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REIMAGINED

designing better transit together

Choices & Concepts Report

MARCH 2022

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kat

KNOXVILLE AREA TRANSIT

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This project is funded under an agreement with the State of Tennessee, Knoxville Area Transit, and the Knoxville Regional Transportation Planning Organization.

1 Introduction

What is KAT Reimagined?

KAT Reimagined is a chance for Knoxville to rethink and reconsider its entire bus network and consider how its transit system is meeting the City of Knoxville's mobility needs. A bus network redesign is a collaborative planning effort to decide where today's bus service should go, when it should run, and how frequently it should operate, starting from a clean slate. This project is a collaboration between Knoxville Area Transit (KAT) & Knoxville Regional Transportation Planning Organization (TPO) and will involve riders, the general public, and key stakeholders in conversation about how Knoxville's bus network should serve its residents, businesses, and visitors.

Today, KAT's network is the result of decades of cumulative small changes and adjustments. The resulting network may not be meeting the goals and priorities of today's residents, employers, and institutions. Redesigning KAT's bus network is an opportunity to review existing and potential transit demand and need, and to design a network that meets those demands and needs most effectively. It is also a key opportunity to carefully think through and weigh competing goals for transit.

Redesign does not mean changing every bus route and stop. The key point is that thinking is not constrained by the existing network. Where the analysis suggests that existing service patterns make sense, those elements would be retained. Ultimately, the goal is a network designed for the Knoxville of today and tomorrow, not one based on the past.

What Is the Purpose of This Report?

This Choices & Concepts Report is the first step in **KAT Reimagined.** It is meant to spark a conversation about transit needs and goals in Knoxville. This report helps lay out relevant facts about transit and development in Knoxville, and draws the reader's attention to major choices that these facts force us to weigh.

The goal of this report is to assess the existing transit network and the geometry of Knoxville today and engage the public, stakeholders, and elected officials in a conversation about the goals of transit in Knoxville.

Reasonable people can disagree about the purpose of transit in their own community. Transit can deliver many different outcomes, but some of these outcomes trade-off against others.

Learning how the community values different outcomes is an essential step in deciding where to run service, what kind of service to run, and how to define success. This report explains some of those trade-offs and helps the reader identify which choices are most consistent with his or her own values for transit.

The anticipated timeline for this process is:

- **March to April:** Community review and response to this report and transit network concepts.
- **May to June:** KAT and TPO staff and consultant team draft a new network.
- **July to August:** Community review of a draft new network for KAT
- **September to October:** KAT and TPO staff and consultant team finalize the new network, implementation plan, and supporting elements for the new network.

At two key phases in this process KAT, TPO and City staff and the consulting team will engage the public, current transit riders, and community stakeholders in multiple ways:

- In-person outreach at transit stops and community events.
- Online and paper surveys.
- Consultation with a committee of major stakeholders.
- Public meetings with online and telephone call-in options.

The public health conditions mean that our study team may adjust our outreach events and processes depending on changes in guidelines and conditions. General information and details on the latest events is posted at

www.katreimagined.com

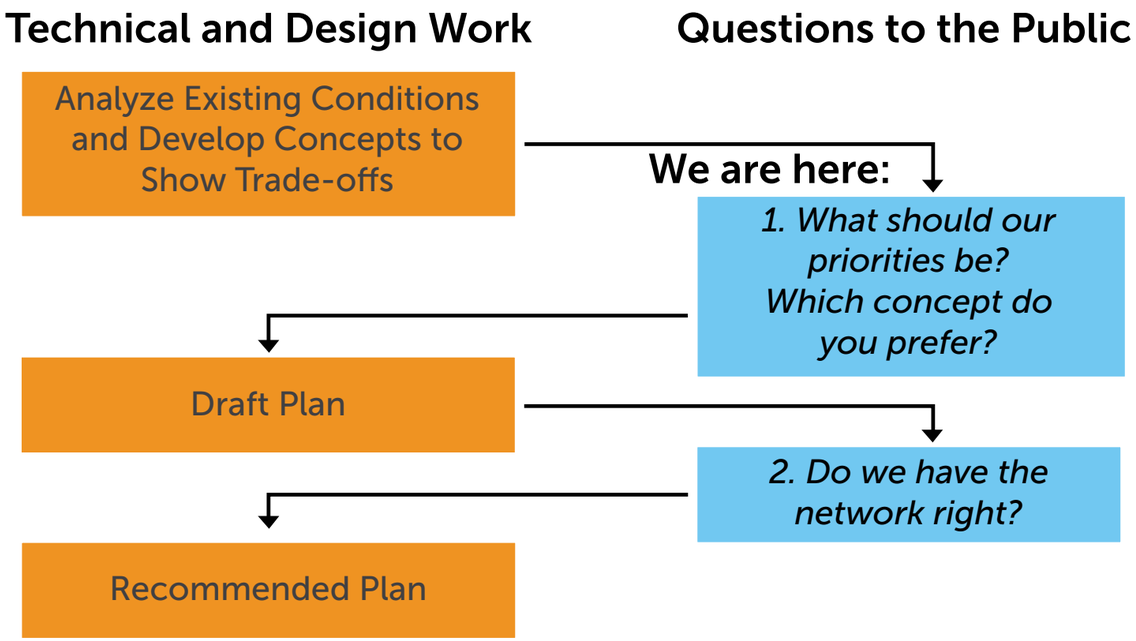


Figure 1: The process of technical work and public engagement that will inform the KAT Reimagined.

Transit's Many Goals

Transit can serve many different goals. It is not possible to excel towards all these goals at the same time. In addition, reasonable people will disagree about which of these goals is most important.

Understanding which goals matter most in Knoxville and the region is a key step in updating the KAT network and in thinking about regional service expansions. Some possible goals for transit include:

- **Economic:** Transit can give businesses access to more workers, workers access to more jobs, and students access to education and training.
- **Environmental:** Increased transit use can reduce air pollution and greenhouse gas emissions. Transit can also support more compact development and help conserve land.
- **Social:** Transit can help meet the needs of people who are in various situations of disadvantage, providing them with access to support services and opportunity.
- **Health:** Transit can be a tool to support physical activity by walking. This is partly because most riders walk to their bus stop, but also because riders will tend to walk more in between their transit trips. The social contact people gain on transit can also contribute to positive health outcomes.
- **Personal Liberty:** By providing people the ability to reach more places than they otherwise would, a transit system can be a tool for personal liberty, empowering people to make choices and fulfill their individual goals.

Some of these goals are served by high transit ridership. For example, the environmental benefits of transit only arise from many people riding the bus rather than driving. The same is true of some economic and health outcomes. We call such goals "ridership goals" because they are achieved through high ridership.

Other goals are served by the mere presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if few people ride it. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every political district. We call these types of goals "coverage goals" because they are achieved by covering geographic areas with service, regardless of ridership.

High Ridership Is Not the Only Goal

If Knoxville wanted to maximize transit ridership, it would focus its network around the busiest places where the greatest numbers of people live and work. If Knoxville did this, it would be acting more like a business: delivering the best service in places with the most potential customers.

Businesses are under no obligation to spread their services around widely. In fact, they tend to avoid spending a lot of money to reach only a few customers.

For example, McDonald's is not obliged to provide a restaurant within 1/2 mile of everyone in Knoxville. If it were, then the company would have to add many additional locations. Some locations would serve just a handful of homes, and most would operate at a loss because there are so few customers nearby.

People understand that less-inhabited areas will naturally have fewer McDonald's restaurants than more-inhabited areas. We don't describe this as McDonald's being unfair to places where few people live; they are just acting like a private business. McDonald's has no obligation to cover all areas with its restaurants.

Transit agencies are not private businesses. Most transit agencies decide that they do have some obligation to cover places with fewer people in them even when this would not be a "good business decision."

