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Walking the Walk: An Assessment of the 5-Minute Rule in Transit Planning

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Walking the Walk: An Assessment of the 5-Minute Rule in Transit Planning

by

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Report

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Dedication

To my mom and grandmother.

No one would have been more proud.

Acknowledgements

Thanks to all the friends and colleagues who helped me through this process.

And a special thank you to my dad, who still makes time to help me with my homework.

Abstract

Walking the Walk: An Assessment of the 5-Minute Rule in Transit Planning

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The University of Texas at Austin, 2013

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Public transportation and other alternatives to the private automobile are receiving increased attention for their potential to decrease congestion, reduce environmental damage and support healthier lifestyles. In particular, bus transit increases mobility and provides an opportunity for increased physical activity. In light of a scarcity of research on the subject, this report investigates a common rule of thumb used in transit planning that suggests riders will only walk five minutes to access a bus stop. A review of existing research shows that many transit riders walk longer than five minutes to reach a bus and that transit-access walking behavior is far more varied than implied by the 5-minute assumption. An effort was undertaken to estimate walking distances of bus riders in Austin, Texas using data from a 2010 survey administered to riders on local buses. The analysis estimated transit walks of unreasonable distances for some respondents, suggesting that the starting location address or access mode responses were inaccurately reported. Flaws in the data collection process interfered with a

clear analysis of the relationship of walking distances to rider behavior, but the data showed that many riders walked considerably farther than ¼ mile.

The Austin data and reports from others summarized in the literature review of this report indicate that the 5-minute walk is not an accurate representation of transit access behavior and that further evaluation of the 5-minute assumption should be undertaken. Moreover, innovative approaches should be developed to more accurately predict bus commuter behavior to design a more effective transit system. Analysis of the survey data suggests that implementation of improved data collection methods in future studies could provide more useful and accurate data on walking behavior associated with transit use.

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Chapter 1: Introduction

There is a shift in urban development and transportation planning from the conventional emphasis on private automobile use to an emerging interest in a more sustainable, multi-modal transportation system. Public transit offers an alternative to the private automobile that can expand accessibility and mobility across cities. It is also seen as an important component in sustainable solutions to decrease congestion, support social equity, protect the environment and improve public health. It is critical to its success that efforts to support this shift are based on valid assumptions and strong evidence.

Bus transit is by far the dominant form of public transportation used in the United States. With over 5.6 million unlinked passenger trips in 2000, bus trips account for 62% of all transit trips in the United States (Transit Cooperative Research Program, 2003). However, United States Census data revealed that between 1960 and 2009 the use of public transportation to commute to work has declined from 12% to 5%. Meanwhile, private automobile use has increased over the same time period (Pucher, Buehler, Merom, & Bauman, 2011). While still a motorized form of transportation, bus transportation is more fuel efficient, less harmful to the environment and involves more physical activity for individuals than travel in private automobiles (Litman, 2010; "Public Transit Benefits," 2013).

Furthermore, a focus on public transit use is also a deliberation of walking activity. Walking is an active travel alternative that can support the same livability goals as public transit use, in particular health concerns associated with an increasingly sedentary population. While walking as a commute mode has decreased from over 10% in 1960 to 2.9% in 2009, it is an important component of most transit trips. In 2009, 28% of all walk trips were to reach public transportation, more than any other purpose, and over 90% of all public transit trips started and ended with walking (Pucher et al., 2011). Walking to transit offers a simple opportunity for individuals to get some or all of the recommended daily physical activity (Besser & Dannenberg, 2005; Maghelal, 2007) and bus riders access transit service on foot more often than rail riders (American Public Transportation Association, 2007). This link, the access trip from one's origin to the stop, is a critical portion of every bus trip and a valuable focus for research.

A commonly cited rule of thumb is that most people will only walk for five minutes to access a bus stop**.** This assumption is widely used in transportation planning and has become a cornerstone of popular urban planning philosophies that seek to decrease automobile dependence. The 5-minute walk may be a useful and convenient generality for transit service planning (Guerra, Cervero, & Tischler, 2011), but is it actually a reliable reflection of traveler behavior? Transit Cooperative Research Program (TCRP) Report 153 points out that guidelines used for designing transit access can run the risk of being "applied rigidly, ignoring the needs, values, and context around particular stations" (Transit Cooperative Research Program, 2012, p. 22). Furthermore, traditional mode choice analyses prioritize motorized travel, and tend to ignore the presence of non-motorized trips that occur as links in motorized trips (Litman, 2012). Travel demand models are often not sensitive enough to estimate sub-access mode and many local agencies do not have the capacity or desire to collect station level ridership behavior and monitor local or micro trends (Transit Cooperative Research Program, 2012). It is not surprising then that planners might rely too heavily on a conventional rule of thumb, despite a scarcity of research to support the claim.

The empirical foundation for the 5-minute walk rule is often presumed and its prevalence in urban planning and design necessitates a critical review. This paper will focus specifically on usage of this 5-minute walk rule in relation to bus transit; however, the findings may have broader significance since similar estimates of maximum or preferable walking distances are used for other facilities such as parks and in popular planning philosophies such as Transit-Oriented Development.

The accessibility of transit in general is a function of socioeconomic characteristics, environmental factors, and transit service and quality. It is difficult to isolate the effect of any single variable or interactions between variables (Cervero & Kockelman, 1997). It is reasonable to argue that the proximity of a bus stop influences the walk to access it. This report does not intend to minimize the benefits (for riders and transit agencies) of having bus service in close proximity but to review the reliability of the specific 5-minute tenet based on existing evidence.

The primary objective of this report is to investigate the walk to access transit in relation to the 5-minute walk tenet and review the existing research on walking distances to transit. The report will then focus specifically on the transit access behavior of local bus riders in Austin, Texas. The results of a 2010 origin and destination survey from Austin's public transit provider, the Capital Metropolitan Transportation Authority (Cap Metro), will be used to estimate walking distances to bus stops. In this context, this report will answer the following questions: 1 - How far do transit riders walk to access the bus in Austin, Texas? and 2 - How many bus riders are walking longer than five minutes (represented by a ¼ mile distance) to access the bus? The answers to these questions will inform conclusions about the usage of the 5-minute rule of thumb in planning and suggestions for further investigation of the walking distances to access bus transit. The methods used to estimate walking distances will also inform suggestions for updating the standard usage of the 5-minute walk.

Chapter 2: The 5-Minute Walk

DEFINITION

A 5-minute walk is used as a threshold for the distance people are typically willing to walk in order to reach a bus stop or other local destination. It is implied that beyond this distance most people are no longer willing to walk and will decide to use another means of travel. It is this concept that will be investigated in this report.

MEASUREMENT

The five-minute walk threshold is converted to a distance measure based on an estimated average walking speed. The typical illustration of this is to multiply the five-minute walk threshold by an average walking speed of 3 miles per hour (80 meters per minute) to suggest a distance of ¼ mile (400 meters). In practice, a ¼ mile radius is often used to define the area within a 5-minute walk of a transit station (O'Sullivan & Morrall, 1996). This common approach uses a geographic information system (GIS) to draw simple circular buffers with a ¼-mile radius around transit stops or routes. The straight-line distance defined by the buffer radius can be referred to as an "ideal" distance, as it underestimates the actual traveling distance that is constrained by the existing street network (Foda & Osman, 2010). More nuanced methods have been developed to measure walking distances and the capabilities of current GIS and other technological tools present the opportunity for more nuanced analysis.

USAGE IN PRACTICE

This generally accepted rule of thumb, often stated but rarely cited, features prominently in transportation planning and contemporary planning philosophies. The ¼ mile radius can be used as a designation of accessibility to transit or as a convenient boundary for assessing the service area of a transit stop. The figure also influences design and policy decisions in some urban planning philosophies.

Transportation Planning

Transportation planners use the 5-minute walk threshold to identify the service area around transit stops, stations and routes and to define the level of access among the surrounding population. This leads to a common practice by transit authorities of drawing a ¼ mile radius buffer to reflect the catchment area of an existing or potential bus stop. This provides a framework for predictions about ridership and service needs that influence decision-making about route changes. The 5-minute walk is also used in transportation planning as a proxy for the accessibility of public transit. Levels of accessibility are often measured simply as the number or percentage of households within a particular Euclidian distance of a transit station (Pratt & Levinson, 2012, 16-241). Access may also be defined by comparing the distance from the geographic center of a census tract or other analysis zone to the nearest bus stop to the accepted threshold for access (Foda & Osman, 2010).

The prevalence of these methods is exemplified in TCRP Synthesis 66, a review of how agencies approach transit system changes. Survey questions posed to transit agencies specifically quote a ¼ mile radius as a reference for station area review. This both reflects and reinforces the 5-minute walk tenet among transit professionals (Transit Cooperative Research Program, 2006).

Bus stop placement considerations for transit planning involves an important tradeoff between the closely spaced bus stops (offering shorter walk distances) and longer overall bus trip times caused by a higher frequency of stops. An overreliance on a 5-minute walk threshold could limit options regarding this tradeoff. These common methods present a limited definition of access, ignoring the actual spatial geometry of the street network as well as the possibility of other individual or environmental hindrances (Landex, Hansen, & Anderson, 2006).

Urban Planning and Design

The five-minute walk is a cornerstone of planning movements such as Smart Growth, New Urbanism and Transit-Oriented Development (TOD). These popular movements decry existing land use patterns for producing, or at least reinforcing, the current reliance on private automobiles, and encourage land use policies and design standards that aspire to shift travel towards alternative modes. The Congress for New Urbanism supports urban design in which streets and right-of-ways support multi-modal accessibility and shared space for pedestrians (Congress for New Urbanism, n.d.). Transit oriented development, defined as "higher-density development, with pedestrian priority, located within easy walking distance of a major public transit station" is a development form that is intended to increase transit ridership and increase walking activity while accommodating growth (Evans & Pratt, 2007). These objectives are codified with the 5-minute walk as a central definition of walkability and successful design.

LEED for Neighborhood Development (LEED-ND) is a rating system to certify neighborhoods in terms of green design and environmental responsibility created by the US Green Building Council in collaboration with the Congress for New Urbanism (*LEED 2009 for Neighborhood Development Rating System*, 2009). LEED-ND incorporates the ¼ mile walking distance into many of its checklist criteria. For example, points are given for project sites where residential and nonresidential buildings "are within ¼ mile walk distance" of bus service. A project outside of this threshold would not receive the credit under this system, thus codifying this rule into this industry standard (LEED ND, 2009).

