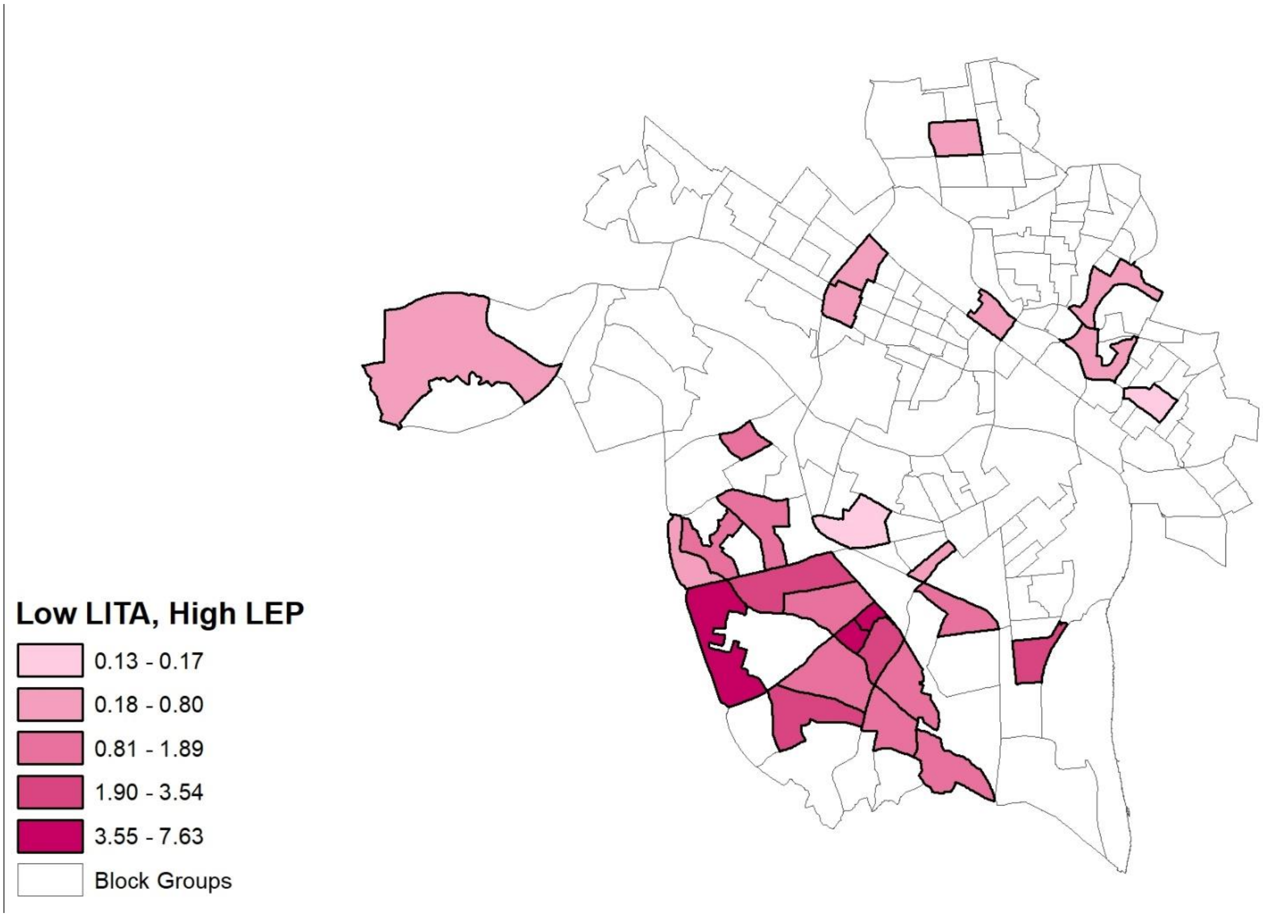


Figure 11. Low LITA, High Population with No Vehicle Access

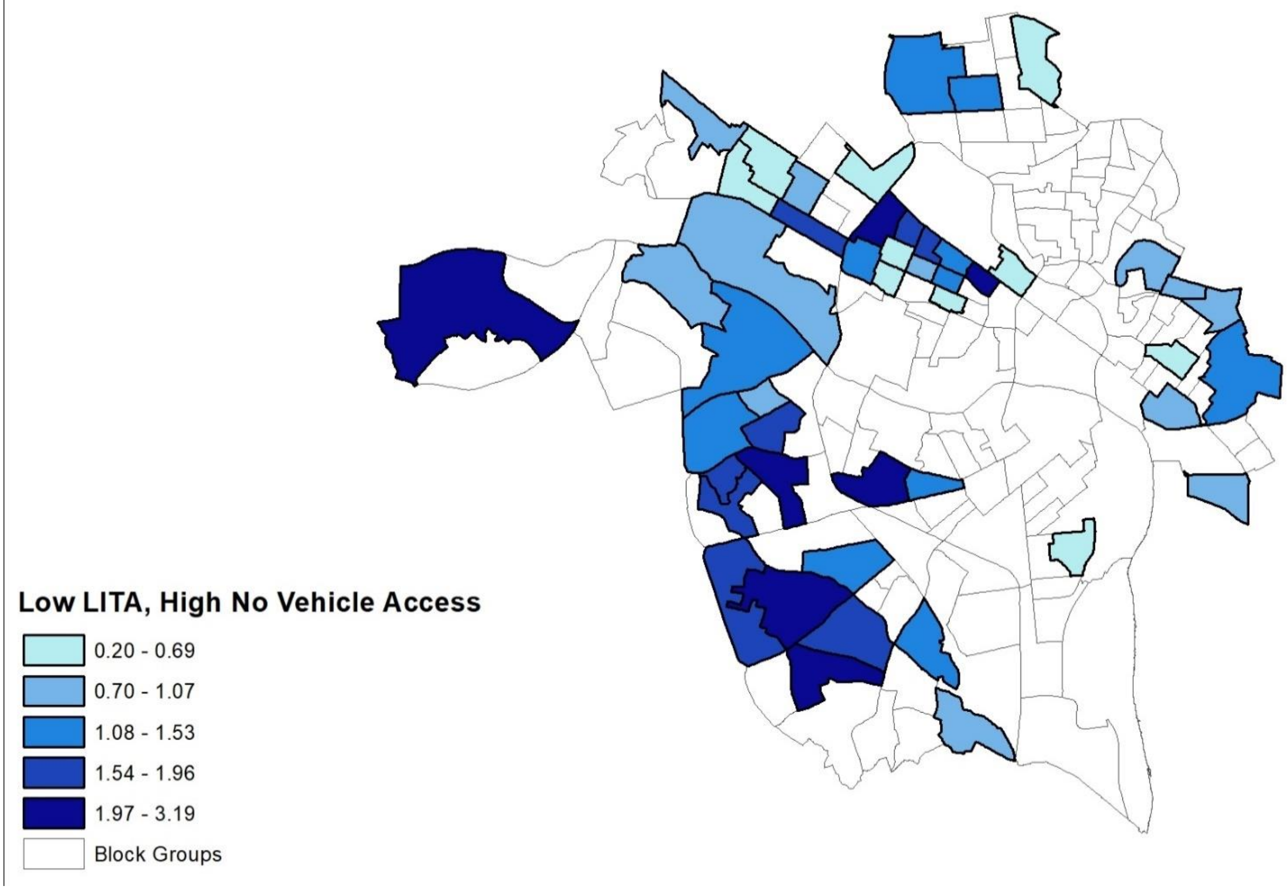
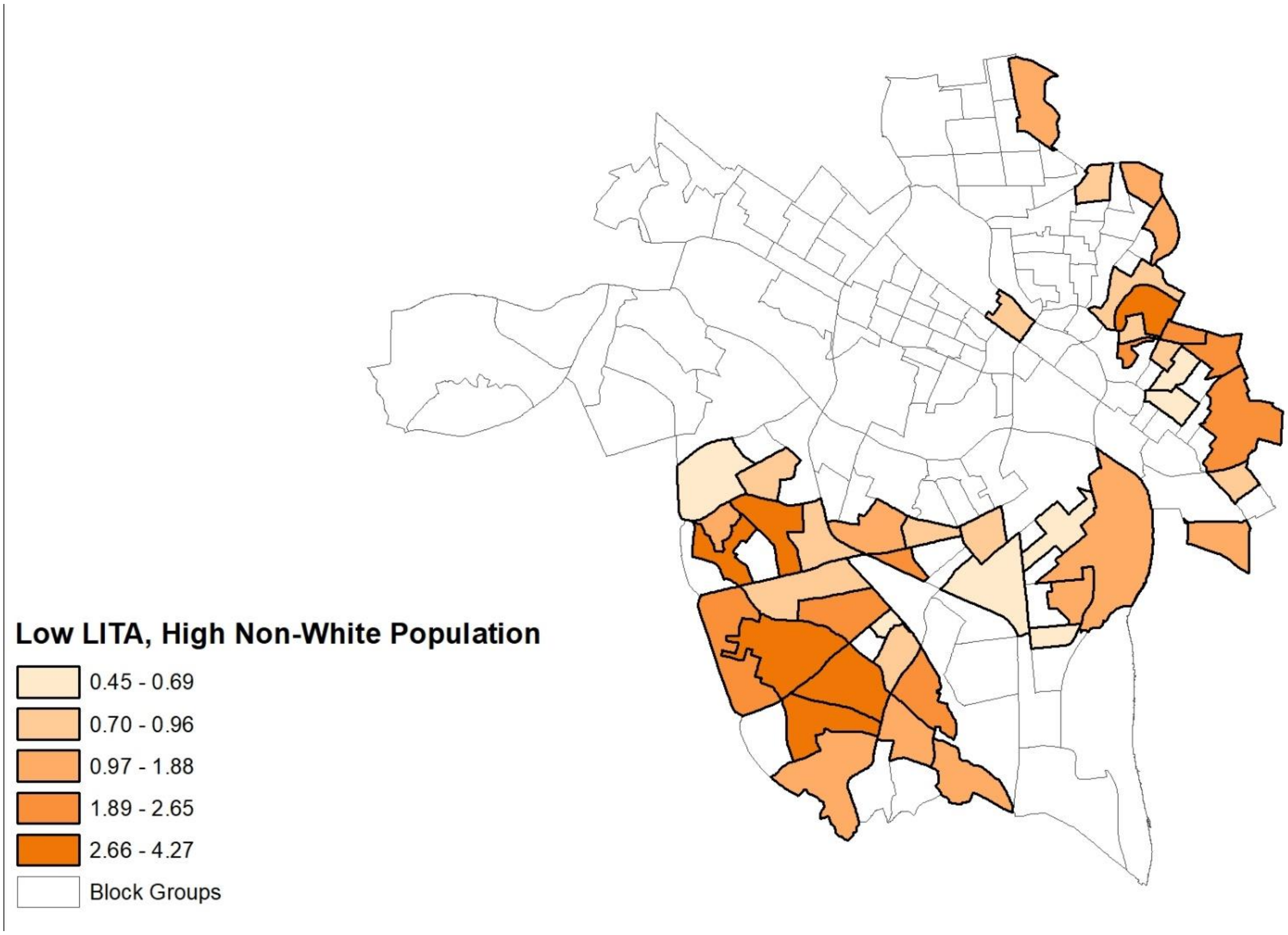