The officials who ultimately make public transit decisions hear their constituents say things like "We pay taxes too" and "If you cut this bus line, I will be stranded" and they decide that coverage, even in low-ridership places, is an important transit outcome. This is why transit agencies rarely act like private businesses.

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal. In fact, most agencies are intentionally operating some coverage services that are not expected to generate high ridership.

Figure 2: Do buses need to be full for transit to be "successful"? That depends on transit's purpose in the community.

How Does KAT Compare to Peers?

The charts on this page show some basic data about the performance of the KAT bus system, compared to similar systems in similar urban areas. These peer cities are similar to Knoxville in terms of the size of their service area population (100,000 to 500,000 people) and urban form, most are in the South but a few are in the Midwest.

Investment

Investment measures the quantity of service relative to the population being served, specifically service hours per capita. KAT provides about 1.2 service hours per capita, which is about average among peers. Most other Southern city peers have similar or lower levels of investment while Midwestern peers tend to have higher investment, particularly Champaign-Urbana.

Relevance

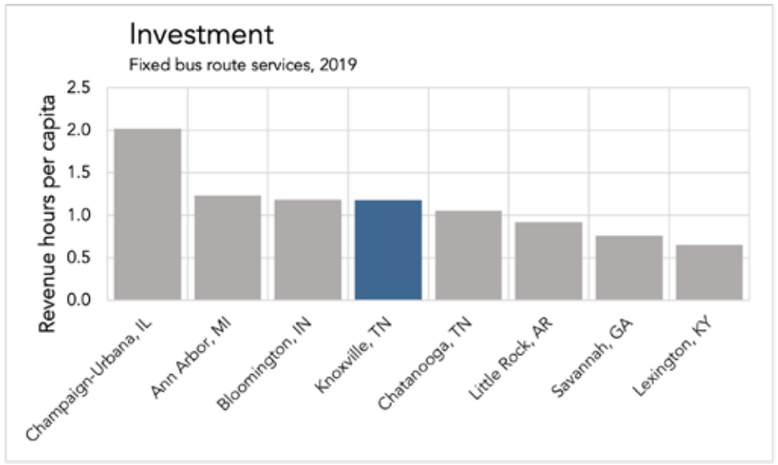
Relevance is a measure of how many people ride transit relative to the total population. Specifically, it measures the number of boardings per year divided by the service area population. Thus, this measure indicates how relevant transit is to the life of the city or region. Cities with higher investment per capita tend to have higher relevance, indicating that "you get what you pay for" in terms of transit usage. Champaign-Urbana stands out as having much higher relevance along side its much higher investment.

Productivity

Productivity is a measure of how efficiently a system is attracting riders relative to cost. It divides the total annual boardings by the total annual service to tell us how many riders are boarding for every hour of service KAT is running (a revenue hour). KAT's productivity is the second lowest among all its peers, suggesting that the system is getting relatively few riders relative to the service provided. Local factors like land use may be affecting this result, or it could be a result of decisions to pursue more coverage service in Knoxville compared to peers. **IF** ridership were primary goal for KAT, this result would be cause for concern.

Costs

KAT's costs per hour of service provided are at the low end of the range compared to its peers at about $90 per service hour. This suggests that KAT is doing well in managing its costs.



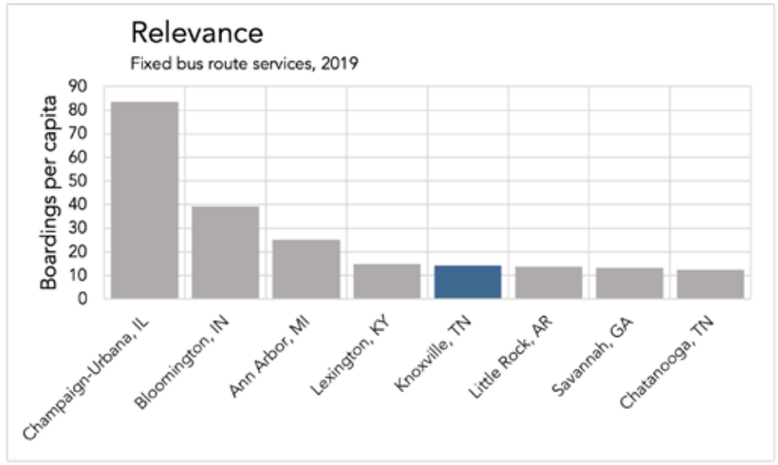
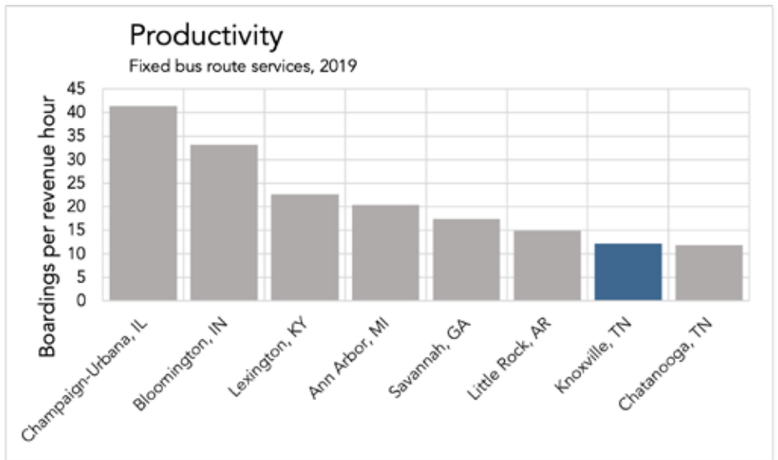
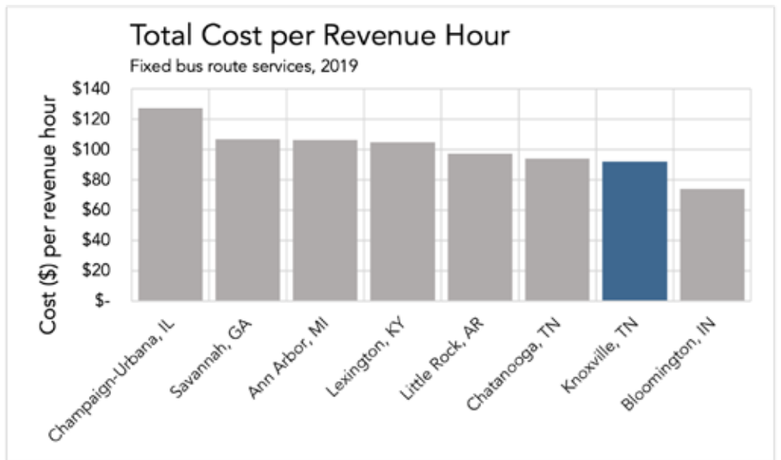


Figure 3: These four charts compare the systemwide performance of KAT to seven peer agencies on measures of Investment, Relevance, Productivity, and Cost per Revenue Hour.





Conflicting Goals

On page 6, we described why most transit agencies offer services that do not attract high ridership relative to their costs. These services provide "coverage," and their mere presence—rather than their ridership—is important to many people.

Ridership and coverage goals are both laudable, but they lead transit planners in opposite directions. Within a fixed budget, if a transit agency wants to do more of one, it must do less of the other.

Here is an illustration of how ridership and coverage goals conflict with one another due to geometry and geography. In the fictional town at right the little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. Most of the activity in the neighborhood is concentrated around two roads, as in many towns.