The policy and design decisions made under the umbrella of these philosophies are implicitly and sometimes explicitly linked to the 5-minute walk. Design elements such as short blocks and a dense street pattern are encouraged in TOD and Smart Growth development partially because they are expected to contribute to more direct routes and thus shorter walking distances. In contrast, development based upon curvilinear streets and walled or gated communities can restrict pedestrian access and lengthen walk times. These elements are also intended to serve other objectives, such as a desirable walking environment, more route choices and a more interesting cityscape but a rigid application of the 5-minute rule could obscure these other goals (Ewing, 1999).

Chapter 3: Literature Review

The walk to access transit service is a critical part of most public transit trips that has received little attention in research historically dominated by a focus on motorized travel. Transit-oriented development and smart growth philosophies often focus on the influence the built environment has on pedestrian behavior, while variations in walking distances are taken for granted. The ¼ mile radius as a proxy for a 5-minute walk has become common practice in transportation planning, ignoring the individual and environmental factors that can influence transit use decisions.

Walking activity can be characterized in various categories, such that a walk to catch a bus would have different considerations than, for example, strolling to the park. Evidence from different types of walk activity may provide insight for bus access trips, but distinguishing between trip purposes and types of walking reveals diverse characteristics and priorities (Walton & Sunseri, 2010). The needs and interests of commuters are likely to differ from recreational walkers. Unlike motorized travel, which is generally undertaken to participate in other activities, walking can often be the activity itself. Thus, in the assessment of walking behavior it is important to distinguish between different types of walk trips – which can be categorized into four typologies: 1- access mode, 2- access sub-mode, 3- leisure or recreation, and 4- circulation or exchange (Tolley, from Walton & Sunseri, 2010). The potential for some walking trips to belong to multiple categories, such as both access and recreation, contributes to the difficulty of making observations about walking behavior. Walking to the bus may be considered a leisurely activity for some, but this report will consider walking a sub-access mode as it supports bus transit.

WALKING DISTANCES TO TRANSIT

There is evidence that as distance from transit increases the likelihood that one will choose to travel by transit decreases (Cervero & Kockelman, 1997; Zhao, Chow, Li, Ubaka, & Gan, 2003), but information on the actual distances individuals walk or would walk specifically to access transit is scarce.

One study determined that the distance to the station was the most significant factor in the decision to walk to [rail] transit (Loutzenheiser, 1997) while another identified minimizing time and distance in their route choices was the dominant consideration of transit riders (Schlossberg, Agrawal, Irvin, & Bekkouche, 2007). The proportion of people walking to transit stations was found to vary significantly between stations within a metropolitan region, indicating the variation in walking behavior should be further reviewed at a micro-level (Loutzenheiser, 1997).

A 1982 study on bus access walking habits found that more than 25% of surveyed bus passengers walked more than 0.28 miles (450 meters) to reach the bus stop (Lam & Morrall, 1982). Lam and Morrall found that in Calgary, Canada the mean walking distance was 0.2 miles (327 meters) and the median was just under 0.18 miles (300 meters). This early study of bus transit walking behavior is a frequently cited reference to support the 5-minute walk tenet. However, the 75th percentile of 0.28 miles (450 meters) was noted by the authors as a reasonable benchmark for use by the local transit agency (Lam & Morrall, 1982).

In a more recent study of bus riders, 40% of transit users in Toronto lived outside of the 0.18 miles (300 meters) standard used by the city to delineate accessible walking areas. Over one-fifth lived farther than 0.31 miles (500 meters) straight-line distance, indicating that many riders are walking more than the assumed ¼ mile distance. Furthermore, the use of Euclidian distance measures underestimates the actual walking distance as it is constrained by the street network (Alshalalfah & Shalaby, 2007).

When detailed studies were undertaken in the study of rail transit, it was determined that riders walk farther than the ¼ mile radius and often farther than ½ mile. A study of Montreal travel survey data showed that the 0.248 miles (400 meters) and 0.49 miles (800 meters) service area boundaries underestimated the distances walked by transit users to reach both bus and rail service, respectively. The authors suggest that service area definitions should be varied with the type of service provided (El-Geneidy, Tétreault, & Surprenant-Legault, 2010). Half of those surveyed in a study of rail transit users walked farther than 0.47 miles to reach the station (Schlossberg et al., 2007). Interest in rail transportation has sparked more research into the walking activity of riders and led to a shift in common practice in rail planning to replace the ¼ mile threshold with a walk distance of ½ mile (or about a 10 minute walk).

FACTORS THAT INFLUENCE WALKING

Despite the habitual usage of the 5-minute walk rule, there does exist research to support a more nuanced view of a sub-access trip to transit. Litman (2012) explains that while "experts generally conclude that typical transit riders will walk up to a quarter-mile to a bus stop," variation in acceptable walking distance can be caused by:

1. *"Demographics: Whether travelers are transit dependent or discretionary users (transit dependent users tend to be willing to walk farther).*
2. *Walkability: The better the walking conditions (good sidewalks, minimum waits at crosswalks, attractive and secure streetscapes) the farther people will walk.*
3. *Transit service quality: People tend to walk farther if transit service is frequent, and vehicles and stations are comfortable and attractive" (Litman, 2012, p. 31).*

Untermann (1984) argues that time, convenience, the availability of auto transportation and land use patterns that hinder walking are the four elements that affect the distance Americans are willing to walk (Untermann, 1984). Safety, aesthetics and sidewalk quality have been found to be less important - though not unimportant - factors in route choice (Schlossberg et al., 2007).

Demographic & Socioeconomic Factors

Walking activity is a function of social and individual factors, varying with gender, age, trip purpose, safety, weather and car accessibility (Guerra et al., 2011). Personal mobility and physical ability are prerequisites for undertaking walking activity in any capacity; this highlights the reality that each individual decision to walk to transit will be influenced by a unique set of factors. It was suggested in one study that socioeconomic characteristics should be reviewed uniquely for different areas in order to provide appropriate service (Alshalalfah & Shalaby, 2007).

Although walking is the traditional mode used to access transit service, park-and-ride facilities and feeder services have increased the incidence of driving and other modes for this trip link. An Australian study looking exclusively at transit users within a short distance to a transit stations found that the conveniences of a car and free parking facilities led to car trips replacing walk sub-access trips for rail stations that would otherwise be considered "reasonable" (Walton & Sunseri, 2010).

Built Environment Factors

Many studies have investigated the effects of environmental factors like density, design and diversity but it is difficult to isolate these imprecise characteristics. While overall neighborhood design seems to correlate with different travel patterns, it is difficult to determine causation (Cervero & Kockelman, 1997). The 5-minute walk tenet obscures the presence of barriers that can exist in neighborhood and street design.

The American Public Transportation Association (APTA) describes the typical "areas of influence" for transit. A typical radius is suggested as a baseline for defining these areas that assumes certain conditions: "1) Station or stop infrastructure that does not create access barriers to and from the surrounding community. 2) Absence of non-transit barriers, such as freeways or gated communities that impede direct connection to the transit stop or station. 3) Relatively flat topography. 4) Reasonably connected gridded or grid-like street network that allows for direct routes to and from the transit stop, with a complete and connected pedestrian facility network, 5) 20 minute headways" (American Public Transportation Association, 2009). The use of the 5-minute walk threshold implies that these conditions are being met. However, a study of the application of assumed walk thresholds as service area boundaries found it far from clear that the application of such buffers represent a "correct" catchment area for transit stations (Guerra et al., 2011).

Transit Service Quality

Service quality, summarized as how transit is perceived by its users, can be evaluated from a number of perspectives (Litman, 2013). The Transit Capacity and Quality of Service Manual (TCQSM) is a reference manual for transit planning sponsored by the Federal Transit Administration. The TCQSM frames quality of service for fixed-route transit into two categories: 1- availability and 2- comfort and convenience. Availability can refer to spatial, temporal, informational and capacity requirements. Availability at the stop level (as opposed to a system-level) can be measured in terms of bus frequency. High frequency routes have been found to be associated with longer access walks and higher ridership in general. Transit users were also found to walk farther for trips involving fewer transfers (more transfers correlated with shorter access distances). Average walking distances were shorter in central city areas due to the higher density of transit service itself (Alshalalfah & Shalaby, 2007).

The second set of measures - comfort and convenience – overlaps with some of the environmental factors described above. Topography, grade, sidewalks, crosswalks and street patterns can all influence a potential rider's perception of the convenience of service. Service quality can be viewed as a hierarchy, such that comfort is only a consideration once availability has been established. The complex influence of comfort and convenience factors are beyond the scope of this report; however, these are important considerations for future studies.

Vehicle frequency is a central figure in the assessment of transit quality and service. The Transit Capacity and Quality of Service Manual (TCQSM) defines Level of Service with a rating based on the amount of time, called headway, between buses running a scheduled route. It provides a uniform standard that can be used to define the level of transit service (Transportation Research Board, 2003).

This standard was applied to the bus routes reviewed in this report and the definitions can be found in Chapter 4.

SUMMARY OF LITERATURE

Interestingly, many of the commonly cited references regarding transit-related walking are decades old. It seems pertinent to update and improve our knowledge of this category of travel behavior, especially considering dramatic increase in fuel costs, environmental concerns and escalating obesity rates in recent years. Many recent studies have concluded that the conventional use of 5 minute or ¼ mile thresholds is an inaccurate reflection of transit rider walking behavior. Overall the studies reveal a far wider range of walking distances than the 5-minute walk implies, especially when one takes into consideration the potential of barriers and limitations. The decision to walk to transit and the distances people walk vary with environmental factors, demographics and service type and quality.

Chapter 4: Analysis and Results

Home-Based Bus Access Walking Trips in Austin, Texas

STUDY AREA

Austin, the capital city of Texas, is a booming metropolis located in the Central Texas region. The city urbanized in an auto centric era of American city development, such that the street network was generally designed for car use while public transit and other modes of transportation have been disregarded. Decades of rapid population growth and continuing urban development contribute to a belief that Austin can benefit from a more multi-modal approach to its transportation network. This pattern can be seen in cities across Texas, the United States and in developing cities throughout the world. A growing interest in cycling, walking and motorized alternatives to the private automobile calls for a reassessment of conventions that dictate transportation planning decisions. In addition to contributing to the academic literature on transit access, this study may provide insight on the Austin environment that can support context-sensitive solutions for the city's acute congestion problems (Bricka & Moran, 2013).