Figure 12. Low LITA, High Non-White Population



A lower equity index score for block groups meeting LH criteria indicates less severe equity issues, although there is still inequity present; a higher equity index score means less accessibility and more serious equity issues. Results from the analysis reveal that several block groups in the city receive higher access equity access scores than others, and there is wide variation in access equity citywide. It is interesting to note that several block groups on Southside and the East End remained among the highest scoring block groups for all social demographics. The downtown area, by contrast, received the highest LITA scores (meaning good accessibility) and did not meet the "LH" criteria, so this area of the city is considered to have good, relatively equitable access.

Table 4 shows the block groups with the highest (worst) equity scores in each social demographic category, indicating more severe equity issues. Block groups that received the highest equity scores are located in pockets throughout the city, and they illustrate the gap between neighborhoods with good access and those lacking access.

Comparing results across all social demographic categories, the greatest variation in equity was for elderly populations. The least variation was for populations with no vehicle access. The block groups with the lowest poverty equity scores, indicating more serious equity issues, are located in the north side and Southside neighborhoods. Block groups with the worst equity scores for the LEP population are located in the far Southside, although LEP saw the least amount of block groups meeting “LH” criteria compared to the other populations. The worst equity scores for the elderly population are in the Southside and north side. The worst equity scores for no vehicle access are in the West End, and Southside. The worst equity scores for the non-white population are in the north side and Southside neighborhoods. The most serious gaps in access equity are illustrated in the “LH” results, provided in Appendix D. The block groups meeting this criterion show which block groups have the worst accessibility in terms of equity, and should therefore be the focus of access improvement efforts.

Table 4. Block Groups with Highest (Worst) Equity Scores in All Categories

Poverty	
Block Group	Poverty Equity Score
517600708014	5.476181407
517600202002	4.193787397
517600202001	3.673059565
517600201001	3.510125281
517600709003	3.275607415
LEP	
Block Group	LEP Equity Score
517600706013	7.625397
517600707002	6.066783
517600706014	4.980099
517600708014	3.541066
517600608001	2.869133
Elderly	
Block Group	Elderly Equity Score
517600102003	5.494422
517600701001	5.009903
517600404001	2.96478
517600707001	2.891155
517600506002	2.480087
No Vehicle Access	
Block Group	No Vehicle Access Equity Score
517600407001	3.187462839
517600701001	2.867336772
517600605005	2.675045991
517600404001	2.664056397
517600710022	2.58899204

Non-White Population	
Block Group	Non-White Equity Score
517600708014	4.26563
517600710022	3.173074
517600707001	3.010441
517600710012	2.881551
517600201001	2.797361

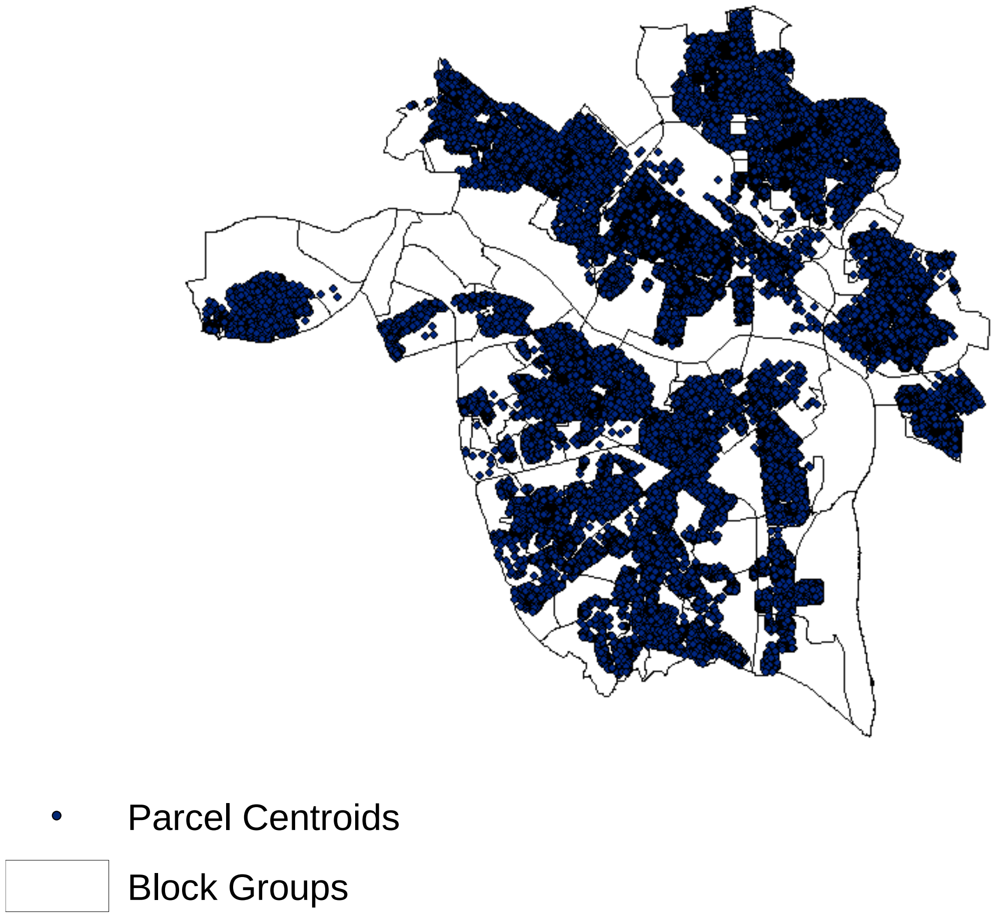
4.3 Improvements to the Richmond Transportation Network System

One key takeaway revealed through quantitative and qualitative analysis found that improvements should be made to improve and enhance the existing transportation network system instead of a complete overhaul of it. Several strategies were identified as having the most potential in improving access equity. In order to determine potential impacts to changes in the existing transportation network system, ArcGIS was used to model the existing transportation network system and making incremental changes.

In the initial steps of using Network Analyst, it was necessary to determine the number of people being served and not being served across the city in order to make recommendations for additional bus stops or other service changes. To determine the total number of people per block group that are not being served, two steps were involved. The first step included calculating the number of parcels in each block group (this was completed by exporting a summary table from GIS that included a spatial join of residential parcels and block groups in the entire city. The second step was calculating the average population for each parcel. This data was used later to compare the percentage of people being served within one quarter mile with the number of people who could potentially be served by GRTC (this includes parcels located within one quarter mile of bus routes but not bus stops because this would indicate that parcel is not currently accessing the bus route).

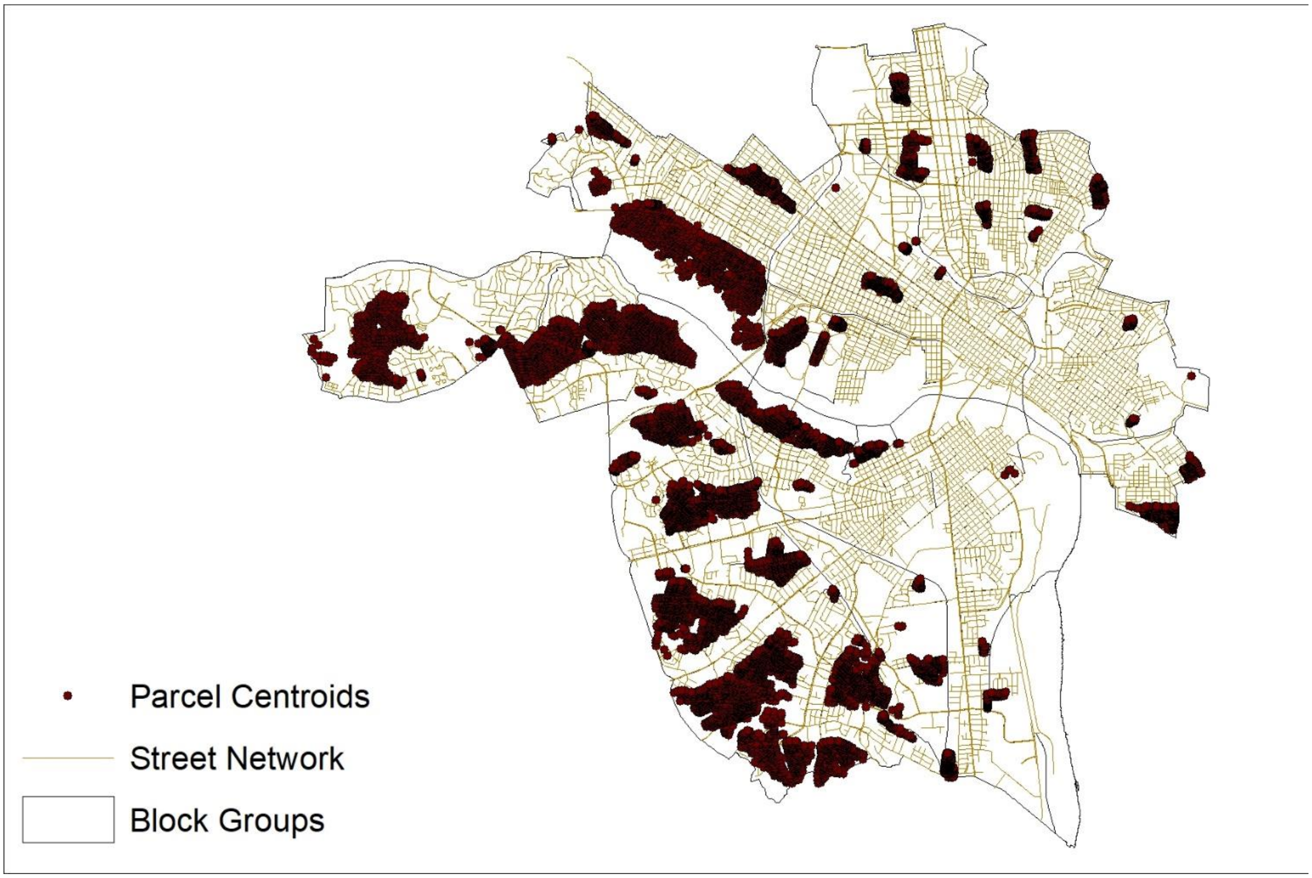
The method of analysis in using Network Analyst included an Origin Destination Cost Matrix (OD Matrix) to determine the percentage of people served (and not served) currently by public transit. The unit of analysis was all residential parcels within the City of Richmond. Each parcel's centroid was calculated in Arc GIS which was used as the inputs for the OD Matrix. GRTC bus stops were the destinations. There were 56,316 parcel centroids (origins) and 1,225 bus stops (destinations) inputted into the system. The end result of the OD Matrix calculated 369,887 possible connections (or lines) between origins and destinations. From there, residential parcels were selected by intersecting the parcels centroids with the connection (lines) data whose lengths were less than or equal to 0.25 miles. According to this method, about 14% of all residential parcels within the city are currently being served within one quarter mile of GRTC bus stops. Figure 13 shows the results of residential parcel centroids within one quarter mile of connections to bus stops.