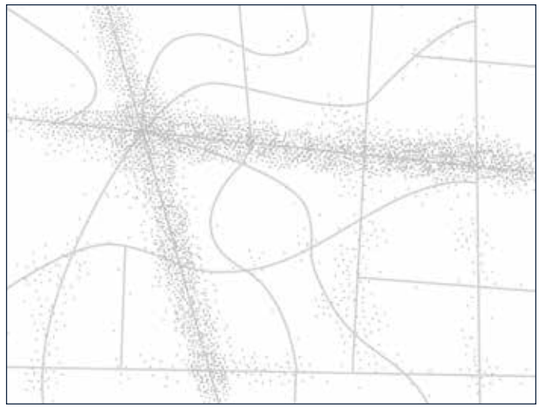
A transit agency pursuing only a ridership goal would focus service on the streets where there are large numbers of people, where walking to transit stops is easy, and where the straight routes feel direct and fast to customers. Because service is concentrated onto fewer routes frequency is high and a bus is always coming through the neighborhood soon. This results in a network like the one on the left of Figure 4 with the two red lines.

If the transit agency were pursuing only a coverage goal, on the other hand, it would spread out services so that every street had a bus route, as in the network on the right in Figure 4 with the green lines. As a result, all routes would be infrequent, requiring long waits, even in the busiest places.

On a fixed budget, designing transit for both ridership and coverage is a zero-sum game. Each bus that the transit agency runs down a main road, to provide more frequent and competitive service in that market, is not running on the neighborhood streets, providing coverage. While an agency can pursue ridership and provide coverage within the same budget, it cannot do both with the same dollar. The more it does of one, the less it does of the other.

These illustrations also show a relationship between coverage and complexity. In this imaginary neighborhood, any person could keep the very simple "high frequency" network in their head, since it consists of just two routes running in straight lines. They would not even need to consult a schedule to catch a bus. The coverage network would be harder to memorize, requiring people to consult a map (to understand the routing) and a schedule (to catch these infrequent services).

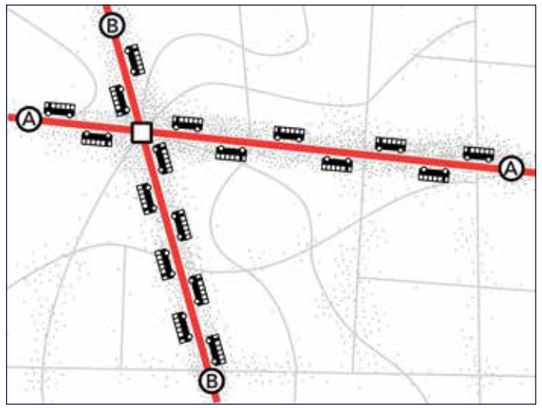
Transit can serve many different purposes; which purposes it should serve depends on your values.



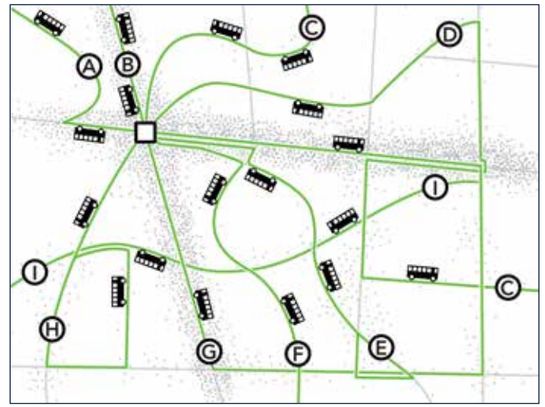
Imagine you are the transit planner for this fictional neighborhood. The dots scattered around the map are people and jobs.

The 18 buses below are the resources the town has to run transit

Before you can plan transit routes, you must first decide: What is the purpose of your transit system?



All 18 buses are focused on the busiest streets. Waits for service are short but walks to service are longer for people in less populated areas. Frequency and ridership are high but some places have no service.



The 18 buses are spread around so that there is a route on every street. Everyone lives near a stop but every route is infrequent, so waits for service are long. Only a few people can bear to wait so long, so ridership is low.

Figure 4: Ridership and coverage goals, while both laudable, are in direct conflict within a fixed budget.

What else is in this report?

Geometry of Transit

In Chapter 2, we summarize the basic principles of transit geometry, how they affect the access and opportunities that transit can provide to residents, workers, and visitors, and how the underlying geometry forces every community to grapple with some key value trade-offs in the design of its transit system.

Markets and Needs

In Chapter 3, we assess the markets for transit in Knoxville, the potential for high ridership, and the areas where the need for transit is high but the density of demand is not.

By "market" we are referring specifically to the demands for transit that result in high ridership relative to cost. This way of thinking about a transit market is similar to the way a private business thinks about its market for sales – how many potential customers there are, how useful they will find the product, and how well the product competes for their business.

High transit ridership satisfies a number of commonly-held values, like:

- If a community wants its transit system to compete successfully with cars to achieve environmental benefits—such as cleaner air and reduced carbon emissions—a Ridership goal is the path to that achievement.
- For transit to act as an economic stimulus, by providing job access to large numbers of workers, it must attract ridership. These interests are therefore also served by a Ridership goal.
- If leaders are concerned about government efficiency, they may want to maximize fare revenue relative to costs and reduce subsidy per rider. They would likely be drawn to a Ridership goal.

Existing Transit Network

In Chapter 4, we analyze the fixed route transit network performance including the frequency of service, productivity of service and how the network performs on measures like access to jobs. We also assess some key challenges and opportunities for improving transit service in Knoxville.

Key Questions

In Chapter 5, we summarize key value choices that only the Knoxville community and its leaders can make about how transit should serve Knoxville. These value choices cannot be answered by technical experts because they are questions about what goals and values the communities prioritizes. There is not a technically correct answer to these value questions.

Concepts

In Chapter 6, we provide concepts for how a redesigned network for Knoxville could look. The two concepts represent the ends of a spectrum of options between a network that emphasizes higher access, frequency, and therefore ridership or a network that emphasizes higher coverage of people and places at lower frequency and lower overall usefulness. The Ridership Concept and Coverage Concepts therefore provide everyone in Knoxville with a clearer picture of what it would mean to change the emphasis of those goals for the city's transit system.

How to get involved

For more information and to stay involved in the project, go to www.katreimagined.com and:

Learn More

- Get more background on the project
- See scheduled events
- Sign up for project emails

Give Input

- Take the online survey
- Sign up for our online meeting
- Connect via social media

Share with Others

- Find videos, articles and reports to share
- Request a community presentation

2 Geometry of Transit

What is the Product of Transit

Public transit can achieve many goals, but a commonly held goal for transit is to help people access opportunities: work, shopping, medical needs, education, and all the economic, social, cultural, and natural riches that a community has. Everyone has a limited amount of time in their day and, therefore, can only spend so much time traveling to meet their needs. Maximizing the people and places that people can reach in a limited amount of time is something we can calculate in assessing how well transit is meeting this goal. Figure 5 shows how we calculate this.

What Access Achieves

When we expand access for as many people as possible, we achieve many important things:

- We **make service more useful** for the trips people are already making and for many other trips that people might want to make by transit. When transit is more useful, more people use it.
- We **increase ridership potential**, as a result of service being more useful.
- We increase transit's potential to help with **pollution and congestion**. Ridership is the key to how transit achieves these things, and improving access is the path to ridership.
- We **expand access to opportunity** (jobs, education, shopping, services) for people who need transit for that purpose.
- We **increase the economic attractiveness** of the urban area. Connecting people with opportunities is the whole point of cities, so improving those connections makes any community more effective.

Access (or Freedom)

Wherever you are, there is a limited number of places you could reach in a given amount of time. These places can be viewed on a map as a blob around your location.

Think of this blob as "the wall around your life." Beyond these walls are jobs you cannot hold, places you cannot shop, and a whole range of things you cannot do because it simply takes too long to get there.

The technical term for this is accessibility, but it's also fair to call it freedom, in the physical sense of that word. The extent of this blob determines what your options are in life: for employment, school, shopping, or whatever places you want to reach.

If you have a bigger accessibility blob, you have more choices, so in an important sense, you are more free.