A public transportation network led by the Capital Metropolitan Transportation Authority (Cap Metro) provides Austin with bus, paratransit and, since 2010, commuter rail service. While this network handled over 33 million trips in 2012 (Capital Metropolitan Transportation Authority, n.d.), only 5% of Austin' commute trips used transit and 72.7% involved driving alone. Still, between 2000 and 2009, the US Census' American Community Survey (ACS) revealed a decrease in automobile mode share and increases in transit use and biking (Freemark, 2010). This review of the walking activity of Austin bus riders can provide information that helps to support this trend and a more efficient and accessible transit system.

DATA AND DATA SOURCES

Origin & Destination Survey

Capital Metro[1] provided the critical data for this report – a 2010 Origin & Destination Survey, distributed aboard their bus fleet between February and May 2010. The raw data included the results of 33,539 passenger surveys. The dataset geocoded by Capital Metro including n= 32,973 samples, is the data that this report tested. The primary research objective was to estimate the walking distance from a bus rider's origin to the bus boarding location. The following survey questions were used in this report to represent the origin and bus stop destination points (a full list of survey questions can be found in Appendix A):

- Q3: "*What is the address OR nearest corner of the place you started your journey today?"*
- Q1: "*What are the names of the cross streets where you got on THIS bus?"*

GIS Data

GIS data used in this analysis were obtained from the City of Austin and Capital Metro websites. The datasets were publicly available on the City of Austin GIS Datasets and the Capital Metro website. All data was projected in a common projection system: Texas Central State Plan (See A1 in Appendix for projection details)**.**

<u>GIS Data Sources</u>

- Street Centerlines[2] (City of Austin GIS Website)
- Capital Metro Service Area, Stop and Route Data[3] (Capital Metro Website)
- Major Lakes (City of Austin GIS Website)

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[1] Special thanks to Lawrence Deeter and Jennifer Govea for sharing this dataset.
[2] Streets.shp, last updated 7/08/2013
[3] Available at: http://www.capmetro.org/datastats.aspx?id=129

METHODS

Data from the 2010 origin and destination survey of bus riders in Austin were used to estimate distances between an origin and the bus boarding location using the Network Analyst Extension tool in ESRI's ArcMap. Microsoft Excel, Access and IBM SPSS Statistics software were used to sort and analyze the original and derived data.

Sample Selection

The survey sample from Capital Metro was pared down for quality control and to select for a sample population specific to this research. This limited the sample to home-based commute to work trips on standard bus routes. Capital Metro matched latitude (X) and longitude (Y) coordinates to the address-based questions in their survey, a process called geocoding, which provided the necessary input for the distance estimations in the next step. Geocoding is a process in which street addresses or intersections are converted into geographic latitude and longitude for mapping in geographic information systems. The analysis dataset was finalized after a series of selection steps that provided quality control and a sample of home-based work trips that began with a walk. This process is detailed in Table 1.

Estimate Walking Distances (GIS Network Analyst)

A GIS tool called Network Analyst, provided as an extension to ArcGIS, was used to develop the original data discussed in the remainder of this report. Network Analyst provides spatial analysis using a network and can be used to find shortest routes, identify closest facilities and map service areas based on travel time or distance (ESRI, n.d.). This tool was used in this report to estimate walking distances between origin and bus boarding locations, based on the cumulative street length along the shortest path on the Austin road system.

Quality Control and Sample Selection Procedure	**Adjusted Sample Size (n)**	**Samples Removed**
Original Cap Metro File (*Bus Geocode;* in Access**)**	**32973**	
Delete samples with no origin location identified (in Excel) (Q3_X or Q3_Y = "0")	30285	-2688
Delete samples with no bus stop location identified (in Excel) (Q1_X or Q1_Y = "0")	29169	-1116
Delete samples if Q3 XY = Q1 XY; Flagged using Excel IF function Justification: A match between Q3 and Q1 implies that home and the bus stop are in the same location, it was deemed unlikely that 12,000 individuals are living atop a bus stop.	17032	-12137
New table imported to GIS and plotted samples based on Q1 XY (Bus Boarding Locations)		
Delete samples if Q1 location was outside Austin streets boundary (*GIS tool: Select by Location*) Justification: Q1 bus stop locations must be within street network	16984	-48
New table saved, imported to GIS and plotted samples based on Q3 XY (Origins)		
Delete samples if Q3 location was outside of Austin streets boundary (*GIS tool: Select by Location*). Justification: Q3 origins must overlap with street network.	**16897**	-87
New GIS shapefile and spreadsheet exported and saved		
Select for sample riders who responded "Walked" to Q4: "How did you get to the bus stop?"	13125	-3772
Select for sample riders who responded "Home" to Q2: "Where did you come from?" Justification: The connection from home to other destinations is a primary focus of transportation planning, and isolating it further controls for variation due to origin type.	3914	-9211
Delete non-traditional bus routes (Deleted Routes: 143-299, 400s, 680-685, 900s) Justification: Deleted routes include limited service, night owls and special routes that have unusual schedules.	3415	-499
Delete sample riders who responded "Home" to Q6: "Where are you going?" Justification: Quality control. Assumed that answering "Home" to both Q2 and Q6 was an indicator for misunderstanding the survey questions and would help correct for over counting distances walked.	3193	-222

Table 1: Quality Control and Sample Selection Procedure

Step 1: Build the Network Dataset

The first step was to build a Network Dataset reflecting the Austin street system that would be used to estimate street-based walking distances. Such a dataset is typically comprised of streets or paths (polylines), attributes that define connectivity, street names, elevations, street hierarchy, and a measure of network impedance. Network impedance is a necessary component of any Network Dataset, representing the 'cost' of travel generally in the form of distance or travel time.

The Network Dataset in this report was built from the City of Austin GIS data file titled "Streets." This street dataset contains roadway segments with attributes describing the characteristics of the streets in Travis County and additional jurisdictions of the City of Austin. Other features in the network dataset were addressed, including:

- Connectivity – Network paths were assigned "Endpoint" connectivity. This means that segments that link at vertices are continuous/traversable/connected. The street segments in the dataset have endpoint vertices at all junctions with other paths.
- Turns – Turns were not mapped in this analysis.
- Elevation – The fields "ELEV" and "EVEL_1" in the provided dataset identify the elevation of path segments. These are used to model connectivity when the endpoints of path segments have the same elevation value. Differing elevations are flagged (in this case either a 0 or 1) and thus endpoints that do not match would not be allowed connectivity.
- Attributes (impedance) – A network attribute was created for Distance (miles) based on street segment length. The One-way attribute, included in the original streets dataset, was removed, as this travel restriction does not apply to pedestrians.

Built environment variables such as sidewalk connectivity, topography and physical barriers would be valuable inputs to a pedestrian network, as these variables would effect, and likely increase, the amount of time required walking to a bus. However, the development of such a detailed network, while considered important to transit accessibility, was beyond the scope of this report and the ¼ mile distance was used as the representation of the industry standard described earlier. For this reason, walking distances rather than walking time are generally used in this report.

Step 2: Locate the Stop Locations

The geocoded origins and destinations (bus boarding locations) for the walking trips to be measured were added as locations in the network map. The starting points were entered as one set of stops, labeled by its unique sample number and the bus stop boarding sites were entered as a second, correspondingly labeled, set of stops. The "Load Locations" function was used to add these stops to the Network Dataset. All points were successfully added and linked to the network. Each matched pair of stops represented the starting location and the bus boarding location for each passenger. The locations of the origins and bus boarding locations are presented in Figure 1.

Step 3: Solve Routes

The Route function in Network Analyst was used to map and measure the distances between each sample rider's starting location and bus boarding location (survey question 1). Routing in Network Analyst is generally used to optimize driving directions for a large number of stops, such as a truck delivery route. Uniquely, this analysis used the tool to create one route for the paired origin and bus boarding location for each sample rider. Routes were "Solved" such that each pair of points was identified as a unique route (linked to one survey respondent number) and mapped along the Network Dataset street system. All 3193 routes were successfully created (see Figure 2).