Figure 13. Parcels Currently Served with Adequate Access



In order to determine where additional bus stops should be added, first a Service Area was created in ArcGIS. Then, parcels that are not currently being served were overlayed with the polygons. This result shows the *potential* population to be served if bus stops were added (population living outside one quarter mile of the GRTC network). Next, an intersect was used to show these parcels that could potentially have better access (Figure 14). These results indicate that additional bus stops would improve access equity for several block groups primarily located in the north side and Southside neighborhoods.

Figure 14. Parcels Potentially Served (outside 1/4 Mile of Transit Corridor)



Based on findings from the above parcel-level analysis and through AADT data, TODA, and LITA, several areas should take higher priority based on the demand for transit needed in those areas. Increasing capacity and frequencies on high-demand routes would have a positive effect on equity: identified routes include the Chamberlayne North Side routes, Hermitage/East Main route in North Side, Chamerlayne/Hull southside route, Highland/Jefferson Davis route in the southside, and the Church Hill route in the East End.

It is assumed that adding additional bikeshare station locations would improve accessibility for people living one quarter mile or more away from bus stops. Using Network Analyst, new bikeshare station locations were added based on location (mainly along bus routes) and demand (block group population). Preference to new locations was given to more densely populated areas, and more bike share station locations were added to block groups receiving lower LITA scores. A total of 58 new stations across the city is recommended to improve accessibility (Figure 15).

Figure 15. New Bikeshare Station Locations

Improvements to the existing transportation network system should not only improve accessibility, but should emphasize equity. Through the analysis, several block groups were clearly identified as having low equity scores when there was a high total of disadvantaged population. The analysis revealed that transit access equity for the non-white populations was relatively high; block groups with high total non-white populations also were among the block groups receiving the highest accessibility scores. There were few block groups with large LEP populations; therefore, few block groups were identified as having low equity scores for the LEP population. Access equity for populations with no vehicle access varied more greatly; block groups in the north side, east end, and on the southside, south of Forest Hill Avenue had the greatest populations without vehicle access. However, these block groups did not receive the highest LITA scores, which signifies such block groups as having low access equity for households with no vehicles. The largest concentration of the population ages 65 and older are located in the west end and in the north side. Results revealed that elderly access equity is adequate, minus a few block group exceptions that could benefit from higher access equity scores.

4.4 Qualitative Research on Technologies and Strategies to Improve Transit Access Equity

Between January 15th and 30th, 2019, formal phone interviews were conducted with transportation planners, city staff, and transit advocates from Charlotte, NC, Atlanta, GA, and Richmond, VA. Interview participants were chosen after conducting an internet search on public, private, and non-profit organizations whose work relates to transportation/transit planning. Specific persons were contacted through organizations' contact information available on their websites. Seven participants were interviewed from a total of six organizations (three from Charlotte, one from Atlanta, and two from Richmond).

Interviews were recorded and analyzed through several steps. First, abstracts were created shortly after all interviews were complete. Next, Audacity, a free, open-source software program, was used to play back the interviews at slower speeds; this was also used to find notable quotes. Finally, Microsoft Word and Excel were used create a coding system to identify themes and keywords.

Interview questions covered a broad range of topics related to transportation planning, accessibility, and transit technologies. Informants were asked technical questions regarding internal processes, funding, timelines, and program evaluation procedures. Informants were also asked what technologies or strategies they were implementing to improve accessibility to transit services and which ones they see as having the most impact on improving accessibility.

Several overarching themes emerged from the Key Informant (KI) Interviews: 1) it is important to plan for changing transportation choices, 2) a holistic approach to transportation planning is necessary, 3) planning for social equity is important, 4) effective community engagement can be a leading factor in a project's success, 5) regulatory guidelines must strengthen policies, and 6) new technologies are improving the transportation planning processes. These themes were identified after the coding process was complete. Several of the themes were guided by the existing literature.

The first theme of changing transportation choices was illustrated through several interviews with representatives from Charlotte, Atlanta, and Richmond. The Atlanta Regional Commission's work currently focuses on the FMLM problem and pedestrian/bike accessibility; Alta provides advisory services to localities looking to improve physical mobility modes; Charlotte Department of Transportation (CDOT) is currently evaluating five radial corridors to expand BRT services; Charlotte Area Transit System (CATS) is looking at how best to serve a population that is increasingly growing outward from the city; Richmond recently passed a dockless scooter ordinance.

These specific examples point to the fact that improving accessibility is increasing in awareness in the transportation planning field. Taking on the task of improving accessibility is one thing, but doing it through an equity lens is another. It is clear that cities are working to improve transit services to serve the most people efficiently in the cheapest way. Changing population, migration, and commuting patterns are additional challenges cities must plan around; Charlotte is becoming one of the country's fastest growing cities, and with that comes growing pains. CDOT works to improve accessibility to transit stations (i.e. bikeshare systems, Lyft partner programs, etc.). Based on findings from the qualitative analysis, transportation planning in Atlanta focuses on station enhancements and connectivity. Richmond's current focus seems to be on increasing transit ridership and increasing its efficiency.

A key takeaway resulting from the qualitative analysis is that the future of transportation planning has potential but is not currently meeting the needs of the people who need it most. The Atlanta Regional Commission believes current technologies and strategies are effective in moving the needle forward toward social equity, but there are still gaps in addressing the issue. Similarly, CDOT believes the only effective way to continue improving transit in a way that addresses social equity issues is if the planning process takes a holistic approach, not a piecemeal, technical one. The term 'holistic' is best understood to mean that transportation planning includes all possible aspects encompassing quality of life: commuting, preferred travel modes, additional transit services to harder-to-reach populations, and better access opportunities to populations who have historically been left out of the planning process. One interview participant from CATS believes transportation planning can have the most impact on addressing equity issues when the focus is on connecting low-income workers from houses to their jobs.

Effective community engagement was cited by almost all interviewees as one of the most important tools planners can use to tackle social issues. In the last five to ten years, CDOT has experienced the success of digital community engagement: Nextdoor, Twitter, Facebook, project websites, open houses, public forums, and interaction with community members during festivals and other events. CDOT measures effective community engagement as the formation of positive relationships with community members and partners that have influenced and/or changed transportation projects. All informants representing their respective agencies hold neighborhood or public meetings, and these are effective for planning organizations to receive direct feedback from community members about what works or does not work for a project. Alta conducts focus groups and administers random surveys. ReMix and ArcGIS Online were two interactive tools identified as providing useful feedback and comments for projects. Currently, RVA Rapid Transit is administering rider surveys to GRTC users, and the goal is to improve ridership by listening to what riders need.

A resounding agreement across almost all interviews was that policies and regulatory guidelines must go hand-in-hand with transportation plans and projects. This aspect of the planning process provides the most influential opportunity in ensuring projects get implemented. John Cock and Tracy Newsome both said, "the best transportation plan is a good land use plan". This means that regulatory and development guidelines must exist in a way that encourage public transit use and multimodality. CDOT and CATS representatives emphasized this view by expressing how important a role Charlotte's complete streets policy[1] plays in improving accessibility. Richmond's complete streets policy is a newer strategy the city can use to prioritize equity in transportation projects.

One technology identified from the key informant interviews was RideFinders, a regional ridesharing program. RideFinders provides real-time carpool sharing and vanpooling services and park-n-ride information. This theme emerged both from quantitative analysis (demand sharing) and through findings from key informant interviews. Ridesharing programs not only reduce the demand impact from lacking public transit services, they provide cost-effective options to supplement subsidized transportation services (Kramer, 2015).

The Livable Centers Initiative (LCI)[2] grant program was identified through key informant interviews as one that is growing as a regional quality improvement technique for transportation planning projects. It is currently used in the central Atlanta region, but its increasing popularity nationally provides the potential for other similarly innovative funding strategies and collaborations. Similarly, when localities and regional entities (such as RRTPO) collaborate with state-level agencies (such as VDOT), federal funding becomes more readily available, or at least takes higher priority for such projects who have FMLM or accessibility components.