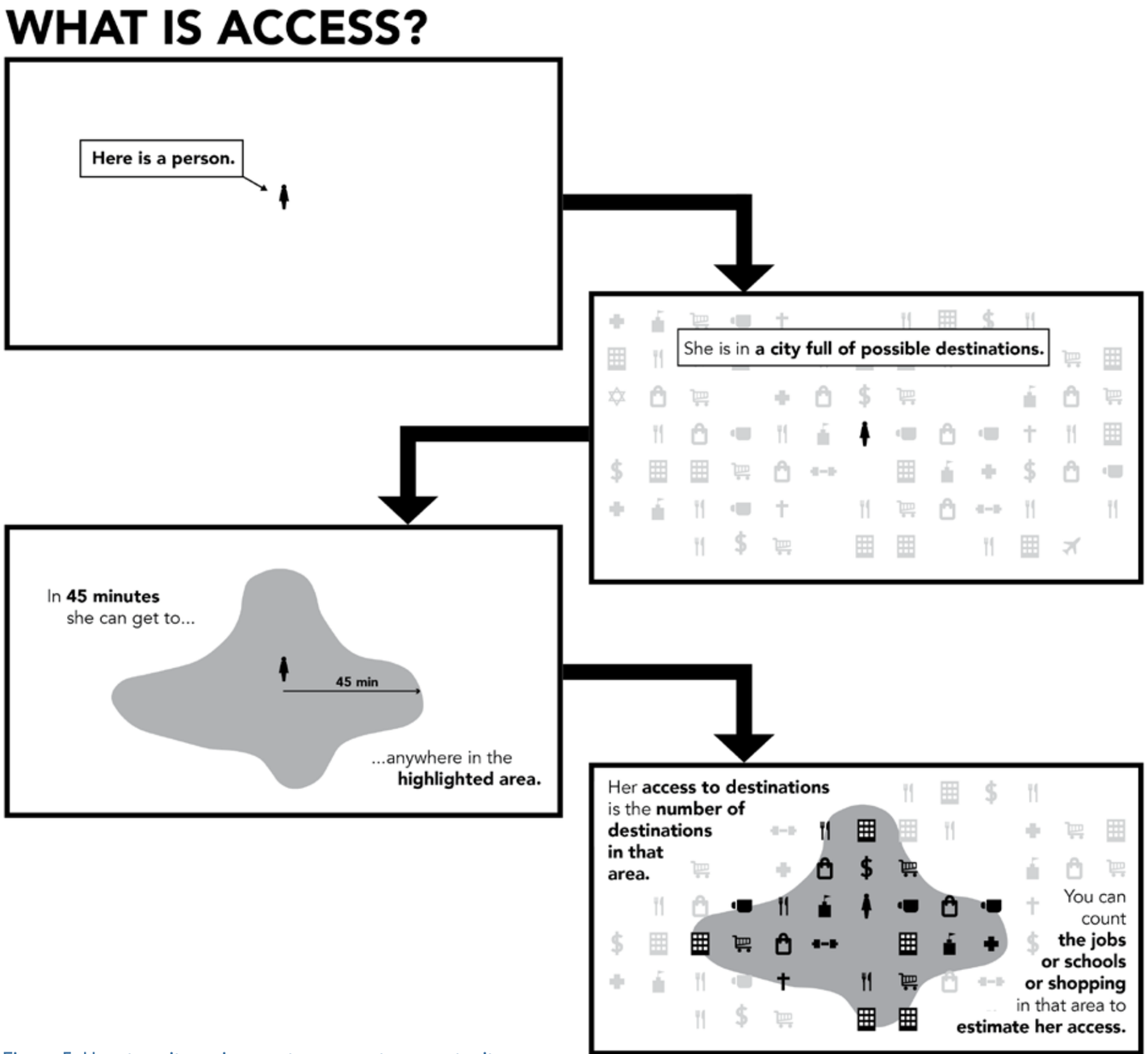


Figure 5: How transit service creates access to opportunity.

Access and Freedom

Access and Freedom

Wherever you are, there is a limited number of places you could reach in a given amount of time. These places can be viewed on a map as a blob around your location. Figure 6 shows an example of this type of visualization of transit access.

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The technical term for this is accessibility, but it's also fair to call it freedom, in the physical sense of that word. The extent of this blob determines what your options are in life: for employment, school, shopping, or whatever places you want to reach.

If you have a bigger accessibility blob, you have more choices, so in an important sense, you are more free.

That increase in freedom is also closely related to transit ridership. Public transit ridership arises from the combination of three things:

- **Access (or freedom).** Where can you get to on public transit in a reasonable amount of time, compared to your alternatives?
- **Pricing.** What does transit cost compared with its alternatives?
- **Preferences.** These include everything else, all the subjective factors that govern decisions about how to travel, as well as reactions to other aspects of the transit experience.

Network design and planning mostly determine access, so let's look at that concept in more detail.

How Transit Expands Access

When using transit, the extent of access is determined by:

- **The transit network.** This includes the frequency, speed, and duration of the transit lines. These features determine how long it takes to get from any point on the network to any other point.
- **The layout of the community.** For each transit stop on the network, this determines how many useful destinations are near the stop or within easy walking distance. For example, higher density around a given stop means more access, both because there are more useful destinations around the stop, and also because good access from that point is of more value to more people.

Access Is a Matter of Geometry

The way these factors combine and determine access is a matter of geometry. That's because freedom (and access) is about what you *could* do, not predictions of what you *will* do. Access is a basic driver of ridership, but it can also be considered a worthy goal in itself by many people. For example:

- Access to jobs helps keep people employed.
- Access from a particular location is something that gives that a location value. Real estate firms routinely study where you can get to by car from a particular development parcel, and we can do a similar analysis using transit.

If you are deciding where to live based on whether you can get to your job, school, or relatives, you are asking about access.

Five Points

Within...	Jobs	Residents
30 min	5,100	10,600
45 min	36,200	27,800
60 min	64,400	63,300