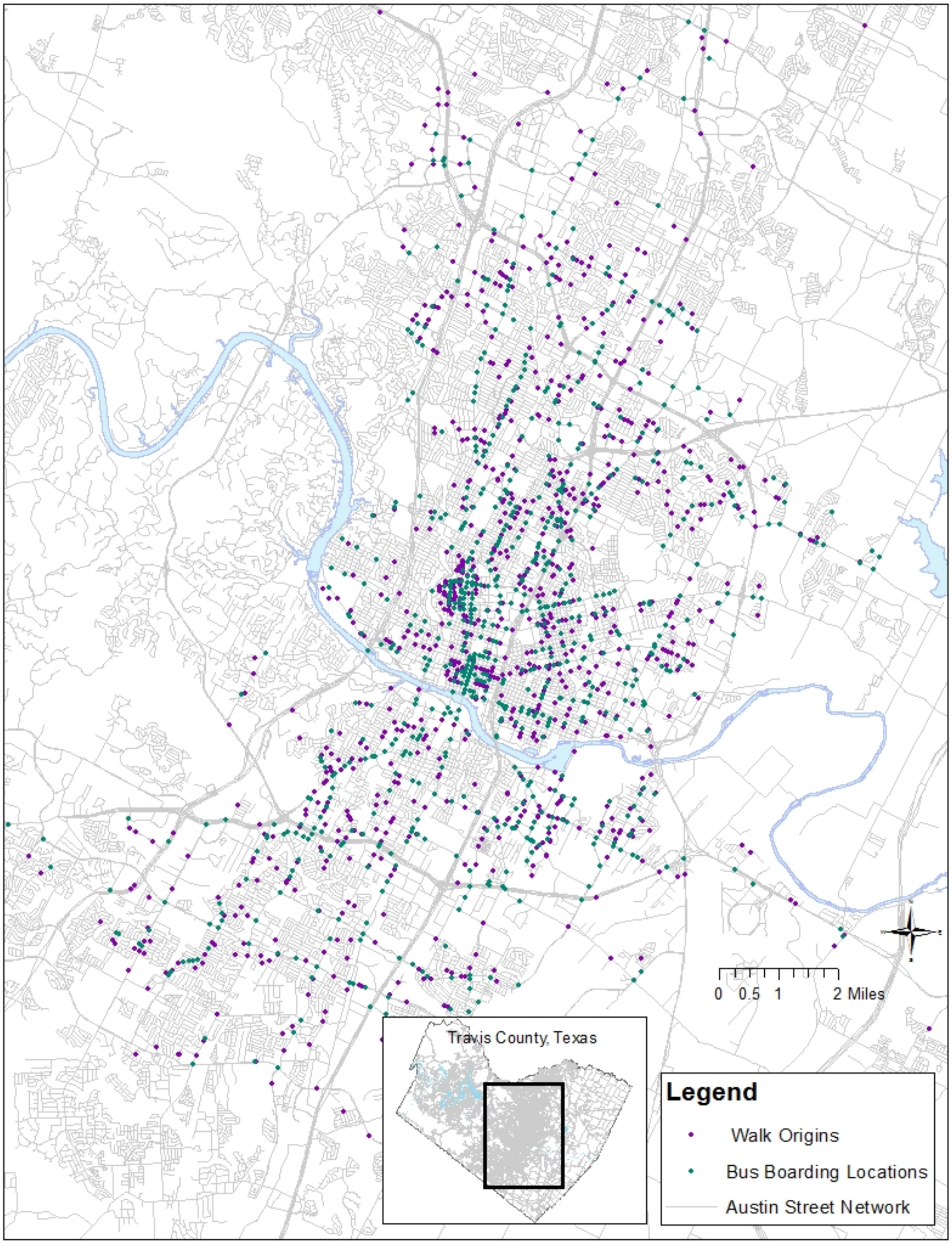

Figure 1: Origins and Bus Boarding Locations

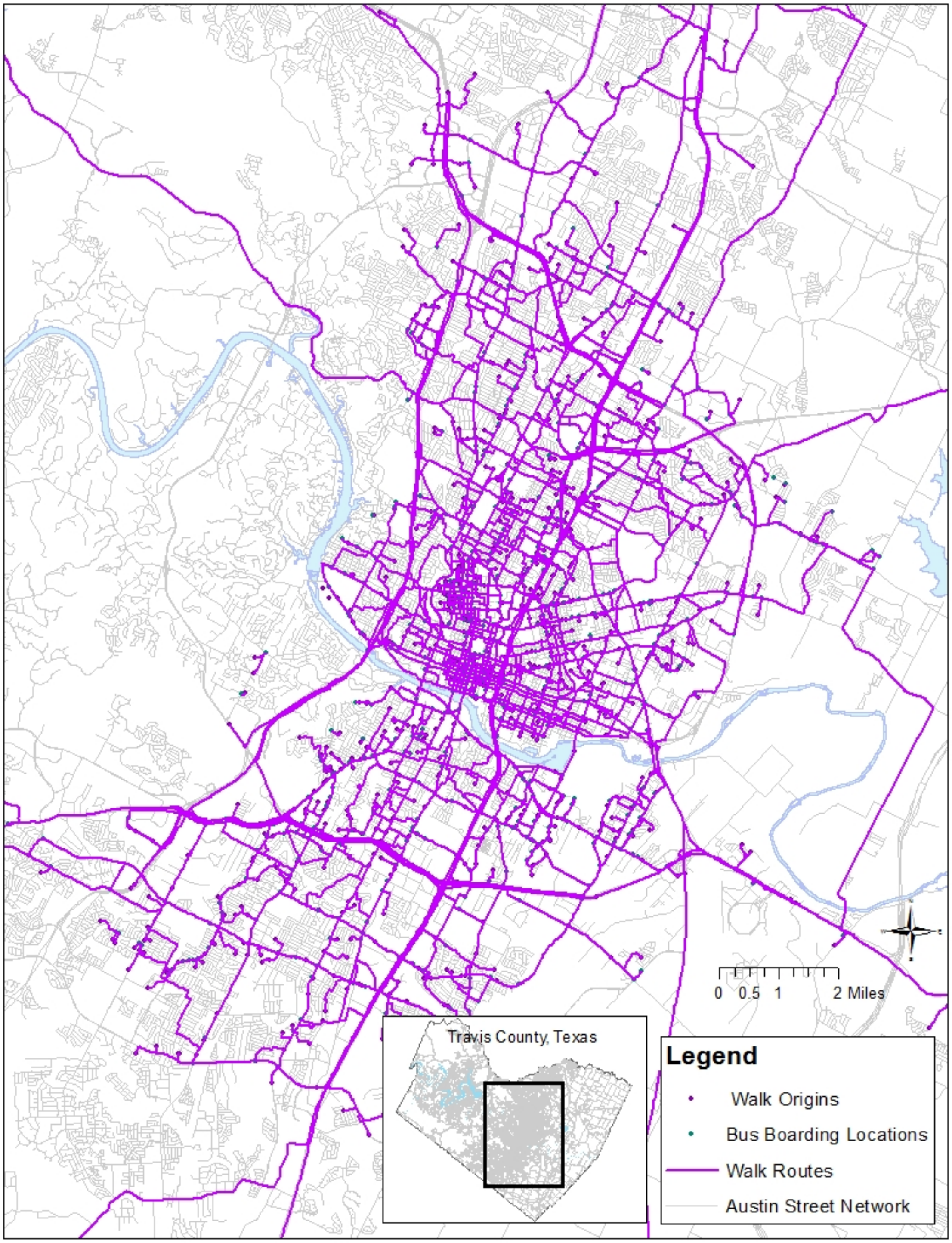

Figure 2: Home-Based Walking Routes to Bus Stops in Austin, Texas

(Data Source: Cap Metro 2010 On-Board Survey)

STATISTICAL ANALYSIS AND RESULTS

The final dataset included 3,193 Austin bus riders whose home-based access walk trips were mapped and measured using ArcGIS. Surveyed riders who stated that they accessed the bus by a mode other than walking were removed from the sample set in the content control data processing step (see Table 1). The remaining sample at this stage included 13,125 riders, indicating that almost 78%[4] of this sample of riders reported walking to the bus. The next highest access mode was a transfer from another bus. The sample set was further reduced to control for only bus riders who reported starting their trip at home and to remove non-standard bus routes like night owls and other special routes (Table 1).

Outliers

The preliminary set of estimated routes (n=3193) produced a range of walking distances that exceeded common sense expectations. Based upon an assessment of the frequency table and histogram of the original 3,193 routes, a conservative decision was made to eliminate only the most obvious outliers. The preliminary frequency distribution is displayed in Figure 3. Seventeen samples with estimated walking distances of over 15 miles were removed for the final data analysis. It was assumed to be extremely unlikely that a person would walk 15 miles or more to catch a bus. While it is reasonable to expect that sub-access walks of 5 or 10 miles are also unlikely, clear evidence could not be identified in the data set to remove sample points simply for resembling long walks. Figure 4 displays the final frequency distribution of the dataset reviewed in the remaining analysis and Table 2 details the frequency and cumulative percentage by distance.

[4] 13125/16897=77.7% of riders reported walking to the bus stop.

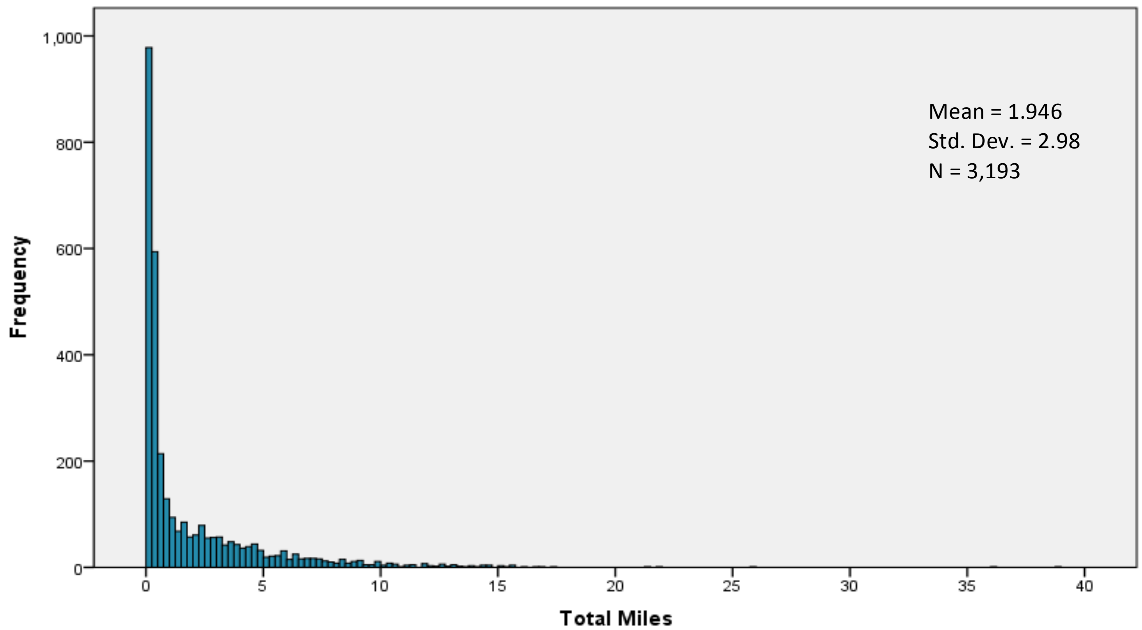

Figure 3: Frequency Distribution of Walking Distances (Includes Outliers)