The importance of bikeshare systems, B-Cycle, dockless bikes, and electric scooters were emphasized in every interview. However, the difference between such technologies in Charlotte and Atlanta compared to Richmond is that they have been around longer than Richmond's, which means Charlotte and Atlanta may be further along in strengthening the link between technologies and existing transit via transfer stations, station enhancements to increase capacities for new and/or expanded technologies, mobility hubs, etc.

4.5 *Research Limitations*

The availability of quantitative data was the largest limiting factor in this study; because this project was not funded by a grant or any other outside resource, the scope of this research was limited due to its reliance on publicly available data. Further, most of the data available at the smallest unit of analysis were at the block group level; if more data were available, the neighborhood level would have been the optimal choice in order to determine how many people (for each social demographic category) were served within each block group. The best way to calculate estimates for this type of information was by using parcel data and Network Analyst (to determine additional bus stops/service changes). As such, the Accessibility Index scores (LITA)

[1] Complete streets policy is a transportation policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation, as defined by Smart Growth America.

[2] Livable Centers Initiative is a grant program in the Atlanta region that encourages cities and communities to develop strategies to link quality of life activities (recreation, dining, shopping, etc.) via sidewalks, bike lanes, walking trails, and other TOD infrastructure (ARC, 2017).

and equity index scores at the block group level are still valuable, but there is room for future research at the neighborhood level. Considering the index measures used in this study, the methods used here are part of one approach to measuring accessibility and equity. While the methods here were guided by existing literature, it is understood that different methods will produce different results, thus leading to different conclusions. If this type of analysis is done in the future, additional methods should be considered.

Similarly, due to time constraints imposed on the project, limited interviews with transportation officials were conducted. If more time was permitted, a more thorough city search would be conducted; because of this limiting factor, interview participants only included three cities in the Southeast US. A more comprehensive comparative analysis would allow Richmond City's public transportation system to be evaluated at a more detailed level with other cities' systems. Another limiting factor is the lack of interview data from transit users and members in disadvantaged populations.

To further explain the accessibility measures used in this study, they are focused on origins as opposed to destinations – how people get to transit stops rather than physical places individuals can reach by using public transit after reaching their destination via transit. This is important to note because public transit systems are equitable if they are accessible *and* deliverable. Also, the findings from this study emphasized the importance of transit stops (frequency, coverage, and accessibility) in measuring accessibility. Connecting power is an important accessibility measure, but due to the scope and focus of this study, this area of research was limited. Regarding LITA scores, it is important to note that block groups that did not have any bus stops located within them – regardless of how many people live within it – received a score of zero, the lowest accessibility score, which influenced the overall composite scores.

As explained in Chapter 2, there is a slew of social determinants and accessibility metrics with which to evaluate and assess existing transit systems. Mainly due to time and feasibility, this project primarily used LITA, TCQS, and Time of Day Analysis. It is important to note that these accessibility metrics measure in terms of the availability of transit services, proximity, ridership, and travel time. In no way are these tools exhaustive measures of transit performance; other accessibility measures that would be useful to measure include ease of use of existing transit services, evaluation of payment methods, and evaluating whether policies directly assist individuals with Limited English Proficiency, visual and hearing impairments, physical disabilities, etc.

Additionally, analysis of adding paratransit services was limited in this study for two reasons: most of the available paratransit services are on-demand (meaning there is no fixed route and customers call ahead to request service), and most of the paratransit services available are managed by RideFinders, which is a separate entity from GRTC. However, it is assumed that adding more paratransit services city-wide would improve accessibility and equity for individuals with disabilities.

CHAPTER 5

5. Discussion and Conclusion

5.1 *Summary of Key Findings*

Through content analysis and conclusions from key informant interviews, several strategies and technologies were identified as potentially having the most impact on addressing transit access equity in Richmond. For example, TOD ordinances and districts are such tools that improve accessibility and quality of life, thus increasing overall equity in that immediate geographic area. Targeting infrastructure investments, including providing priority funding, for projects that improve accessibility to transit stations will directly contribute to improving access equity. Furthermore, localities receive more funding when they collaborate regionally and with the state (e.g. VDOT). Sustaining working and long-term relationships among localities and community partners ensures positive collaboration.

When transportation planning emphasizes multiple modes of transportation and their ability to "transfer goods and people beyond their ability to move vehicles" (John Cock, Alta), transportation planning takes an equity focus. Findings from the thesis support the integration of car-based and mobility-based strategies to improve access equity opportunity. The interview with RVA Rapid Transit justified the inferred finding from several aspects of the quantitative analysis: Richmond is a small city with an historic street network (i.e. it was not originally designed for cars), so a complete redesign of the street grid network is not possible or feasible (Catrow, 2019). Therefore, making small, intentional changes to the system will further the City of Richmond's ability to become an equitable place for transit access. Richmond's recent adoption of the dockless scooter ordinance is one example of the city's response to improving the transit-automobile gap (Roldan, 2019).

Areas where the findings between the quantitative analysis and qualitative analysis differ include areas of policy, agency goals versus reality, and the rate at which transportation planning meets intended goals. There is a thin line between transportation planning and transit planning; while this thesis used the terms interchangeably, the discussion during the interviews over policies related to each area revealed some differences. In 2004 the Commonwealth Transportation Board (CTB) adopted the 'Policy for Integrating Bicycle and Pedestrian Accommodations', which requires all VDOT projects to plan for bicycle and pedestrian access in the planning and design processes. In Charlotte, CDOT and CATS use the complete streets policy as their guiding light for all transportation projects. According to the interview with a CATS representative, the reasoning for relying so heavily on the complete streets policy was, "More people use our buses when they can access them." CDOT uses data to validate their reasons for proximity as a key priority; most of Charlotte's travel trips happen around light rail stations, and the increasing number of dockless bikes being taken on the bus show origins and destinations and how people choose to take their trips are equally important. Therefore, policies and programs implemented by CDOT emphasize multimodal travel trips and proximity. Alta's planning focus is on improving active transportation, so most of their policies are related to streetscape, design, and complete streets. These differences are important to consider for transportation planning, because goals will be achieved according to which policies or programs are implemented first, or at higher priorities.

The feasibility of project implementation and the availability of funds and resources were common responses regarding limitations to transportation planning. Solving equity disparities are often limited due to funding, inadequate or corrupt political influence, institutional racism, and disproportionate levels of development for and by populations focused on serving themselves with little time and/or funds left for serving others; disadvantaged populations are not usually the ones who have human or financial capital to fix the issues causing the disproportionate access. This point was illustrated by one key informant from CATS: "New technologies are supposed to help people get to where they want to live and work. The hard part is that big projects that incorporate all the possible factors involved are so reliant on funding" (McAdory, 2019).

Political constraints also inhibit an organization's ability to focus on an issue. Henrico, Richmond, and Chesterfield have technical advisory committees who are looking at improving FMLM and bicycle and pedestrian access but are not currently included in a plan due to political reasons (McAdory, 2019). By focusing on increasing ridership, Richmond is currently working on improving bicycle and pedestrian access to GRTC stops and BRT. This is important to consider because a goal of increasing the number of people using public transit is very different from a goal of improving accessibility and equity, and different results will occur when one goal is favored over another.

One of the major themes that emerged through qualitative analysis was the consensus that transportation planning must take a holistic approach to achieve equity access. Several organizations such as CDOT, CATS, and the Atlanta Regional Commission focus on improving accessibility as a key priority and have incorporated accessibility measures into their regular planning processes. Other organizations, such as Alta, fold in goals for improves accessibility into projects they are already working on; accessibility in this situation is more of a checklist item than a focus area. VDOT, and by extension Richmond, is not quite to the step where accessibility is at the forefront of all transportation projects. Transportation planning takes time. Tracy Newsome at CDOT explained, "Fifty years of planning did not take into account multiple modes of getting around. Only now are we starting to see people plan their commutes by using the train, Uber, bikeshares, and scooters. It takes time" (Newsome, 2019). [again, cite all interview quotes, and don't use first names only] It seems regular practice for many cities to evaluate projects using performance measures focused on efficiency before incorporating measures for accessibility and equity. The City of Richmond's transportation network would benefit from performance measurement that encompasses all aspects – i.e. an holistic approach.

This thesis can be used as a step in this direction; it provides a picture of where transit is performing well and where it can be improved to serve the most individuals.

Findings from the quantitative analysis largely support the findings from the qualitative analysis. Intentional changes focused on improving accessibility and equity will lead to overall positive improvements in the existing transportation system. By increasing the number of bikeshare stations, making them accessible to all neighborhoods, and strategically placing them near transit stops and transfer stations will lead to more travel trips near transit stops, which will likely positively influence the number of transit users. By incorporating physical improvements, such as lighting and sidewalks, into the existing system, overall accessibility will increase. Providing on-demand services such as paratransit services, call-ahead ridesharing services, and carsharing programs will also help reduce the transit-automobile gap. Focusing efforts on block groups identified as having low LITA scores and high disadvantaged populations has the potential to make the most impact on improving access equity for all social demographics in the city.

Findings from content analysis and from key informant interviews reveal that the current Richmond transportation network is automobile-centric. GRTC, which is known as originally being a “poor man’s service” (McAdory, 2019), currently provides services that benefit some more than others. However, it is important to note that at the block group level and the neighborhood level, about one-third of the city population has adequate access to public transit; there is generally more accessibility at the block group level.

New technologies are emerging to enhance the existing transportation system which will contribute to higher levels of access equity. Bikeshare programs, scooter-shares, ridesharing programs, paratransit services, and non-banking fare payment options are designed with an accessibility and/or equity focus. Other strategies that have been known for linking transportation and social equity are Transit-Oriented Development ordinances, creative ways of using Big Data, complete streets policies, affordable housing initiatives, and effective, strong community engagement efforts.

The results from this thesis support the notion that a complete, city-wide redesign of the transportation network system is neither feasible nor encouraged. Instead, smaller changes and improved coordination between services are recommended, to improve overall system performance and better serve the transit dependent riders. Such approaches include 1) bikeshare and scooter-share programs and the general integration of bicycle/scooter access and transit services, 2) ridesharing (public and private) programs that will reach populations who live more than one quarter-mile away from or have barriers to accessing public transit (Pendall et al., 2016), and 3) a general increase in travel options for populations with no vehicular access or other barriers to using transit.