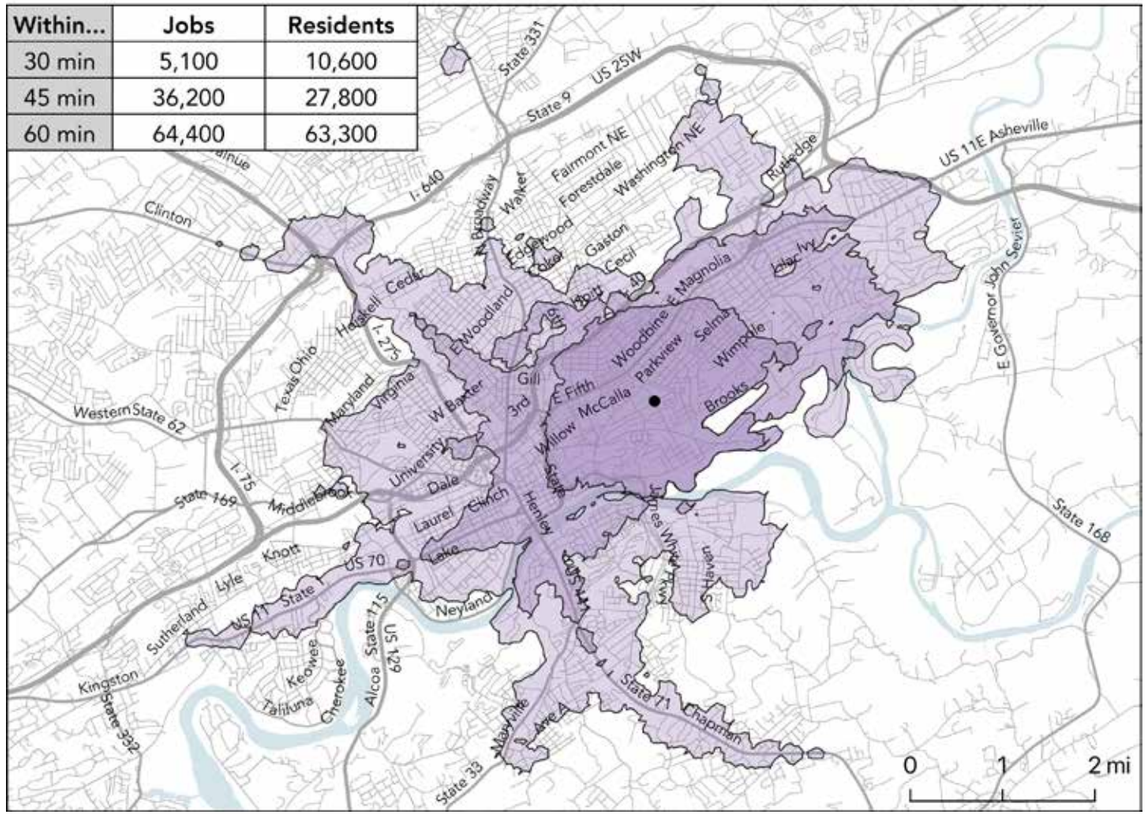

Figure 6: Where you can get to in 30, 45, and 60 minutes via transit and walking from Five Points with regular, Pre-Covid service.

Frequency is Freedom

Frequent service provides several related benefits for customers. These include:

- **Short Waits.** The average wait time for a 15-minute service is just 7.5 minutes.
- **Fast Connections.** Transferring between routes lets a rider reach a multitude of places that may not be all along one route. Connections are the glue that combine a pile of routes into a useful network, and frequency makes connections easy, because the next bus is always coming soon.
- **Easier Recovery from Disruption.** Frequent service is more reliable because if a bus breaks down, the next bus is always coming soon.
- **Spontaneity.** Rather than building their life around a bus schedule, customers can show up at the stop and go.

The payoffs of frequency are non-linear, with the highest ridership benefit usually being found in 5 to 15-minute frequencies. Figure 7 plots the frequency and productivity of routes operated by 37 transit agencies across North America.

The horizontal axis shows frequency (better, more useful frequency means a lower wait time, so more frequent service is to the left). The vertical axis shows productivity—how much ridership occurs compared to the quantity of service. A dark hexagon means that lots of transit routes share a particular combination of frequency and productivity, while a light hexagon means less route examples share a particular frequency and productivity combination.

Following the pattern of hexagons, particularly the darker ones, across the plot, we can see that ridership relative to cost rises with frequency even though better frequency costs more and pulls the productivity down.

How much frequency is enough? Two points should be noted:

- For most urban purposes, **a frequency of 15 minutes or better has the best chance of being useful,** and it's at these better frequencies that the non-linear payoff begins to appear.
- Adequate frequency depends on average trip length, because **it doesn't make sense to wait a long time to travel a short distance.** Very short downtown circulators, for example, don't usually make sense unless they can be run at frequencies well under 10 minutes. If the bus isn't coming very soon, it's probably quicker to walk the whole way.

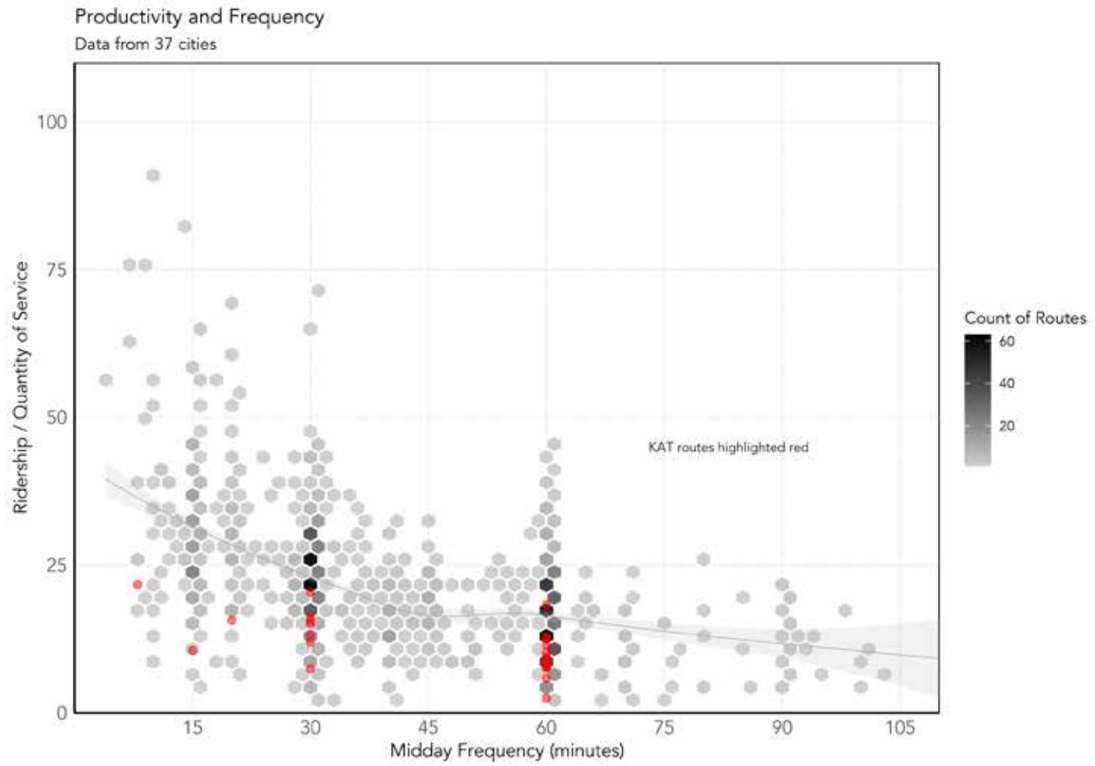

Figure 7: Transit frequency and productivity for routes from 37 cities.

Development Patterns Affect Ridership

Since frequency is expensive, it can't be offered everywhere. The greatest access arises from focusing frequency in the places where it can benefit the most people.

- **How many residents or useful destinations can be easily reached from each transit stop?** This question looks for density and walkability. High density means more people will find a stop useful, and high walkability means that people over a larger area will find the stop easy to walk to.
- **Are stops with high demand concentrated along a logical line?** This question looks for linearity (can the line be straight?) and proximity (does the line have to cross empty gaps with no demand?).

These geometric facts result in a difficult political challenge around transit. A transit system designed to maximize ridership serves its community unevenly, concentrating service where demand is high, yet even in areas where demand is low, some people value transit and will ask for service to their area. This leads to complaints about equity no matter what network design is proposed. People who live in places that are dense, walkable, and linear are cheaper to serve, on a per-rider basis, than those who live in places with lower density, walkability, and linearity.

Imagine that Ms. Smith lives in an apartment in a town center (dense, walkable, linear, proximate) while Ms. Jones lives in a large house in a cul-de-sac on a peninsula in a suburban area (not dense, not walkable, not linear, not proximate).

The objective fact is that it would cost much more to serve Ms. Jones than to serve Ms. Smith. Is it fair to give them the same level of service regardless? Or is it fair to spend the same amount serving each of them, which would mean very little service for Ms. Jones? The answer depends on the goals for that transit system.