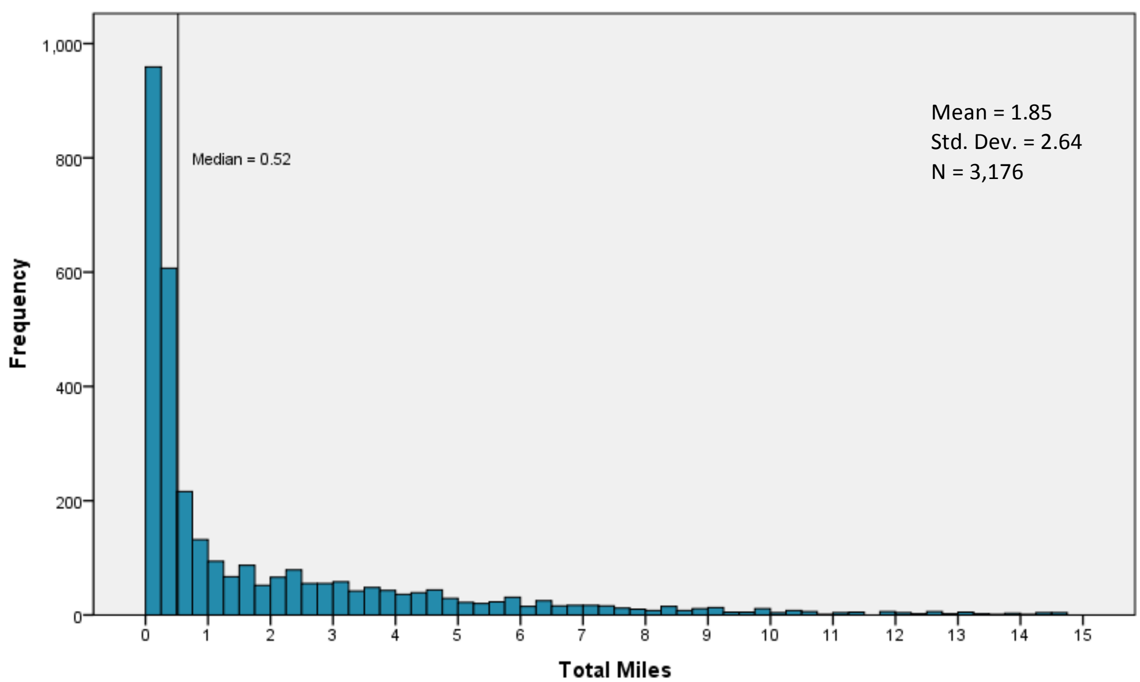

Figure 4: Frequency Distribution of Walking Distances (Outliers Removed)

Table 2: Frequencies of Walk Distances			
Walk Distance (Miles)	Frequency (n)	Valid Percent (%)	Cumulative Percent (%)
Less than 1/8	549	17.3	17.3
1/8 to 1/4	429	13.5	30.8
1/4 to 1/2	594	18.7	49.5
1/2 to 3/4	214	6.7	56.2
3/4 to 1	129	4.1	60.3
1 to 1.5	162	5.1	65.4
1.5 to 2	142	4.5	69.9
2 to 2.5	140	4.4	74.3
2.5 to 3	111	3.5	77.8
3 to 4	190	6	83.8
4 to 5	151	4.8	88.5
5 to 6	93	2.9	91.4
6 to 7	73	2.3	93.7
7 to 8	55	1.7	95.5
8 to 9	42	1.3	96.8
9 to 10	34	1.1	97.9
10 to 15	68	2.1	100
Total	**3176**	**100**	

Characteristics of Austin Bus Riders

The final sample included 3,176 riders, all of whom reported walking from their home to access the bus. Overall ridership in the sample was 58% male. The average age was 31 years, with riders ranging from 14 to 89 (n=3,151 due to non-response). The income and racial breakdown of the sample are summarized in Figures 4 and 5. The income distribution of riders is skewed towards low incomes; this may relate to a high percentage of non-response (12%) and the presence of university routes. Nearly half of the sample identified as White or Anglo, followed by one-quarter Hispanic and one-fifth African American (Figure 6).

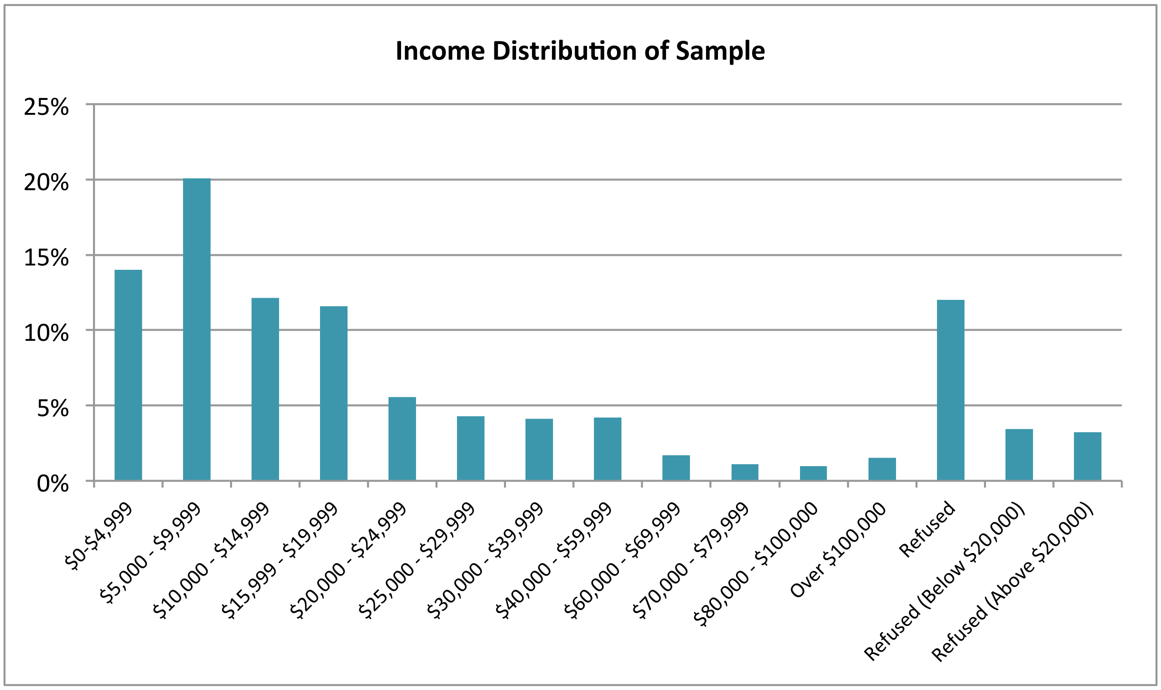

Figure 5: Income Distribution of Sample Riders

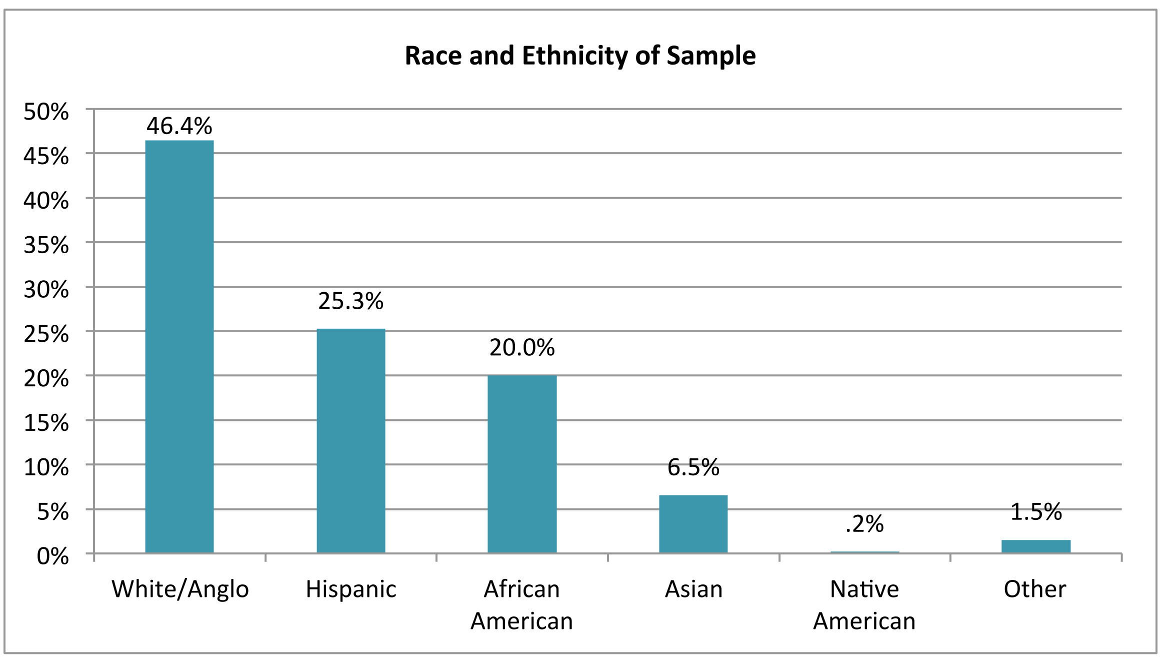

Figure 6: Race and Ethnicity of Sample Riders

Travel Behavior of Austin Bus Riders

The majority (87%) of riders walking from home to access the bus reported that they would walk to their next destination when they exited the bus. This reinforces previous findings that most bus riders are walking from the bus. Another 11.3% reported they would transfer to another bus. The median walking access trip distance was shorter for those planning to transfer to another bus (0.41 miles) than those walking (0.54 miles) or driving or riding in a car (1.23 miles). This may indicate a desire of travelers to reduce a trip's overall inconvenience; for instance, a traveler who knows he will have a ride at the other end of a trip may be more likely to walk a longer distance on the first leg of a trip.

Table 3: Egress Mode of Bus Riders in Austin, Texas

"How will you get to your final destination?"

	Total Miles	
	Median	% of Total
Will drive my car	.35	0.3%
Will ride a bike	.27	0.3%
Will ride with someone/ will be picked up by someone	1.23	0.7%
Will transfer to a Bus Route	.41	11.3%
Will walk	.54	87.4%

The median walking distance for males (0.56 miles) was higher than for females (0.46 miles). Disabled, senior and youth riders (based on fare type) were underrepresented in the sample set (accounting for a collective 6.8% of the sample) and had shorter walk access distances than adults. Riders paying with a UT student or faculty pass fare made up the largest portion of the sample riders, and had a median walk distance of only 0.31 miles. This may be attributable to the high frequency and circulation of the UT buses – several of which are circulators that serve the campus area. Similarly, those riders whose destination was the University of Texas had the lowest median distance.

Riders who reported having no vehicle available for their trip had a much higher median distance (0.70 miles) than those who did have a car available (0.28 miles). Riders reporting that they were going to work had the highest median walking distance (0.98 miles), followed by those traveling to elementary, middle or high school (0.96 miles).

Table 4: Destination of Bus Riders in Austin, Texas
"Where are you going to?"