The results of this research also support conclusions from past studies that improving access/egress to transit stops by multiple modes can improve the overall accessibility of transit services themselves (e.g. Boarnet, 2017; Grengs, 2010; Fan, 2012). In Charlotte and Atlanta, transportation planning organizations use policies to prioritize proximity, accessibility, and multi-modal transportation. By increasing the number of ways people can access transit, the result will be an overall increase in the number of people using transit.

Equity

An important distinction that should be made regarding the aims of this thesis in promoting social equity is the difference between equality and equity. It is guaranteed that transportation planning impacts people (the social aspect). Equality in transportation planning would mean everyone has the equal *opportunity* to access transportation. Equity goes a step further in providing additional services to historically excluded populations. Equity is applicable to this thesis because of the generational wrongs and past harms to disadvantaged populations. Taking, for example, the population of individuals living in poverty in Richmond, Virginia have generally experienced segregation, social exclusion, and displacement. A number of steps can be taken to improve the specific barriers to access this social demographic faces. Providing non-banking fare payment options, pay-per-service options, and on-demand transit services (such as ridesharing, bikesharing, and paratransit services) are tailored investment strategies designed to address transit access equity for individuals living in poverty.

As identified in Chapter 4, several block groups were found to have low access equity despite having larger concentrations of disadvantaged populations. Therefore, it is recommended that these block groups and the neighborhoods that contain them be the focus for improving access equity. Most of the block groups that fall into the inequitable categories are located in the North Side and the East End neighborhoods.

Improving equity should not and does not rely on improving accessibility by itself. As revealed by both quantitative and qualitative analysis, transportation projects do not occur in isolated events. They have rippling effects, and an impact to one piece of the project can impact other parts as well. Therefore, policy recommendations that come from this thesis pertain to improving equity overall, not just accessibility. This is important to separate the work of this thesis from other transportation analyses.

Physical or facility improvements have been identified through quantitative and qualitative analysis to improve access equity. Sidewalk facilities not only help people get to bus stops, but when there are adequate sidewalks, they can be used to supplement the use of transit services. Upgrading transit stops to make them safer is equally important to ensure people can access them easily; adequate lighting, seating/benches, cash/non-mobile fare payment systems, and bike shares were identified as having the most potential to improving access equity for Richmond's network system.

By way of policy, several findings have revealed the importance of effective policies in improving equity. The Environmental Justice Tool is used to identify disadvantaged populations so strategies can be implemented about how to best serve and reach them. Transit Oriented Development ordinances function in the land use regulation arena and are designed to enhance mixed use neighborhoods with a robust system of streets, sidewalks, and bicycle facilities. Complete streets are an extension of locally implemented guidelines for safe and walkable streets. Long-range transportation plans (such as CDOT's Transportation Action Plan) provides an opportunity for local community and regional visioning collaboration for long-term transportation goals unique to that locality.

As the thesis applies to Richmond, VA, the transportation technologies and strategies that would have the most potential in improving access equity include: non-banking payment solutions, increasing paratransit services, and the improved integration of on-demand services into the existing system.

As explained in Chapter 2, evaluating transportation systems through an equity lens signifies balancing between limitations and benefits. The findings from this thesis show that the current system, especially regarding the physical coverage of routes and stops, balances the costs of speed and closer distances. Stops that have shorter walking distances means better accessibility in terms of proximity analysis but means reduced speeds, which impacts frequency and availability. Favoring one area of costs over the other results in policy implications. A possible next step in this research area would be a cost-benefit analysis comparing different transit improvement strategies.

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Appendix A
Interview Protocol:
Key Informant Interviews
To be conducted between January 15th and 30th, 2019

My name is Rachel Jordan and I am a second-year master's student in the Urban and Regional Planning Program at Virginia Commonwealth University. As part of my requirement for graduation, I am completing a thesis exploring the topic of transit access equity in Richmond, Virginia. The focus of my work is on addressing barriers to social inclusion in public transportation systems. My research includes looking at what other cities are doing to improve transit access equity through the use of technologies, policies, programs, or any other services.

Thank you for taking the time to meet/talk with me today. The purpose of this interview is to gather information on your experience in addressing access to public transit in the planning process related to the first mile/last mile problem. Please know that this interview is completely voluntary, and you do not have to answer every question. If you are unsure about a question, I can clarify, or we can skip it.

The Meaning of the First Mile/Last Mile Problem
The first mile/last mile problem has been defined as the first and last mile of an individual's commute that public transit does not serve. It is fairly common that a city bus does not usually stop right outside your front door. For the scope of my thesis, I will be focusing on urban areas, in particular smaller urban areas, so the questions that follow will focus on how urban populations are affected by transportation access.

Experience with Transit Access Equity
Can you tell me about any experiences you have had, directly or indirectly, related to planning for transit accessibility? The First Mile Last Mile Problem?

Do you know about any strategies or services that are being implemented to address the first mile last mile problem and other accessibility issues in your city? State? Elsewhere?

Some of the emerging trends to improve access to transit include bikeshare systems, scooter shares, moped shares, and carshares, but also include physical infrastructure improvements such as sidewalks, bike lanes, and walkable streets. What is your experience, if any, in implementing such services in the transportation arena? (If no experience, "How would you implement them?") Do you think these are effective in providing all people access to transit services?

The City of Richmond has a Bus Rapid Transit System that travels mostly through the downtown area, east to west.

a. What is your experience related to bus rapid transit system planning?
b. Please describe any tools or services that you think can be integrated into an existing transit system.

Operational Questions

What policies or programs have you or your department been directly involved with as they relate to the first mile/last mile problem? Improving access for individuals with disabilities? Transit accessibility in general?

What is your experience drafting transportation policies?

Please explain your experience assessing or evaluating transportation projects. (Do you evaluate the project 6 months/a year after implementation? How do you determine effectiveness of projects?)

What types of planning tools do you use (e.g. GIS, linear/regression modeling, predictive modeling, other mapmaking software, statistical analysis, etc.)?

During the planning phase of a recent transportation project in which you were involved, to what extent did you engage with the public? How were community organizations involved? Did you hold public meetings?

How are relationships with community members sustained throughout transportation planning, implementation, and evaluation plans? Who is given the responsibility to pursue and foster community relationships?

How do you account for disadvantaged populations in transportation planning? ("disadvantaged populations"- racial/ethnic minorities, living below the poverty level, limited English proficiency, transit dependent)
(Probing question: How do you or your agency address access issues for disabled or mobility-challenged individuals? The elderly?)

Strengths & Challenges

What have you found make transportation projects successful?
What about the most challenging?

Improvements

Based on your experience, can you tell me any ways that transportation planning can better address transit access equity?

Given your expertise, in what areas of transportation planning do you foresee as having the most impact in improving access to public transportation? (probe: community engagement, new technologies, demographic shifts, etc.)

This concludes our interview. Thank you again for your time. If I have additional follow-up questions, is it okay to reach back out?

Appendix B

LITA Scores

Block Group	Coverage	Frequency	Capacity	LITA Composite
517600102001	0.54	0.14	-0.08	0.60
517600102002	-0.31	-0.25	-0.10	-0.66
517600102003	-0.23	0.24	-0.08	-0.07
517600102004	0.12	0.42	-0.07	0.48
517600103001	-0.17	-0.14	-0.09	-0.40
517600104011	-0.27	-0.15	-0.10	-0.52
517600104012	0.29	0.29	-0.08	0.51
517600104021	-0.35	-0.33	-0.10	-0.78
517600104022	-0.04	-0.09	-0.09	-0.22
517600104023	-0.10	-0.25	-0.10	-0.45
517600105001	0.31	-0.20	-0.09	0.02
517600105002	-0.36	-0.39	-0.10	-0.84
517600106001	0.21	0.08	-0.09	0.20
517600107001	-0.23	-0.35	-0.10	-0.67
517600107002	0.47	-0.21	-0.09	0.16
517600107003	0.11	-0.30	-0.09	-0.28
517600108001	0.06	-0.19	-0.09	-0.23
517600108002	0.27	0.00	-0.09	0.18
517600108003	-0.32	-0.38	-0.10	-0.79
517600109001	-0.41	-0.40	-0.10	-0.90
517600109002	0.29	-0.26	-0.09	-0.06
517600109003	0.22	-0.31	-0.10	-0.18
517600109004	-0.20	-0.23	-0.10	-0.53
517600110001	-0.36	-0.38	-0.10	-0.84
517600110002	0.10	-0.30	-0.10	-0.30
517600110003	0.11	-0.31	-0.10	-0.30
517600111001	-0.30	-0.38	-0.10	-0.77
517600111002	-0.23	-0.31	-0.10	-0.63
517600111003	-0.16	-0.35	-0.10	-0.61
517600111004	0.44	0.53	-0.04	0.92
517600201001	-0.32	-0.21	-0.10	-0.62
517600202001	0.11	-0.10	-0.09	-0.08
517600202002	-0.09	-0.29	-0.10	-0.47
517600203001	0.02	-0.28	-0.09	-0.35
517600203002	0.13	-0.30	-0.10	-0.27