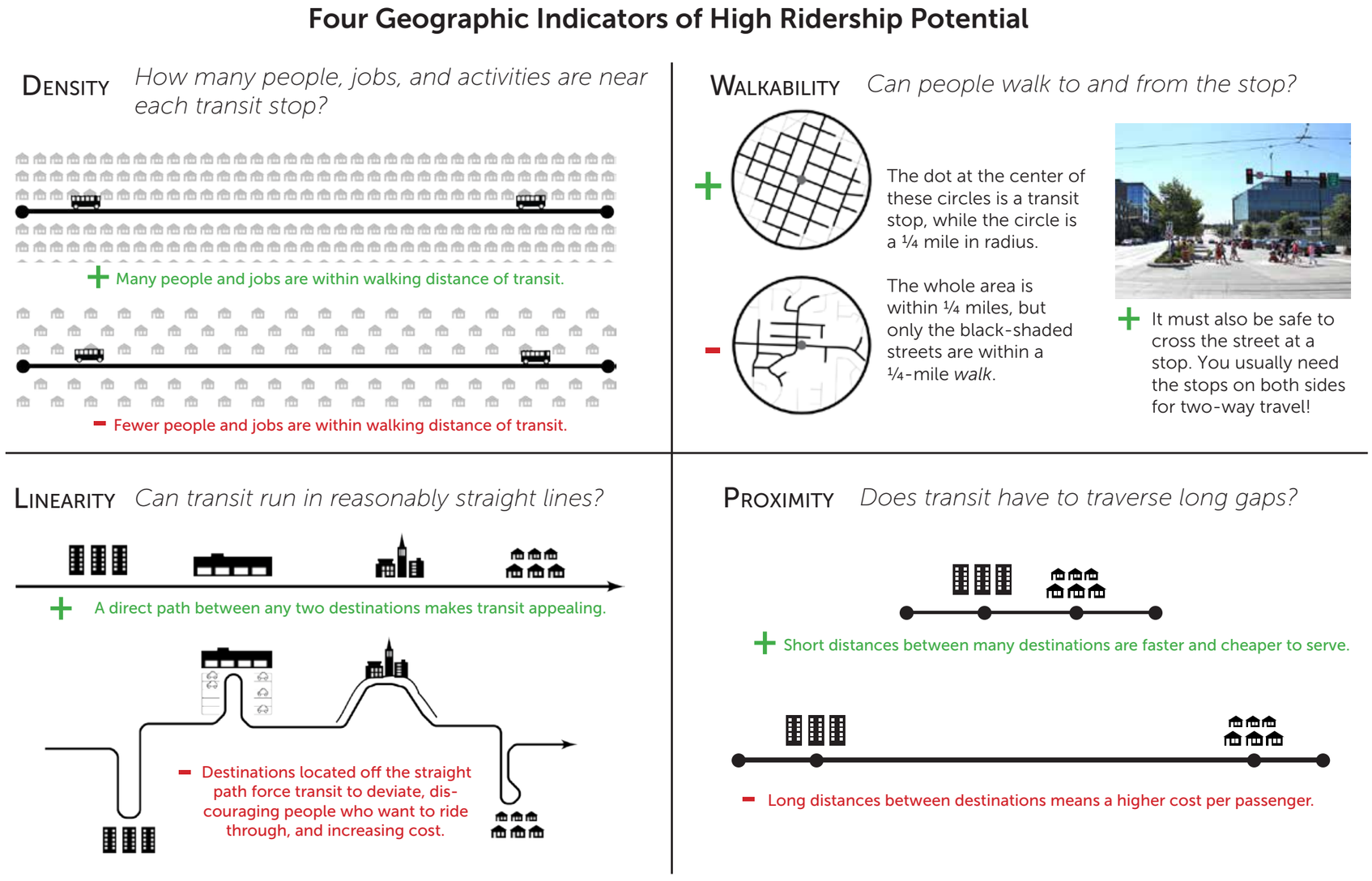

Figure 8: Community Geometry - Four Geographic Indicators of High Ridership Potential

Goals of Transit

Transit can serve many different goals. But different people and communities value these goals differently. It is not usually possible to serve all of them well all the time.

Possible goals for transit include:

- **Economic:** transit can give businesses access to more workers, and workers access to more jobs. Transit can also help attract certain industries, new residents, tourists, or other economic contributors.
- **Environmental:** increased transit use can reduce air pollution and greenhouse gas emissions. Transit can also support more compact development and help conserve land.
- **Social:** transit can help meet the needs of people who are in various situations of disadvantage, providing lifeline access to services and jobs.
- **Health:** transit can be a tool to support physical activity by walking. This is partly because most riders walk to their bus stop, but also because riders will tend to walk more in between their transit trips.
- **Personal Liberty:** by providing people the ability to reach more places than they otherwise would, a transit system can be a tool for personal liberty, empowering people to make choices and fulfill their individual goals.

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Other goals are served by the mere presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if the route is infrequent, not very useful, and few people ride it. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every political district. We call these types of goals **Coverage goals** because they are achieved in part by covering geographic areas with service, regardless of ridership.

KAT receives many different comments requesting changes to the service in order to pursue these goals, but it has a limited budget, so doing more of one thing can mean doing less of another. That's why we need hear what your priorities are.

Transit's Ridership and Coverage Goals Are in Conflict

Ridership and coverage goals conflict. Within a fixed budget, if a transit agency wants to do more of one, it must do less of the other.

Consider the fictional town in Figure 9. The little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. As in many towns, most activity is concentrated around a few roads.

A transit agency pursuing only ridership would run all its service on the main streets because many people are nearby and buses can run direct routes. A high ridership network allocates frequent service to areas with favorable urban development patterns, forming a connected network. This would result in a network like the one on the left.

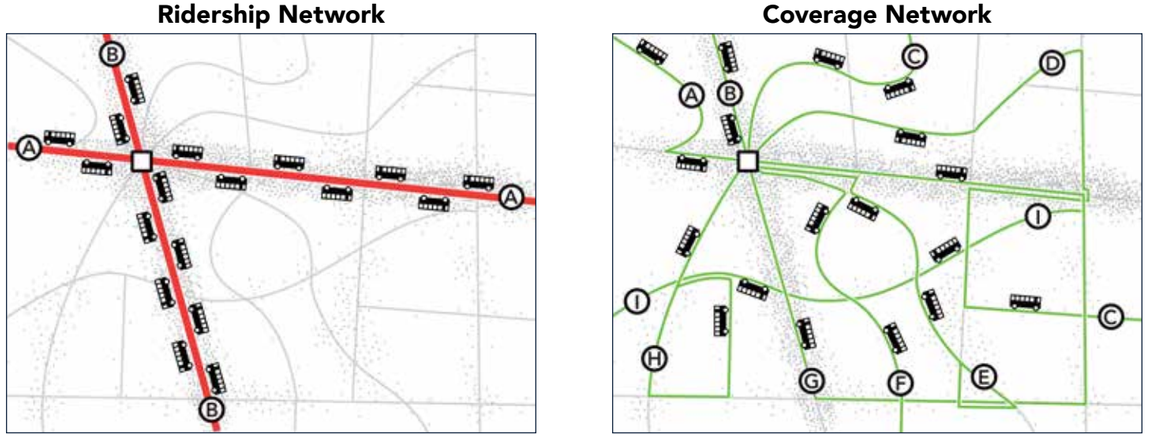


Figure 9: The network on the left is prioritizing ridership goals , while the network on the right is prioritizing coverage goals.

If the transit agency were pursuing only coverage, it would spread out so that every street had some service, as in the network on the right. All routes would then be infrequent, even on the main roads.

These two scenarios require the same number of buses and cost the same amount to operate, but deliver very different outcomes. To run buses at higher frequency on the main roads, neighborhood streets will receive less coverage, and vice versa.

An agency can pursue ridership and provide coverage within the same budget, but not with the same dollar. The more it does of one, the less it does of the other.

These illustrations also show a relationship between coverage and complexity. Networks offering high levels of coverage—a bus running down every street—are naturally more complex.

The choice between maximizing ridership and maximizing coverage is not binary. All transit agencies spend some portion of their budget pursuing each type of goal. A particularly clear way for cities and transit agencies to set a policy balancing ridership and coverage goals is to decide what percentage of their service budget should be spent in pursuit of each.

The "right" balance of ridership and coverage goals is different in every community. It can also change over time as the values and ambitions of a community change.