	Total Miles	
	Median	% of Total
Airport	.44	0.9%
All other	.52	0.6%
College (Not UT)	.48	1.6%
Medical	.73	1.6%
Personal/recreational	.65	27.1%
School (Elementary/Middle/High)	.96	1.3%
Shopping	.71	13.9%
The University of Texas	.30	27.3%
Work	.98	25.9%

Table 5: Egress Mode of Bus Riders in Austin, Texas
"Which fare category do you pay?"

	Total Miles	
	Median	% of Total
Adult	.98	57.7%
Child	.45	0.1%
Disabled	.42	5.4%
Senior	.45	1.3%
Student	.30	35.5%

Quality of Transit Service

Transit frequency and service type have been identified as factors that influencie the distances transit users will walk (O'Sullivan and Morrall, 1996). The TCQSM Manual's Level-of-Service (LOS) rating system (Table 6) was used to assign each route a LOS score based on its peak hourly service frequency. LOS A indicates the most frequent service, while LOS E is the least frequent. It was expected that higher frequency would correlate with a willingness to walk longer distances. The data did not reveal a clear relationship between the level of service and the walking distances. The distances Austin bus riders walked were found to vary by route which can be seen in detail in Table A2 in the Appendix and summarized in Table 7.

Table 6: Fixed-Route Service Frequency Level-of-Service (LOS)

LOS	Avg. Headway Between Buses (minutes)	Vehicles per Hour	Description of Service
A	< 10	> 6	Passengers do not need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service available during the hour
F	> 60	< 1	Service unattractive to all riders

Source: Transit Capacity and Quality of Service Manual – 2nd Edition, Exhibit 3-12

Table 7: Walking Distance and Bus Frequency

		Walking Distance (Total Miles)		
		Mean	Median	% of Total
LOS		.15	.09	4.0%
	A	.90	.31	11.8%
	B	2.21	1.27	23.9%
	C	1.62	.57	8.5%
	D	1.98	.56	39.2%
	E	2.37	1.20	12.6%

How Far Do Austin Bus Riders Walk to the Bus?

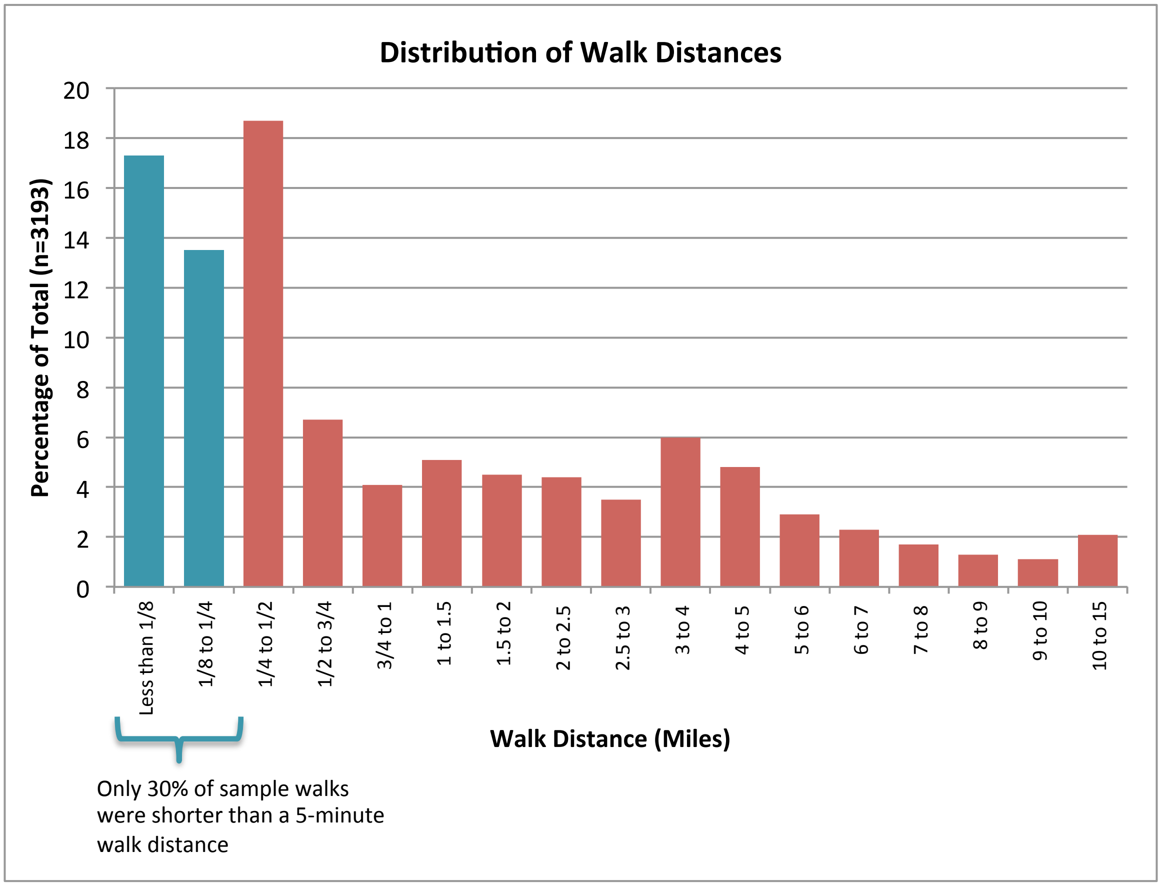

Figure 7: Distribution of Walk Distances

The distances walked by Austin bus riders had a median of 0.52 miles and a mean of 1.85 miles. The distribution is shown in Figure 7. Approximately 30% of riders reported a walking a distance less than the commonly stated ¼-mile distance, the approximate representation of a 5-minute walk. Another 18.7% walked between ¼ mile and ½ mile. Approximately 60% of the walk distances were less than 1 mile and more than three-quarters were less than 3 miles. This suggests a greater variance in home-based walk trips to access a local bus than commonly assumed.

However, the mean and standard deviation point to other findings. The standard deviation is larger than the mean because of the high variance of the sample set. While many (30.8%) reported walking distances shorter than 1/4 of a mile, more than one-quarter of riders reported walk access trips measuring over 2 miles. The mean walking distance for the final dataset was 1.85 miles, which if one assumes a 3 mph walking speed would necessitate a 37-minute walk. This far exceeds the expected distance individuals are expected to walk to the bus. This difference may be a result of inaccuracies in the data collection process, which will be discussed further in the conclusion of this report. Still, according to this analysis, more than half of walk access trips measured over a ½ mile and nearly 70% were greater than ¼ mile – the assumed threshold for bus transit walks – indicating many Austin bus riders are walking farther than is typically assumed.

Table 8: Summary for Estimated Walk Distances (Miles)

		Statistic	Std. Error
Median (Miles)		.5156	
Mean (Miles)		1.85	.04689
95% Confidence Interval for Mean	Lower Bound	1.759	
	Upper Bound	1.94	
5% Trimmed Mean		1.49	
Variance		6.983	
Std. Deviation		2.642	
Minimum		.0012	
Maximum		14.61	
Interquartile Range		2.41	

Comparison to Conventional 5-Minute Walk Estimate

In practice, a straight-line distance of ¼ mile represents the conventional five-minute walk. Furthermore, this distance is further reduced to a simple circular buffer around bus stops or routes. Assessments of this method have revealed that they are not accurate reflections of true walking distances and the use of GIS technology can provide enhanced estimates of walking distances and routes (Biba, Curtin, & Manca, 2010; Landex et al., 2006). In order to compare the conventional buffer method to the results of this analysis, conventional ¼ mile radial buffer areas were created for the Capital Metro bus routes included in this analysis (see Appendix A2 for list of routes). Sample home locations that are located within the buffer area would be presumed to have 5-minute access to the bus using the conventional method. The Select by Location function in ArcGIS was used to identify sample points with a walk origin within the buffer zone but walk distances greater than ¼ mile in the Network Analyst analysis.

If it is assumed that a rider whose origin is located within the buffer area walks less than 5 minutes to reach the bus, the data would indicate that over 96% of the sample riders' home origin was within a ¼ mile distance to bus service. In contrast, the network-based walk distance estimates reveal that only 30% of the reported walk trips were shorter than a ¼ mile. The use of the buffer method to symbolize a 5-minute walk radius would lead to the conclusion that a significantly larger portion of riders are within a 5-minute walk than the route distance estimates suggest.

Table 9: Overestimation of Short Walks Using Conventional Method

	N	Percent of Total
Total Sample Walks	3176	100%
Walks originating inside ¼ mile buffer from bus route	3068	96.6%
Walks under ¼ mile distance based on street network	978	30.6%

Figure 7 presents a sample of walk access trips that originate within a ¼ mile radius distance from a bus route, the commonly used method to represent an acceptable access distance, and the trips that originate outside of that distance. This measure may be overestimating the number of residents with reasonable access to the bus system. Figure 7 also serves to highlight the fact that some portions of Austin are not within the ¼ mile buffer at all.

The map in Figure 8 offers examples of bus riders who started their journey within the ¼ mile buffer catchment zone but, according to the route analysis, walked distances ranging from 0.27 miles to over a half mile to access the bus (distances are noted on the routes). The displayed selection of routes was limited to trips under 1 mile; some riders who live within the buffer reported traveling even further. This exemplifies the potential of the use of the 5-minute walk as an assumption to obscure the walking habits of actual riders. The buffer method not only underestimates actual walking distances but it implicitly assumes that the closest bus route is the route a rider would want to access.