517600204001	-0.35	-0.28	-0.10	-0.73
517600204002	-0.41	-0.40	-0.10	-0.90
517600204003	-0.13	-0.35	-0.10	-0.58
517600204004	-0.32	-0.36	-0.10	-0.78
517600204005	-0.29	-0.32	-0.10	-0.71
517600205001	-0.02	1.52	-0.08	1.43
517600205002	0.89	0.62	-0.06	1.45
517600206001	0.34	-0.27	-0.10	-0.03
517600206002	0.45	0.26	-0.08	0.63
517600207001	0.00	0.01	-0.09	-0.09
517600208001	-0.07	-0.24	-0.10	-0.41
517600209001	-0.35	-0.35	-0.10	-0.79
517600209002	-0.32	-0.37	-0.10	-0.79
517600209003	-0.26	-0.26	-0.10	-0.62
517600210001	-0.16	-0.38	-0.10	-0.63
517600210002	-0.38	0.61	-0.10	0.13
517600211001	0.14	0.68	-0.05	0.77
517600212001	-0.36	0.02	-0.10	-0.43
517600301001	1.77	0.04	-0.06	1.74
517600301002	0.27	0.16	-0.09	0.34
517600302001	5.42	3.20	0.38	9.00
517600302002	9.51	10.75	12.53	32.80
517600305001	4.55	1.88	1.12	7.55
517600305002	0.28	-0.10	-0.10	0.09
517600402001	0.03	0.03	-0.09	-0.04
517600402002	0.51	2.19	0.36	3.06
517600403001	0.88	-0.33	-0.10	0.45
517600404001	-0.41	-0.40	-0.10	-0.90
517600404002	-0.41	-0.40	-0.10	-0.90
517600405001	-0.41	-0.40	-0.10	-0.90
517600405002	0.07	-0.38	-0.10	-0.41
517600406001	-0.16	-0.26	-0.10	-0.52
517600407001	-0.28	-0.15	-0.10	-0.53
517600408001	0.02	-0.34	-0.10	-0.42
517600409001	-0.30	0.21	-0.10	-0.18
517600409002	0.39	-0.34	-0.10	-0.05
517600410001	-0.41	-0.40	-0.10	-0.90
517600410002	-0.10	-0.10	-0.10	-0.30
517600411001	0.25	-0.26	-0.09	-0.11

517600411002	-0.19	-0.24	-0.10	-0.52
517600411003	0.27	-0.01	-0.09	0.17
517600412001	0.08	-0.32	-0.10	-0.34
517600413001	-0.16	0.39	-0.09	0.13
517600413002	-0.26	-0.31	-0.10	-0.67
517600414001	-0.18	0.49	-0.09	0.22
517600414002	-0.17	-0.13	-0.10	-0.39
517600416001	-0.41	-0.40	-0.10	-0.90
517600416002	-0.11	-0.23	-0.09	-0.43
517600501001	-0.18	-0.30	-0.10	-0.58
517600501002	-0.30	0.42	-0.09	0.03
517600502001	0.73	-0.35	-0.09	0.29
517600502002	-0.24	-0.34	-0.10	-0.68
517600502003	-0.31	-0.28	-0.10	-0.68
517600503001	-0.41	-0.40	-0.10	-0.90
517600504001	-0.06	-0.06	-0.09	-0.22
517600504002	-0.26	-0.15	-0.10	-0.50
517600505001	-0.07	-0.13	-0.09	-0.29
517600505002	-0.37	-0.06	-0.10	-0.53
517600505003	-0.37	1.44	-0.09	0.97
517600506001	-0.41	-0.40	-0.10	-0.90
517600506002	-0.41	-0.40	-0.10	-0.90
517600602001	-0.22	-0.05	-0.09	-0.36
517600602002	-0.03	-0.30	-0.10	-0.42
517600602003	0.03	-0.23	-0.10	-0.29
517600604001	-0.10	-0.25	-0.10	-0.44
517600604002	-0.04	-0.29	-0.10	-0.42
517600604003	-0.41	-0.40	-0.10	-0.90
517600604004	-0.03	-0.32	-0.10	-0.44
517600604005	-0.33	-0.28	-0.10	-0.71
517600605001	-0.37	-0.38	-0.10	-0.84
517600605002	-0.22	-0.30	-0.10	-0.62
517600605003	-0.24	-0.35	-0.10	-0.69
517600605004	-0.41	-0.40	-0.10	-0.90
517600605005	0.05	0.01	-0.09	-0.03
517600606001	-0.10	0.53	-0.08	0.35
517600606002	-0.07	-0.24	-0.09	-0.40
517600606003	-0.41	-0.40	-0.10	-0.90
517600607001	-0.14	0.16	-0.08	-0.06

517600607002	-0.35	-0.36	-0.10	-0.81
517600607003	-0.32	-0.07	-0.10	-0.49
517600607004	0.00	-0.21	-0.09	-0.31
517600607005	-0.08	-0.24	-0.10	-0.42
517600608001	-0.36	-0.21	-0.10	-0.66
517600608002	0.06	0.57	-0.07	0.57
517600608003	-0.38	0.94	-0.08	0.48
517600609001	-0.23	1.83	-0.03	1.57
517600610001	0.13	0.41	-0.05	0.49
517600610002	1.09	0.56	0.00	1.64
517600701001	-0.40	0.00	-0.10	-0.49
517600701002	-0.41	-0.40	-0.10	-0.90
517600701003	-0.34	0.93	-0.09	0.50
517600703001	-0.33	0.96	-0.09	0.54
517600703002	-0.41	-0.40	-0.10	-0.90
517600704001	-0.35	-0.12	-0.09	-0.56
517600704002	-0.38	-0.24	-0.10	-0.72
517600704003	-0.41	-0.40	-0.10	-0.90
517600706011	-0.31	-0.07	-0.09	-0.48
517600706012	-0.35	-0.28	-0.10	-0.73
517600706013	-0.08	-0.34	-0.10	-0.52
517600706014	-0.05	-0.32	-0.10	-0.47
517600706021	0.41	0.19	-0.05	0.55
517600706022	-0.37	-0.37	-0.10	-0.83
517600707001	-0.35	-0.22	-0.10	-0.67
517600707002	-0.37	-0.30	-0.10	-0.77
517600708011	-0.34	-0.27	-0.10	-0.70
517600708012	-0.41	-0.40	-0.10	-0.90
517600708013	-0.41	-0.40	-0.10	-0.90
517600708014	-0.41	-0.40	-0.10	-0.90
517600708021	-0.37	-0.35	-0.10	-0.81
517600708022	-0.38	-0.36	-0.10	-0.84
517600708023	-0.38	-0.37	-0.10	-0.85
517600709001	-0.23	-0.19	-0.09	-0.51
517600709002	-0.23	0.75	-0.07	0.45
517600709003	-0.35	-0.31	-0.10	-0.76
517600709004	-0.40	-0.36	-0.10	-0.86
517600709005	-0.39	-0.37	-0.10	-0.86
517600710011	-0.38	-0.38	-0.10	-0.86

517600710012	-0.36	-0.35	-0.10	-0.80
517600710013	-0.36	-0.36	-0.10	-0.82
517600710014	-0.15	-0.18	-0.09	-0.42
517600710021	-0.34	-0.25	-0.10	-0.69
517600710022	-0.35	-0.21	-0.10	-0.65
517600711001	-0.21	0.15	-0.09	-0.16
517600711002	-0.34	-0.37	-0.10	-0.81
517600711003	-0.33	-0.32	-0.10	-0.75
517600711004	-0.37	-0.08	-0.10	-0.54

Appendix D

Block Groups with Low LITA, High Disadvantaged Populations

Poverty				
Block Group	Total Poverty	Percent in Poverty	LITA Score	Poverty Equity Score
517600711002	196	0.20082	24.03	220.03
517600404001	984	0.489552	0	0
517600409001	97	0.077476	66.27	163.27
517600209002	95	0.143505	30.46	125.46
517600604003	809	0.531887	0	0
517600708014	1792	0.57	0	0
517600701003	35	0.027581	85.75	120.75
LEP	Total LEP	Percent LEP	LITA	LEP Equity Score
517600109001	7	0.018918919	0	0
517600701001	17	0.013832384	21.5	38.5
517600704001	8	0.009142857	33.58	41.58
517600711002	20	0.034542314	24.03	44.03
Elderly	Total Edlerly	Percent Elderly	LITA	Elderly Equity Score
517600416001	235	0.21	0	0
517600606003	207	0.22	0	0
517600212001	216	0.12	36.86	252.88
517600604004	103	0.15	138.14	241.14
517600604005	94	0.063513514	31.79	125.79
517600413002	118	0.107959744	55.05	173.05
No Vehicle	Total No Vehicle	Percent No Vehicle	LITA	No Vehicle Equity Score
517600708014	1024	0.323743282	0	0
517600607002	370	0.313825276	21.46	391.46
517600708012	419	0.279333333	0	0
Non-White	Total Non-White	Percent Non-White	LITA	Non-White Equity Score
517600110001	523	0.834130781	16.65	539.65
517600708012	1029	0.686	0	0

GEOID	LITA	Poverty_Zscore	Equity_Score
Poverty			
517600708014	-0.903692416	4.572488991	5.476181407
517600202002	-0.472734205	3.721053193	4.193787397
517600202001	-0.079877682	3.593181882	3.673059565
517600201001	-0.624913824	2.885211457	3.510125281
517600709003	-0.758415827	2.517191588	3.275607415
517600404001	-0.903692416	2.052488534	2.95618095
517600707002	-0.766099182	1.647042916	2.413142097
517600604003	-0.903692416	1.506696356	2.410388772
517600204005	-0.708874107	1.481745856	2.190619963
517600710012	-0.800213743	1.325805234	2.126018977
517600607003	-0.492984776	1.466151794	1.95913657
517600607002	-0.807844105	0.982735865	1.79057997
517600204002	-0.903692416	0.792488306	1.696180722
517600706012	-0.730324034	0.942191303	1.672515337
517600404002	-0.903692416	0.723874432	1.627566848
517600708012	-0.903692416	0.602240746	1.505933163
517600708011	-0.704791806	0.770656618	1.475448424
517600402001	-0.03666874	1.38506267	1.42173141
517600706014	-0.468544638	0.95154774	1.420092378
517600109001	-0.903692416	0.393280312	1.296972729
517600710022	-0.653059579	0.524270435	1.177330014
517600212001	-0.433882046	0.726993244	1.16087529
517600605001	-0.844789356	0.23733969	1.082129046
517600108001	-0.231661969	0.845508117	1.077170087
517600706013	-0.516293073	0.55545856	1.071751632
517600707001	-0.66589772	0.349616938	1.015514658
517600708021	-0.80901044	0.203032753	1.012043193
517600210001	-0.631739748	0.37768625	1.009425998
517600103001	-0.404934322	0.499319936	0.904254258
517600710013	-0.819877346	-0.002808868	0.817068477
517600209001	-0.792434096	-0.002808868	0.789625228
517600413002	-0.669149943	0.115706005	0.784855948
517600706011	-0.479452166	0.268527814	0.74797998
517600411002	-0.52227236	0.193676316	0.715948676
517600204004	-0.784378675	-0.077660367	0.706718308
517600405001	-0.903692416	-0.199294052	0.704398364
517600107001	-0.673214264	0.019022819	0.692237083