What about On-Demand Transit?

You may have heard about new service concepts consisting of small vehicles that pick you up when and where you request them, rather than running fixed routes. You may hear these called "microtransit" or "TNC partnerships," where "TNC" (Transportation Network Company) refers to companies like Uber and Lyft.

The basic idea isn't new. Taxis have always responded to customer requests, and shared-ride demand-response services, often called Dial-a-Ride, have been used for decades by US transit agencies. Special services for the disabled, called paratransit, also work this way.

The Trouble With Fixed Route Transit

There are obvious inconveniences in relying on fixed transit routes:

- **Long Walks.** Depending on where you are located, it may not be easy to get to the nearest transit stop. It might be far away, or require you to walk down streets where you don't feel as safe as you'd like.
- **Long Waits.** Even on frequent routes, you may have to wait 10 to 15 minutes to get a bus or streetcar. On some routes, you could wait an hour or longer. And you'll wait twice if your trip requires a transfer.
- **Travelling out of direction.** Using fixed routes means staying on the bus' path, even when it's not taking the fastest way to your destination.

The Trouble With On-Demand Transit

It may seem obvious that transit would be more convenient if it were provided on-demand, precisely when and where each person wanted to travel. It would then be more like a taxi or traditional "dial-a-ride" transit.

Smartphones have raised the possibility that more transit could be this responsive, with great real-time information. Apps have made these services more responsive, so that they can be called on shorter notice.

There is an argument that transit is better when it is provided on-demand because it removes the problem of walking and traveling out of direction. It's more convenient, some might say. But that makes sense only if we don't account for the cost. The main source of operating cost for transportation (fixed route, on-demand or even local freight delivery) is the time the driver and vehicle spend on the road. Neither apps nor sophisticated dispatching software change that cost.

The costs of a fixed route are fixed, so more useful services are cheaper (per rider) to operate. KAT knows how much a bus route costs to operate, because the schedule tells us how many vehicles are needed, how many miles will be driven, for how many hours. **So the more people ride, the less expensive it becomes to provide each ride.**

In contrast, the costs of on-demand service tend to rise as more people find it useful. There is a low ceiling on how many rides per hour an on-demand vehicle can serve, even with the best possible dispatching. Imagine driving your car (or a bus) around Knoxville, picking people up and dropping them off in different places. How many times could you do this before an hour passed?

On-demand services run by public agencies generally report averages of no more than 5 boardings per vehicle per hour. Some private operators have reported as high as 9 boardings per hour in mid-sized North American cities. In contrast, all but two fixed-route bus routes in the KAT system handle 5 boardings per hour on average over a weekday. Moving fewer riders per hour means a service is more expensive per passenger.

For these reasons, demand-responsive services are never high-ridership services, when accounting for the full costs and the lack of scalability. These service may be relevant in low-demand areas, or at low demand times, like late at night, but as coverage services, where maximum ridership is not the goal.

Given the limited resources KAT has to try to serve the city, an expansion of lower frequency fixed routes to cover more areas or the use of on-demand services would both mean having to reduce service somewhere else in the existing system. If the community wants KAT to expand its coverage, then on-demand options might be suitable in some areas of the city. Use of these kinds of services will be explored in KAT Reimagined, but the basic geometric challenge of their use, the trade-offs they require, and their role should be clear from the beginning of the process.

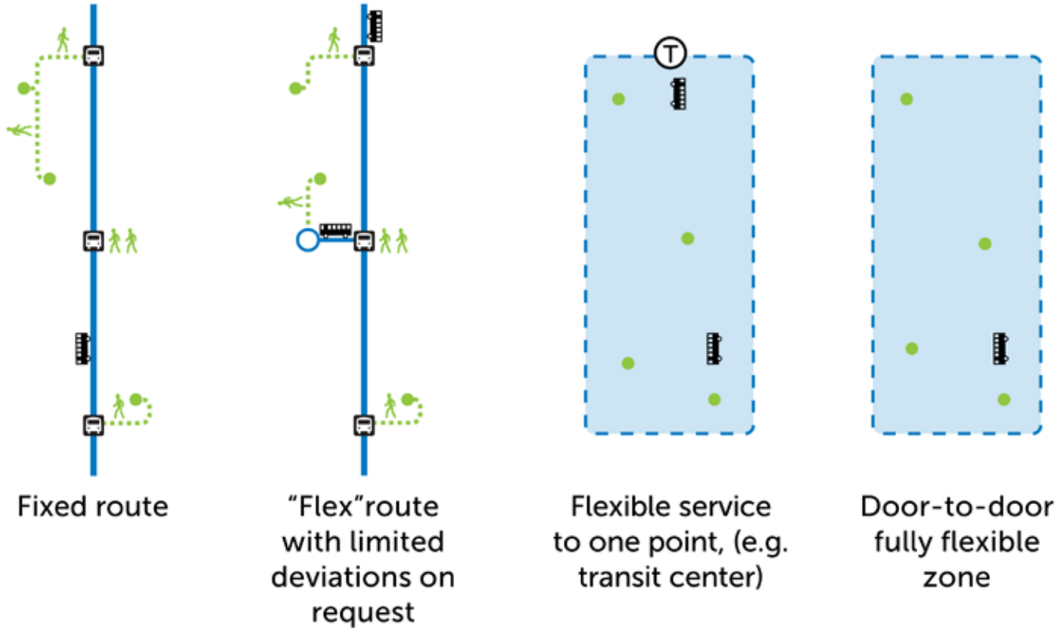


Figure 10: The spectrum of service, from a traditional fixed route to a fully on-demand service.

3 Market and Needs

Market and Needs Assessment

In this chapter, we present and discuss data that inform two different types of considerations in transit planning:

- Where are the strongest markets for transit, where ridership is likely to be high relative to cost?
- Where are there moderate or severe needs for transit, regardless of potential ridership and cost?

These two types of considerations help us design transit networks that pick a balance between the competing goals of high ridership and wide coverage.

Market Assessment

The transit market is mostly defined by **WHERE** people are, and **HOW MANY** of them are there, rather than by **WHO** they are.

On the following pages, these maps help us visualize the transit market:

- Residential density
- Job density
- Activity density (the sum of residents and jobs)
- Density of low-income residents

None of these data alone tell us that a place has high ridership potential and is therefore a strong transit market. Rather, we must consider them in combination.

If you asked a transit planner to draw you a very high-ridership bus route, that planner would look mostly at densities of all residents and jobs; at the walkability of streets and neighborhoods; and at the cost of running a bus route long enough to reach them. Only secondarily would that planner look into the income or age of those residents or workers.

However, the "who" attribute that has the strongest influence on transit ridership potential is income. This is especially true in suburban areas where driving and parking cars is so easy. Low income people are, as individuals, more likely to choose transit. That said, the density of all people—including low-income people—around a transit stop will still be the overriding factor in predicting whether that stop gets high ridership.

All else being equal, density matters more than income and age if you are trying to predict where transit will get high ridership.

This is not to say that who people are is not important. It is extremely important, especially when designing transit services to achieve a coverage goal.

Need Assessment

We learn about transit needs by examining **WHO** people are and what life situation they are in.

If you asked a transit planner to draw you a route that met as many needs as possible, that planner would look at where low income people, seniors, youth, and people with disabilities live and where they need to go.

While the densities at which these people live would matter because at higher densities a single bus stop can be useful to more people in need, the planner would still try to get the route close to even small numbers of people. In fact, the more distant and scattered people are, the more isolated they can be and the more they might need access to transit.

On the following pages, these maps help us visualize where transit needs are in Knoxville:

- Density of low-income residents
- Density of zero-vehicle households
- Density of seniors
- Density of youths

These measures cannot by themselves tell us that a person has a severe need for transit. For example, some people in a zero-vehicle household can afford to hire drivers, or rarely drive but are comfortably retired. We must consider these measures in combination to understand where in Knoxville people's needs for transit are likely to be severe.