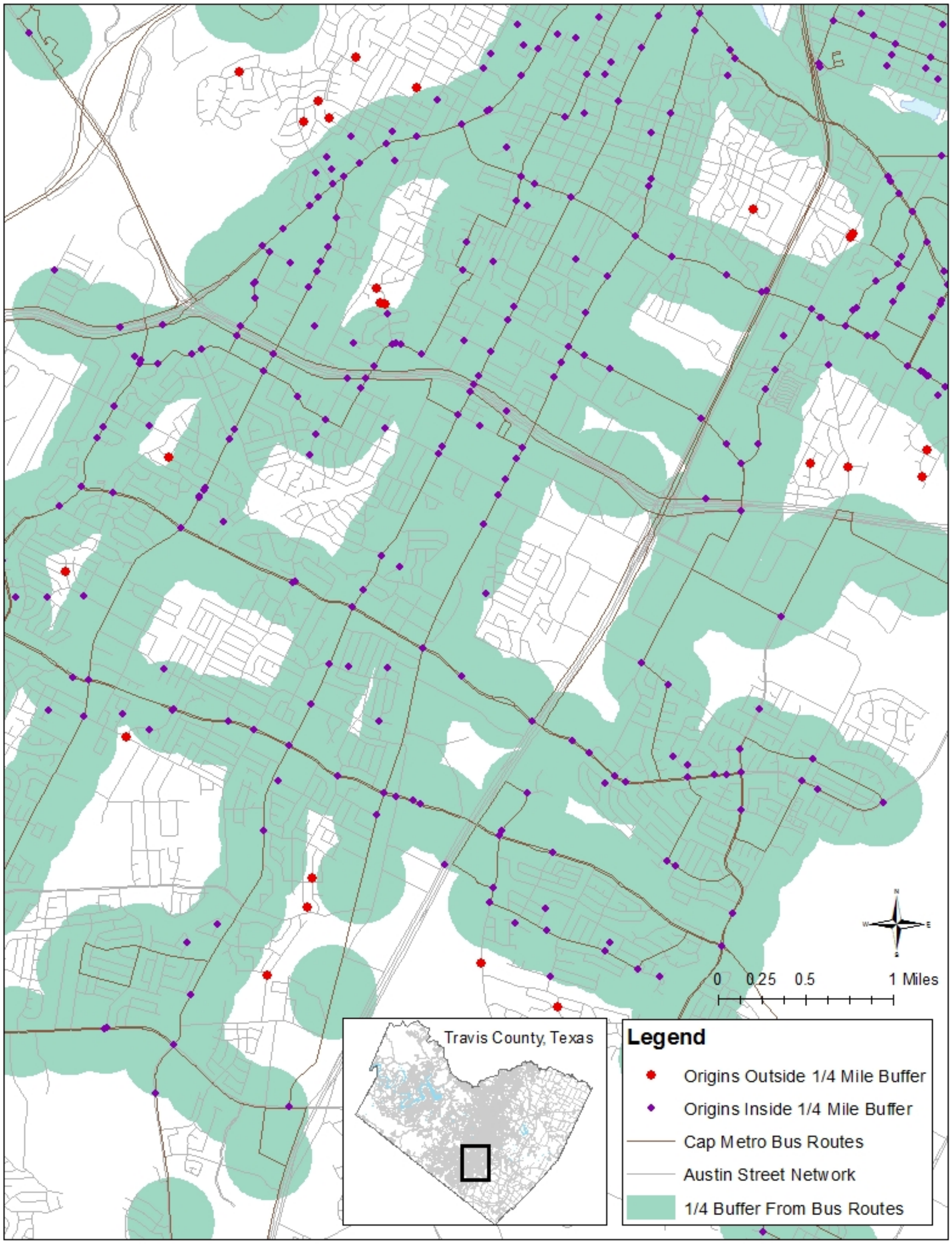

Figure 8: Surveyed Walk Origins Compared to ¼ Mile Buffer

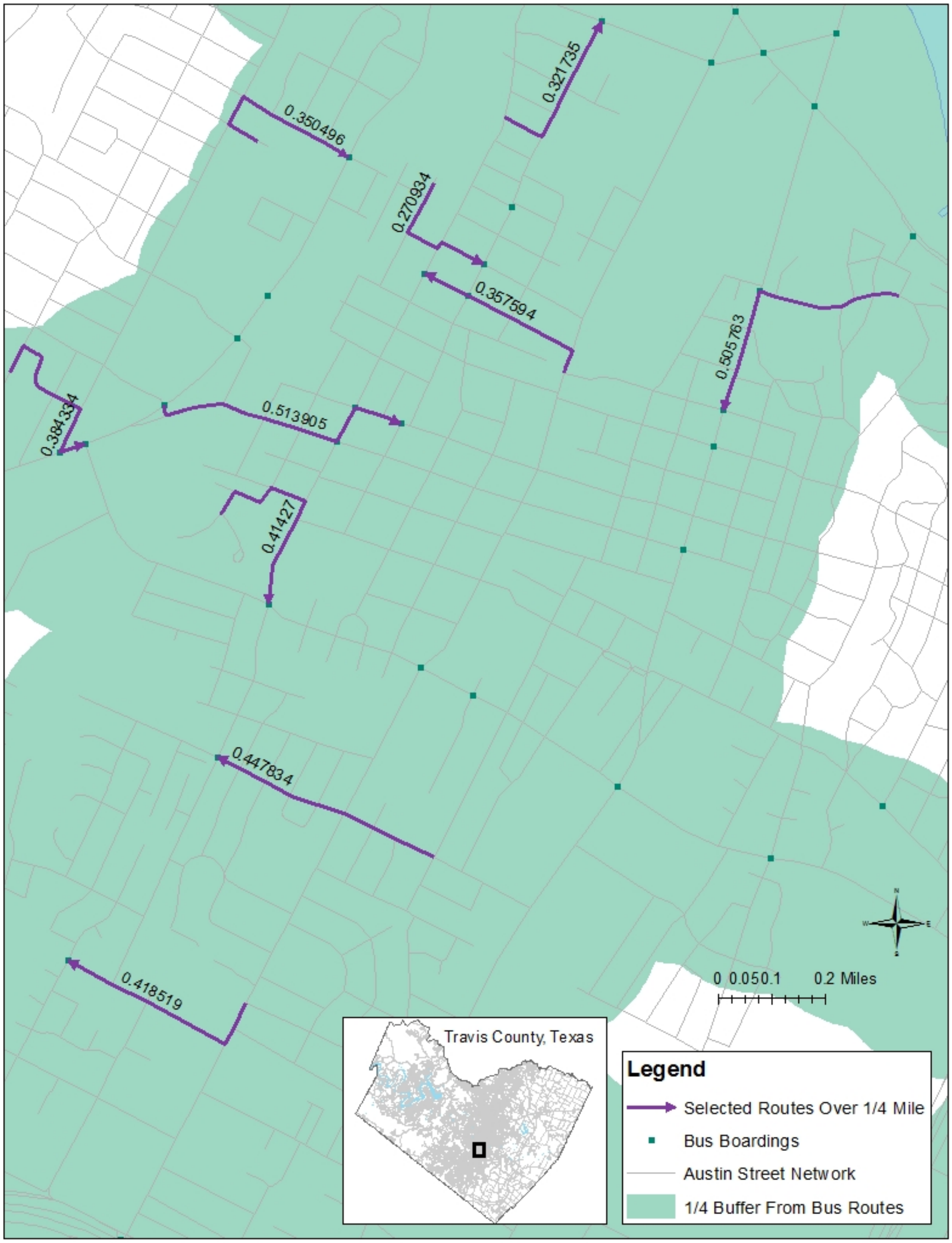

Figure 9: Network Analyst Routes Versus Conventional Buffers

Chapter 5: Discussion and Future Considerations

The review of walking activity in this report, specifically home-based walk trips to access bus transit, revealed a lack of support for the commonly stated 5-minute walk rule. An analysis of bus survey data from Austin, Texas revealed that many bus riders are walking distances longer than a 5-minute walk. Walking distances also show wide variation and may be linked with demographic characteristics, environmental features and transit service characteristics. Use of ArcGIS Network Analyst proved to be a simple but informative method for measuring walking distances. The analysis further revealed flaws in the data collection for transit access studies and suggests that updated methods be used in order to better understand this travel activity.

WALKING DISTANCES

A walking distance threshold of five minutes or ¼ mile is commonly assumed in both transportation and urban planning practice, despite a scarcity of evidence to support this rigid guideline. This report tested this rule with a unique implementation of ArcGIS Network Analyst to estimate street-based route distances that Austin bus riders walked to access a bus. The analysis revealed a range of distances, with fewer trips occurring at longer distances, consistent with previous distance decay studies. The median of 0.52 miles indicates a large number of riders are walking farther than is commonly assumed. Indeed, this analysis found that 70% of Austin bus riders walked distances greater than ¼ mile. Many riders appear to be walking further than ¼ mile and some are walking distances even longer distances than the ½ mile commonly ascribed to rail transit service. Austin's transit system is primarily bus-based at present; the new Metrorail and planned bus rapid transit services in the city will offer opportunities to further investigate the walking behavior as it relates to service type and frequency.

The analysis confirms the findings of several studies discussed in the literature review that the 5-minute walk is not an accurate representation of bus access behavior. The literature review has shown that while specific catchment radii or thresholds may have some practical use (for predicting ridership for instance), research has shown that the decision-making about walk distances to transit is influenced by many factors and is not well represented by this simple measure. Bus rider characteristics, physical design and transit service collectively influence the distances walked. In addition, research shows that there are many factors to consider in transit stop access, including directness and speed of route, pedestrian facilities and design, crime, and access to information (Transit Cooperative Research Program, 2012).

Walking distances are longer and more variable than reflected by the 5-minute walk. This is especially significant in light of the fact that there is inadequate data on walking distances and it is difficult to isolate the impact of independent variables. Efforts to comprehensively investigate these influences offer the potential for cities and transit agencies to increase walking mode share to stations.

NETWORK ANALYSIS

The 5-minute walk has its foundation in transportation studies written in the 1980s when today's technology was not available to support more comprehensive analysis of routes. Modern mapping and data collection technology allow for much more nuanced and accurate data collection. This report has demonstrated that the development of technology such as geographic information systems (GIS) provides opportunities for better analysis. Network Analyst was successfully used to estimate precise walking routes based on the data collected in a typical bus rider survey. This procedure has the potential to be replicated and expanded in the study of walking behavior as a sub-access link to bus transit and in general.

Spatial analysis tools like ArcGIS can be employed to investigate the intricacies of walking behavior and transit use in even more detail. One technique integrates parcel-level census data, compatible with GIS, into the network method to provide much more accurate counts of the population within walking distance to bus service. Access to a transit stop is often aggregated at larger geographic areas, which assumes populations are uniformly distributed. The analysis in the report suggests that this is not accurate (see Figure 8). Biba et al.'s 'parcel-network' method for estimating the level of access to transit stops using network-based routes and micro-level population data (Biba et al., 2010).