GEOID	LITA	Poverty_Zscore	Equity_Score
517600203002	-0.274396981	0.40263675	0.67703373
517600204003	-0.578870931	0.078280255	0.657151187
517600406001	-0.516741082	0.137537692	0.654278773
517600407001	-0.52691138	0.10946838	0.63637976
517600706022	-0.831818199	-0.255432677	0.576385523
517600709004	-0.859267642	-0.289739613	0.569528029
517600412001	-0.336233364	0.21238919	0.548622555
517600605002	-0.618303919	-0.074541555	0.543762364
517600204001	-0.72695536	-0.189937615	0.537017745
517600710011	-0.85661381	-0.333402988	0.523210823
517600709005	-0.857922413	-0.339640613	0.518281801
517600604005	-0.707575106	-0.199294052	0.508281053
517600605005	-0.030455303	0.474369436	0.504824739
517600608001	-0.659203998	-0.161868303	0.497335695
517600207001	-0.087450301	0.399517937	0.486968238
517600604001	-0.443427781	0.025260444	0.468688225
517600711002	-0.807113963	-0.405135674	0.401978289
517600111001	-0.774870464	-0.377066362	0.397804103
517600708013	-0.903692416	-0.523650547	0.38004187
517600602001	-0.3635079	0.009666381	0.373174281
517600209003	-0.618049134	-0.252313864	0.36573527
517600701002	-0.903692416	-0.570432734	0.333259683
517600109004	-0.52843274	-0.199294052	0.329138688
517600410001	-0.903692416	-0.592264421	0.311427996
517600709001	-0.512874718	-0.214888115	0.297986603
517600108003	-0.789786687	-0.523650547	0.26613614
517600208001	-0.41498279	-0.177462365	0.237520425
517600111003	-0.609279401	-0.380185174	0.229094226
517600704003	-0.903692416	-0.823056542	0.080635875
517600209002	-0.793819416	-0.720135731	0.073683685
517600405002	-0.413059263	-0.339640613	0.073418651
517600110003	-0.303198814	-0.242957427	0.060241388
517600111002	-0.633715095	-0.573551546	0.060163549
517600711003	-0.74740059	-0.688947607	0.058452983
517600606003	-0.903692416	-0.851125854	0.052566563
517600708022	-0.838939964	-0.788749605	0.050190359
517600110001	-0.840329702	-0.791868417	0.048461285
517600605004	-0.903692416	-0.866719916	0.0369725

GEOID	LITA	Poverty_Zscore	Equity_Score
517600602002	-0.421833039	-0.389541612	0.032291427
517600604002	-0.424389277	-0.392660424	0.031728852
517600501001	-0.576611012	-0.548601046	0.028009965
517600104022	-0.215871615	-0.189937615	0.025934
517600604004	-0.44248623	-0.426967361	0.015518869
517600711004	-0.541463175	-0.536125797	0.005337379
LEP			
GEOID	LITA	LEP_Zscore	Equity_Score
517600706013	-0.516293073	7.109104225	7.625397297
517600707002	-0.766099182	5.300683716	6.066782898
517600706014	-0.468544638	4.511554767	4.980099404
517600708014	-0.903692416	2.637373512	3.541065929
517600608001	-0.659203998	2.209928665	2.869132662
517600706011	-0.479452166	1.979766054	2.45921822
517600706022	-0.831818199	1.453680088	2.285498287
517600706012	-0.730324034	1.157756732	1.888080767
517600709005	-0.857922413	0.894713749	1.752636163
517600710022	-0.653059579	0.763192258	1.416251837
517600708011	-0.704791806	0.56591002	1.270701826
517600708021	-0.80901044	0.401508156	1.210518596
517600710012	-0.800213743	0.401508156	1.201721899
517600709003	-0.758415827	0.434388529	1.192804356
517600711002	-0.807113963	0.269986664	1.077100627
517600709001	-0.512874718	0.533029647	1.045904365
517600407001	-0.52691138	0.269986664	0.796898045
517600604002	-0.424389277	0.368627783	0.793017059
517600104011	-0.518657613	0.204225919	0.722883532
517600204003	-0.578870931	0.138465173	0.717336104
517600402001	-0.03666874	0.631670766	0.668339506
517600701001	-0.49407919	0.171345546	0.665424735
517600109004	-0.52843274	0.1055848	0.63401754
517600408001	-0.418674411	0.171345546	0.590019957
517600710014	-0.417117779	0.138465173	0.555582952
517600605005	-0.030455303	0.138465173	0.168920476
517600207001	-0.087450301	0.039824054	0.127274355
Elderly			

GEOID	LITA	Poverty_Zscore	Equity_Score
GEOID	LITA	Elderly_Zscore	Equity_Score
517600102003	-0.071752122	5.422669438	5.49442156
517600701001	-0.49407919	4.515824032	5.009903221
517600404001	-0.903692416	2.061087329	2.964779745
517600707001	-0.66589772	2.225257618	2.891155338
517600506002	-0.903692416	1.576394095	2.480086511
517600704001	-0.563718833	1.912552306	2.476271139
517600710013	-0.819877346	1.59202936	2.411906706
517600605005	-0.030455303	2.334704477	2.36515978
517600605004	-0.903692416	1.443494337	2.347186753
517600710022	-0.653059579	1.662388056	2.315447635
517600104021	-0.776847789	1.255871149	2.032718939
517600709005	-0.857922413	1.036977431	1.894899844
517600604001	-0.443427781	1.34186511	1.785292891
517600503001	-0.903692416	0.794630813	1.69832323
517600704002	-0.715260326	0.95098347	1.666243796
517600704003	-0.903692416	0.732089751	1.635782167
517600506001	-0.903692416	0.70081922	1.604511636
517600501001	-0.576611012	1.005706899	1.582317911
517600708011	-0.704791806	0.833718978	1.538510783
517600407001	-0.52691138	0.966618735	1.493530116
517600710012	-0.800213743	0.661731056	1.461944799
517600416001	-0.903692416	0.544466563	1.44815898
517600505002	-0.533559881	0.802448446	1.336008328
517600410001	-0.903692416	0.403749173	1.307441589
517600504002	-0.50446683	0.786813181	1.291280011
517600606003	-0.903692416	0.325572845	1.229265261
517600109001	-0.903692416	0.325572845	1.229265261
517600708022	-0.838939964	0.333390478	1.172330441
517600405001	-0.903692416	0.255214149	1.158906566
517600708014	-0.903692416	0.177037821	1.080730238
517600204001	-0.72695536	0.294302313	1.021257674
517600202002	-0.472734205	0.497560767	0.970294971
517600108003	-0.789786687	0.161402556	0.951189242
517600706012	-0.730324034	0.184855454	0.915179488
517600111001	-0.774870464	0.130132024	0.905002489
517600203002	-0.274396981	0.622642892	0.897039872
517600209001	-0.792434096	0.098861493	0.891295589

GEOID	LITA	Poverty_Zscore	Equity_Score
517600711001	-0.155295379	0.708636853	0.863932232
517600212001	-0.433882046	0.39593154	0.829813586
517600711003	-0.74740059	0.044138064	0.791538653
517600107001	-0.673214264	0.106679126	0.77989339
517600710021	-0.689938713	0.036320431	0.726259144
517600102002	-0.660168949	0.059773329	0.719942278
517600706011	-0.479452166	0.231761251	0.711213417
517600504001	-0.217239821	0.466290235	0.683530057
517600103001	-0.404934322	0.239578884	0.644513206
517600710014	-0.417117779	0.169220189	0.586337968
517600505001	-0.29267035	0.231761251	0.524431601
517600104022	-0.215871615	0.223943618	0.439815233
517600208001	-0.41498279	0.020685165	0.435667955
517600405002	-0.413059263	0.012867532	0.425926795
517600202001	-0.079877682	0.231761251	0.311638933
No Vehicle Access			
GEOID	No_Vehicle_Access_Zscore	LITA	Equity_Score
517600407001	2.660551459	-0.52691138	3.187462839
517600701001	2.373257583	-0.49407919	2.867336772
517600605005	2.644590688	-0.030455303	2.675045991
517600404001	1.760363981	-0.903692416	2.664056397
517600710022	1.93593246	-0.653059579	2.58899204
517600708014	1.504991646	-0.903692416	2.408684063
517600707001	1.64544643	-0.66589772	2.31134415
517600710012	1.163431149	-0.800213743	1.963644892
517600405002	1.421995638	-0.413059263	1.835054901
517600503001	0.856984348	-0.903692416	1.760676765
517600707002	0.994246978	-0.766099182	1.760346159
517600711003	0.991054824	-0.74740059	1.738455413
517600710013	0.885713736	-0.819877346	1.705591081
517600406001	1.169815458	-0.516741082	1.686556539
517600708011	0.981478361	-0.704791806	1.686270167
517600711004	0.991054824	-0.541463175	1.532517999
517600704001	0.936788203	-0.563718833	1.500507036
517600104011	0.898482352	-0.518657613	1.417139966
517600405001	0.486694463	-0.903692416	1.39038688
517600709005	0.521808159	-0.857922413	1.379730573