Several other techniques have been reported for assessing the quality and condition of the walking environment to address the connection between transportation and the built environment. Network Analyst can build more detailed representations of the pedestrian environment that include barriers like those described above such as topography, sidewalks, and crosswalk location. Many cities, Austin included, maintain GIS libraries that include many of these elements that simply need to be incorporated into transit research. Other research has aimed to create inventories or ratings for the quality and comfort of walking environments. The Real Accessibility Index (RAI) is an example of a tool that allows a score to be given based on the "extent and condition of transportation infrastructure." The objective of the RAI is to support the integration of multiple mode types and identify the best use of limited resources to make improvements ("The Real Accessibility Index," 2013).

DATA COLLECTION

The walking distance analysis revealed a likely shortcoming in the survey data collection process during the on-board surveys. The origin and destination questions in the self-administered survey were not specific enough to elicit the information necessary for this analysis. The unreasonable walk distances found in the route analysis suggests that the survey questions may have been misinterpreted or misreported. Respondents may have mistakenly responded "walk" as the access mode when they actually transferred from a bus or parked a car and then walked. A respondent may have provided an origin address where they started their day but not the particular trip that is the subject of the analysis.

It had to be assumed for the analysis of this report that the respondents correctly provided an origin address that reflected the place they were immediately before starting to walk to the bus where the survey was administered. The quality control efforts in the sample selection aimed to correct for these errors in the data. However, a follow-up consultation with transit survey experts confirmed that the abundance of very long walk distances is not consistent with the expected transit rider behavior. Transit access walks over 3 miles are extremely rare across transit surveys. (Email Correspondence with Chris Chatham, ETC Institute and Guy Rousseau, Atlanta Regional Commission, August 2nd – August 5th, 2013).

Modest updates to data collection and survey methods can produce more accurate data that can support the analysis of walking behavior using GIS and Network Analysis methods. Transit surveys should emphasize the collection of information related to walking distances, particularly the origin and destinations addresses. The role of maps in this type of inquiry have long been shown to provide very accurate results regarding walking routes; see O'Sullivan and Morrall (1996) and Schlossberg, Agrawal, Irvin, & Bekkouche (2007). Technological tools such as tablets and mobile devices can be integrated with GIS tools for use during interviews to collect detailed information about walking distances and routes. On-board surveys are increasingly administered by an interviewer, which allows for immediate clarifications and the opportunity for follow-up questions. The Atlanta Regional Commission (ARC) demonstrated some updated techniques in the 2009-2010 Regional On-Board Transit Survey. Interviews were conducted in person with the aid of tablet PCs. The use of technological aides such as the tablets used by ARC can greatly improve the collection of address and location data. Unreasonable access or egress walks can be immediately flagged by the interviewer for follow-up (ETC Institute, 2013). These updated methods are expected to significantly reduce the errors in collection of access and egress trip information (Email Correspondence with Chris Chatham, ETC Institute and Guy Rousseau, Atlanta Regional Commission, August 2nd – August 5th, 2013).

CONCLUSION

The understanding that walking distances to transit are more complex than implied by the 5-minute rule can pave the way for more research into walking behavior of bus riders. If the 5-minute walk assumption is not representative of transit use, investigating this activity at a micro-scale as in this analysis, may reveal the unique needs of specific riders as well as lead to better system design and inform decision-making about transit investments. By focusing in on an under-researched but crucial element of a public transit trip, this report is intended to contribute to the development of a more nuanced understanding of transit travel behavior and ultimately better service for all transit users. Researchers must continue to investigate the use of public transit and planners and policy makers should make decisions that are based on strong research.

In contrast to the decrease in transit use since the 1960s, public transportation ridership has increased by 34% from 1995 to 2012, faster than the use of highways in the United States over the same period. In response to this growing demand, communities should be supplied with improved services and enhanced multi-modal networks to support existing and potential riders. Public transportation supports economic activity, saves fuel, reduces congestion, reduces carbon emissions and provides healthy, personal mobility to millions of people ("Public Transit Benefits," 2013). As land and funding become increasingly scarce, efforts to improve data collection and analysis of transit behavior can inform new ways to make service updates cost and time effective for transit providers, local governments and transit users.

Appendix

A1: GIS Projection Information	
Projected Coordinate System	NAD_1983_StatePlane_Texas_Central_FIPS_4203_Feet
Projection	Lambert_Conformal_Conic
Linear Unit	Foot_US
Geographic Coordinate System	GCS_North_American_1983
Datum	D_North_American_1983
Prime Meridian	Greenwich
Angular Unit	Degree

A2: Median Walking Distances by Route

Route	Median (miles)	N		Route	Median (miles)	N		Route	Median (miles)	N
1	.76	**114**		37	.47	**68**		640	.28	**50**
2	.29	**76**		100	.63	**48**		641	.32	**26**
3	.44	**187**		101	.85	25		642	.09	**126**
4	.53	**73**		103	9.81	1		651	.16	**39**
5	.22	**121**		127	.05	1		653	.09	22
6	.66	21		137	4.78	15		656	.44	**43**
7	.88	**65**		142	2.44	17		661	4.40	**39**
9	2.16	**84**		300	.91	**104**		662	3.17	**117**
10	.52	**79**		311	4.57	**83**		663	.04	18
17	2.47	**166**		320	.21	**44**		670	.42	**86**
18	.42	**44**		325	.42	**43**		671	.17	**134**
19	.35	**33**		328	1.86	**50**		672	1.35	**91**
20	.51	**99**		331	.74	**62**		675	.20	**53**
21	.41	**64**		333	3.54	**134**				
22	.28	**60**		338	1.26	**121**				
23	.45	5		339	4.48	**42**				
29	.18	17		350	.99	**128**				
30	1.47	**38**								
								Total	**.52**	**3176**

Capital Metro Origin & Destination 2010: Survey Questions

ID1	ID	Field	Question	QUEST	OPT 0	OPT 1	OPT 2	OPT 3	OPT 4	OPT 5	OPT 6	OPT 7	OPT 8	OPT 9	OPT 10	OPT 11	OPT 12	OPT 13	OPT 14	OPT 15	OPT 16	OPT 17	OPT 18	OPT 99
1	1	respnum$	RESPONDENT NUMBER																					
2	2	route	ENTER ROUTE:																					
3	3	intv	ENTER INTERVIEWER ID																					
4	4	start	START																					
5	5	ddate	DDATE																					
6	6	BLOCK	BLOCK NUMBER																					
7	7	direct	DIRECTION.																					
8	8	a_lang	A. Language	a_lang		English	Spanish																	
9	9	s1	S1. Have you participated in a survey for Capital Metro in the past 3 months?	s1		Yes	No																	
10	10	q1	1. What are the names of the cross streets where you got on THIS bus?																					
11	11	Q1_STREET	1. Intersection, address																					
12	12	q2	2. Where did you come from?	q2		Home	Work	College (Not Universi	The Unive	Shopping	Medical	Personal/	School (el			Airport	Other							All other
13	13	q3	3. What is the address OR nearest corner of the place you started your journey today?																					
14	14	Q3_STREET	3. Intersection, address																					
15	15	q4	4. How did you get to the BUS STOP?	q4		Transferre	Rode	Drove	Walked	Bike	Other													
16	16	q4a	4a. What bus route did you transfer from?																					
17	17	q4b	4b. How many blocks did you walk?																					
18	18	q4c	4c. How many miles did you travel to this bus stop?																					
19	19	q5	5. How will you get from this bus stop to your final destination?	q5		Transfer	Ride	Drive	Walk	Bike	Other													
20	20	q5a	5a. What bus route will you transfer too?																					
21	21	q5b	5b. How many blocks will you walk?																					
22	22	q5c	5c. How many miles will you travel from this bus stop?																					
23	23	q6	6. Where are you going to?	q6		Home	Work	College (Not Universi	The Unive	Shopping	Medical	Personal/	School (el			Airport	Other							All other
24	24	q7	7. What is the address OR nearest corner of your final destination?																					
25	25	Q7_STREET	7. Intersection, address																					
26	26	q8	8. How did you pay to get on this bus?	q8		Cash	31 Day Metro Pass	31 Day Express Pass	Day Pass	UT Student/ Faculty Pass	Mobility Impaired Pass	City of Austin	Free	Other	One-Zone ticket	Metro Plus Day Pass	All zones ticket	31-Day Metro Plus Pass	5-Day Metro Plus Pass	ACC Student/F aculty Pass	Senior Card	Value card/pay as you go	7-day/wee kly pass	All other
27	27	q9	9. Which fare category do you pay?	q9		Adult	Senior	Student	Child	Disabled	Don't kno													
28	28	q10	10. How many working cars, trucks, or vans are available for use by your household?	q10	Zero	One	Two	Three	Four	Five	Six													Refused
29	29	q11	11. Could you have used one of these vehicles to make THIS TRIP instead of riding the bus?	q11		Yes	No	Don't know																
30	30	q12	12. How many people reside in your household? (Family and non-family members)	q12		One	Two	Three	Four	Five	Six	Seven	Eight	Nine										
31	31	q13	13. Are you....?	q13		White/An	African Ar	Hispanic	Asian	Native Am	Other													
32	32	q14	14. What is your preferred language spoken at home?	q14		English	Spanish	Mandarin Chinese	Vietname	Other	Refused													
33	33	q15	15. What is your age?																					
34	34	q16	16. BY OBSERVATION: GENDER.	q16		Male	Female																	
35	35	q17	17. Please read off the letter on this card that best represents your total combined yearly income of you and all members of your household.	q17		$0 - $4,999	$5,000 - $9,999	$10,000 - $14,999	$15,000 - $19,999	$20,000 - $24,999	$25,000 - $29,999	$30,000 - $39,999	$40,000 - $59,999	$60,000 - $69,999	$70,000 - $79,999	$80,000 - $100,000	Over $100,000	Refused (below $20,000)	Refused (above $20,000)	Refused				
36	36	q18	18. How often do you use Capital Metro?	q18		6-7 days a	5 days a w	3-4 days a week	1-2 days a	1-2 days a	Less than	This is my	Don't kno											
37	37	q19	19. How long have you lived in the Austin area?	q19		Less than	1-2 years	2-3 years	3-4 years	4-5 years	5-6 years	6-7 years	7 or more	Refused										
38	38	MACH	MACHINE NUMBER																					
39	39	DAYPART	DAYPART																					
40	40	DAY	DAY																					
41	41	qname	Name																					
42	42	qphone	And telephone number?																					
43	43	EMAIL	email address																					

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