GEOID	LITA	Poverty_Zscore	Equity_Score
517600408001	0.901674507	-0.418674411	1.320348918
517600706012	0.569690472	-0.730324034	1.300014506
517600410001	0.390929838	-0.903692416	1.294622255
517600209001	0.416467072	-0.792434096	1.208901167
517600102003	1.090011603	-0.071752122	1.161763725
517600604005	0.432427842	-0.707575106	1.140002948
517600208001	0.655878635	-0.41498279	1.070861425
517600202002	0.566498318	-0.472734205	1.039232523
517600704003	0.097251654	-0.903692416	1.00094407
517600506002	0.046177187	-0.903692416	0.949869603
517600709003	0.189824125	-0.758415827	0.948239952
517600502002	0.218553512	-0.680348843	0.898902356
517600202001	0.81229419	-0.079877682	0.892171872
517600410002	0.585651243	-0.304143923	0.889795166
517600212001	0.435619997	-0.433882046	0.869502042
517600201001	0.224937821	-0.624913824	0.849851645
517600711002	0.017447799	-0.807113963	0.824561762
517600505001	0.467541538	-0.29267035	0.760211889
517600501001	0.113212425	-0.576611012	0.689823436
517600607003	0.135557504	-0.492984776	0.628542279
517600409001	0.438812151	-0.182654932	0.621467083
517600504002	0.116404579	-0.50446683	0.620871409
517600411002	0.074906574	-0.52227236	0.597178935
517600103001	0.177055508	-0.404934322	0.581989831
517600504001	0.34623968	-0.217239821	0.563479501
517600409002	0.403698455	-0.053423658	0.457122113
517600207001	0.250475054	-0.087450301	0.337925355
517600402001	0.161094737	-0.03666874	0.197763477
Non-White Population			
GEOID	LITA	Non-White_Zscore	Equity_Score
517600708014	-0.903692416	3.361937154	4.26562957
517600710022	-0.653059579	2.520014537	3.173074116
517600707001	-0.66589772	2.344543691	3.010441411
517600710012	-0.800213743	2.081337422	2.881551165
517600201001	-0.624913824	2.172447284	2.797361108

GEOID	LITA	Poverty_Zscore	Equity_Score
517600708011	-0.704791806	2.052654687	2.757446493
517600202002	-0.472734205	2.180883382	2.653617587
517600202001	-0.079877682	2.432279114	2.512156796
517600204005	-0.708874107	1.718585192	2.427459299
517600707002	-0.766099182	1.566735421	2.332834603
517600709005	-0.857922413	1.376079598	2.234002012
517600706012	-0.730324034	1.3676435	2.097967534
517600604003	-0.903692416	1.190485434	2.094177851
517600209001	-0.792434096	1.278220857	2.070654953
517600212001	-0.433882046	1.450317264	1.88419931
517600709003	-0.758415827	1.035261224	1.793677051
517600109001	-0.903692416	0.84966706	1.753359477
517600708021	-0.80901044	0.90365809	1.71266853
517600607003	-0.492984776	1.198921532	1.691906308
517600103001	-0.404934322	1.236040365	1.640974688
517600607002	-0.807844105	0.713002267	1.520846372
517600108001	-0.231661969	1.273159198	1.504821168
517600710013	-0.819877346	0.669134555	1.489011901
517600708012	-0.903692416	0.468355414	1.37204783
517600605005	-0.030455303	1.225917047	1.25637235
517600604005	-0.707575106	0.254078515	0.961653621
517600604001	-0.443427781	0.510535906	0.953963687
517600711003	-0.74740059	0.171404751	0.918805341
517600107001	-0.673214264	0.238893538	0.912107803
517600706022	-0.831818199	0.068484351	0.900302551
517600204004	-0.784378675	0.068484351	0.852863027
517600109004	-0.52843274	0.323254522	0.851687262
517600402001	-0.03666874	0.788927152	0.825595892
517600204001	-0.72695536	0.090418207	0.817373568
517600706011	-0.479452166	0.33337784	0.812830006
517600710021	-0.689938713	0.108977623	0.798916337
517600210001	-0.631739748	0.12584982	0.757589568
517600602001	-0.3635079	0.328316181	0.691824081
517600711004	-0.541463175	0.146096456	0.687559632
517600706013	-0.516293073	0.130911479	0.647204552
517600607005	-0.417369905	0.205149145	0.62251905
517600607001	-0.055707589	0.530782542	0.586490131
517600203002	-0.274396981	0.216959683	0.491356663

GEOID	LITA	Poverty_Zscore	Equity_Score
517600207001	-0.087450301	0.360373355	0.447823656

Appendix E: Interview Abstracts

Lori Sand
Atlanta Regional Commission

Lori Sand's work with the Atlanta Regional Commission currently focuses on complete streets and accessibility measures. Concept 3 is the long-range comprehensive plan for the Atlanta region. The Atlanta Regional Commission focuses on the FMLM problem and pedestrian/bike accessibility. The Commission works with four transit agencies (including MARTA), and station enhancements are common focal points of collaboration. Livable Center Initiative (LCI) grant program allows the region to look at FMLM and connectivity for a variety of projects. Lori has extensive technical experience in transportation planning and is currently seeing projects being implemented that thoroughly approach the FMLM problem.

Tracy Newsome & Alex Riemondy
Charlotte Department of Transportation (CDOT)

CDOT's focus in transportation planning includes streets, sidewalks, and highways. Charlotte Area Transit System oversees the transit side of planning. CDOT works on policy and projects: TOD ordinances, carshare, bikeshare, park-n-ride programs, corridor studies, bike studies, and improving access to transit stations (look for opportunities to provide multiple modes at station locations. The organization's experience with project implementation includes B-Cycle, dockless bikes, complete streets policy, the light rail system allowing bikes on cars, and the Charlotte Area 2030 Transit System Plan. CDOT is currently evaluating five radial corridors for BRT (CATS is working on this, too). CDOT emphasizes effective land use plans and targets infrastructure programs that favor access to transit. CDOT has seen in the last 5-10 years the effectiveness of digital community engagement. Tracy sees the most opportunity for planning to reach the greatest people in need is by taking a holistic approach.

Molly Carter
Charlotte Area Transit System (CATS)

Molly addresses transit accessibility and the FMLM problem daily, and is currently figuring out how to best plan for a rapidly growing population with changing travel trip preferences. For bus planning, CATS includes bike and scooter share systems, and they work with CDOT to implement the complete streets policy. Bus service changes are focused on routing and scheduling, which is based on demand and funding. CATS is also looking at bringing express routes to areas outside of the city (in order to reach the people moving to the exurbs). Regarding the future of transportation planning in addressing social equity issues and program evaluation, Molly said, "…many projects are hypothetical, so it is difficult to measure them effectively." CATS regularly evaluates infrastructure projects when there is a need to upgrade or end a route. Proximity and accessibility are two important factors that go into the evaluation process. To plan for minority populations and individuals living in poverty, Title VI analysis (managed by the Federal Transit Authority) is necessary for every service change or discontinuation. Molly sees the greatest challenges in transportation planning as the volume of data and factors that go into every project and the long-term timeline for implementation.

John Cock
Alta Planning & Design (Charlotte, NC)

John currently works for Alta and is responsible for the company's planning in the Southeast region; he has past experience doing station design for the first light rail in Charlotte. Alta focuses on transit access in all projects at the macro-level and regularly performs equity analyses; Alta acts as a consultant for CDOT and CATS. Alta has a niche in helping cities plan for and implement bike share and carshare systems to their existing system. At site level analysis, Alta looks at the physical location of stations and their physical access (parking, connector bus, docked bikes, etc.). Alta also emphasizes the importance of effective policies; "when we provide parking, people are encouraged to drive". John stressed the importance of regulations to assist policies, "policies are great but we need the regulatory tools to implement the policies". Alta's evaluation piece is dependent on clients' needs and funding. John sees a better future for improved transportation planning when demographic analysis and demand analysis look at all factors involved to determine the need and propensity for biking, walking, and transit. He introduced this question when assessing transportation projects, "Does it help create, enhance, and support a place?" He strongly believes that the future of transportation planning is the incorporation of multiple modes of travel into city street designs.

Liz McAdory
Virginia Department of Transportation (VDOT)

Liz comes with an extensive background related to transportation planning; she spent several years working at the Richmond Regional Planning District Commission and currently works at VDOT as a Project Manager. She has advanced experience with scoring various transportation projects meeting certain criteria and is very familiar with local, regional, and state policies related to transit accessibility and the FMLM problem. The MPO developed the Equity Justice (EJ) tool to identify the transportation disadvantaged and regularly use the tool to evaluate transportation plans and projects. One new regional policy focus is improving bicycle and pedestrian access along GRTC and BRT routes; similarly, the state (VDOT) requires plans to include a bicycle/pedestrian component in it to receive any funding. The Richmond Regional Bicycle and Pedestrian Plan also includes a component to improve access to transit stops. THE FTA and the FHW also encourage localities (states and regions) to plan for FMLM. Liz spoke about the positive working relationship between the state and the region which is especially useful when either the regional organization or VDOT are applying for federal funding. Technical advisory staff are shared between the two organizations.

Performance measurements (at the regional and state levels) are a recent push from the federal level; they are encouraged for funding purposes, and they are enforced for projects to meet federal guidelines such as ADA compliance. For local or regional projects, federal guidelines are strictly adhered to only when the project is receiving federal funds. The state-level transportation planning follows federal regulations, mainly because the 2004 Policy for Integrating Bicycle and Pedestrian Accommodations, which requires all projects to at the very least consider bicycle and pedestrian access. Liz believes there is a nation-wide growing effort currently occurring to improve transportation accessibility.

Ross Catrow
RVA Rapid Transit

Ross is a public transit advocate and actively shares knowledge with the public and local decision makers about making Richmond's existing transit system the best it can be. Ross used to write for a local newspaper about the region's transportation issues and was involved with the most recent GRTC bus network redesign process with Jarrett Walker & Associates. Ross is well versed in the local political process and regularly holds meetings with elected officials to educate about and advocate for public transit. Ross brings a breadth of knowledge about the history of transportation in Richmond and believes that Richmond doesn't need a big, fancy modern system – it simply just needs to serve more people. Currently, RVA Rapid Transit is administering rider surveys for GRTC users, and the goal is to improve ridership by listening to what riders need. Ross emphasized the importance of design with an equity focus: subsidized bikeshare systems, bank-less payment methods, shuttles to job centers, better sidewalks and lighting. He also sees intentional and meaningful community engagement through an equitable lens as the key to better transportation planning, and it is up to planners, elected officials, and advocates to empower each other to work for the common good.

Vita

Rachel Jordan

Birth Date: August 30, 1994

Education

Bachelor of Science in Urban and Regional Studies, Virginia Commonwealth University
August 2012 – December 2015

Work Experience

Research Fellow, L. Douglas Wilder School of Government and Public Affairs
August 2018 – May 2019

Environmental Planner, POWER Engineers
January 2018 – June 2018

Research Associate, MZ Strategies
November 2017 – May 2018

Planner, Chesterfield County
May 2016 – January 2018