Civil Rights

Another important set of maps in this chapter is not strictly related to need but rather to civil rights. These maps show **where people of color live**.

Unequal treatment on the basis of race, ethnicity, or national origin is prohibited by the Civil Rights Act of 1964. Regulations by the Federal Transit Administration require that KAT and the TPO consider the benefits and burdens that people of color and people in poverty experience from transit service and in the process of planning for transit and transportation projects.

While person's race or ethnicity does not tell us directly if they need transit, or if they have a propensity to use transit, we know that there is a correlation between race and ethnicity and income and wealth. If you are a person of color in the United States you are more likely to be low-income and less likely to own a car.

In addition, the historic impacts of segregation and discrimination have had long lasting effects on the patterns of housing, development, and investment across the region.

Therefore, knowing where people of color live helps us see where there are intersections between patterns of historic segregation and concentrations of people in poverty today. Providing affordable transportation options for low-income communities and communities of color is an important strategy in addressing economic insecurity, and may be an important goal, more broadly, for addressing racial and social equity goals that the community may have.

Seeing where people of color live helps to see how much of the population lives in places that are dense, linear, and proximate, and would therefore be well served by a high ridership network design. It also helps us see neighborhoods that are predominately people of color that are not dense, linear, or proximate and would therefore be relatively expensive to serve, but might be important to serve to achieve a coverage goal.

It is also important to understand where large numbers of people of color, people in poverty, and other historically-marginalized populations live so that public outreach during this project can maximize opportunities for participation for those historically vulnerable communities that have not traditionally participated in the transportation planning process. This requires being sensitive to language and cultural barriers to participation and offers an opportunity for historically vulnerable communities to share their perspective and voice in the contemplation of service changes and how those service changes have an impact on their community.

Market: Residential Density

While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at home on most days. Further, places with many households are also destinations for other people, whether for visiting, worship, caring for family or home-based work.

Figure 11 shows that Knoxville has a dense core, mostly in Downtown and Fort Sanders. This area has a traditional development pattern, with a grid-oriented street pattern so it is easy to serve by transit. This is surrounded by some residential neighborhoods which have a similar grid pattern and small lot sizes. These include, for example, neighborhoods like Western Heights, Oakwood, and Five Points. South Knoxville also has a high residential density.

Farther away form the core, there are some areas that are quite dense but they have development patterns that are harder to serve. These are places have street patterns that are looping and disconnected. This includes places along Middlebrook Pike and Westland Drive to the west.

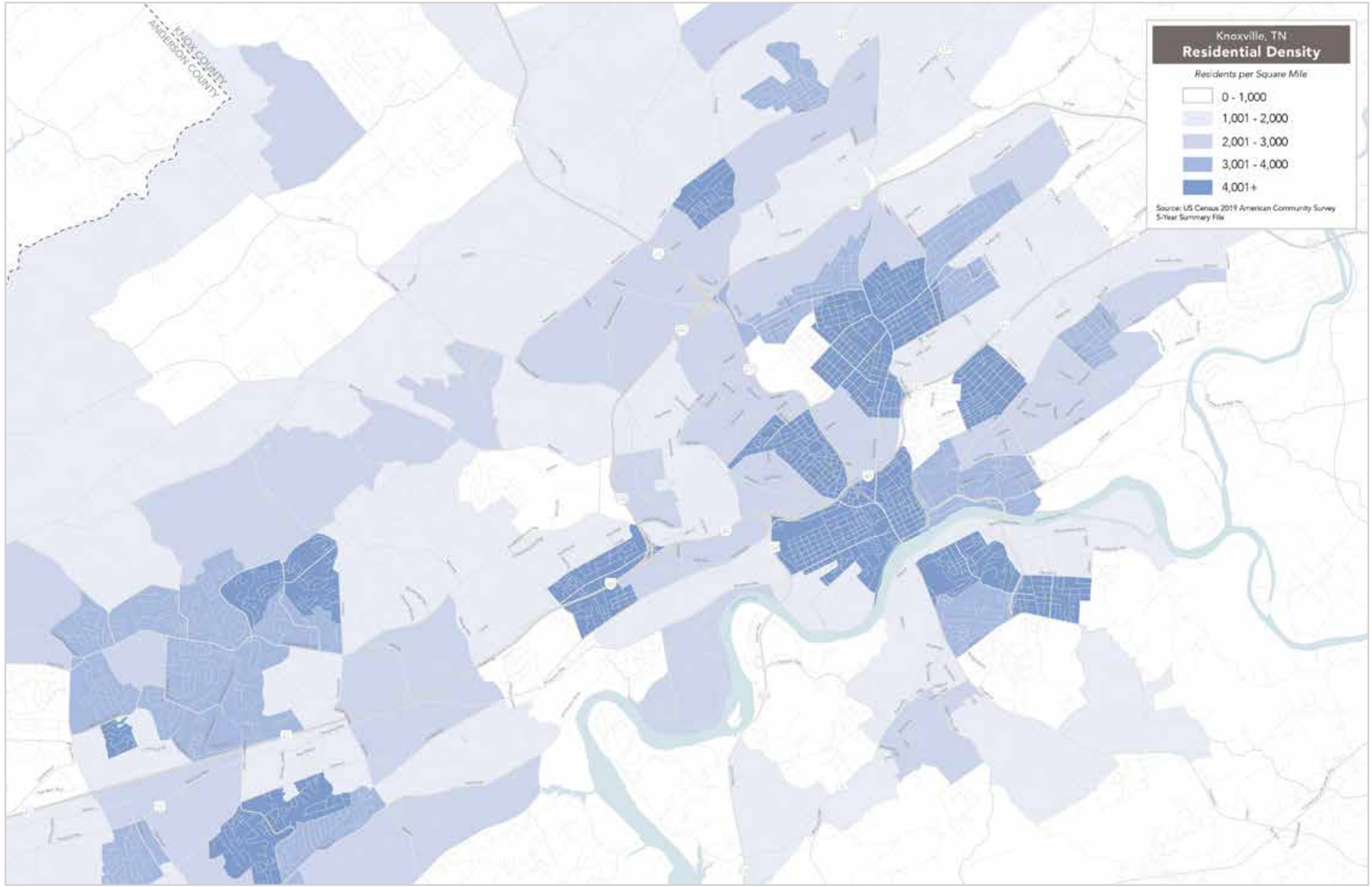


Figure 11: Residential density in the KAT service area.

Market: Job Density

A map of job density shows us not only the places people travel for work, but also places people go for services, shopping, community, health care, and more.

A person's workplace may be, throughout the day, a destination for dozens or even hundreds of people. For this reason, job density is typically an even better predictor of transit ridership than residential density.

In Knoxville, most jobs are concentrated in the core and along certain corridors. There are many jobs from the core to the north along Broadway. To the west, the dense job patterns follow Sutherland Avenue and Kingston Pike. There are also a lot of jobs along Middlebrook Pike and Clinton Highway. The UT Medical Center south of the river also has relatively high job density.

There is a stark pattern of the relatively long Kingston Pike corridor to the southwest of downtown, with job density relatively high along the entire length on this map, a distance of about 15 miles. In contrast, the corridor of job density radiating to the northwest along Central Avenue Pike and I-75 extends only about 7 miles out to Emory Road. Even more stark is the paucity of job density to the northeast of downtown, with only the industrial and commercial corridor along the Norfolk Southern Railway and I-40 showing up as relatively low density job corridor stretching less than seven miles from downtown.

The unbalanced development pattern means there is a significant proximity challenge to serving jobs farther out on the Kingston Pike corridor. While the frequency of service could be increased, the distance imparts a natural cost in the time it will take any transit vehicle to serve all the jobs on that corridor relative to others.

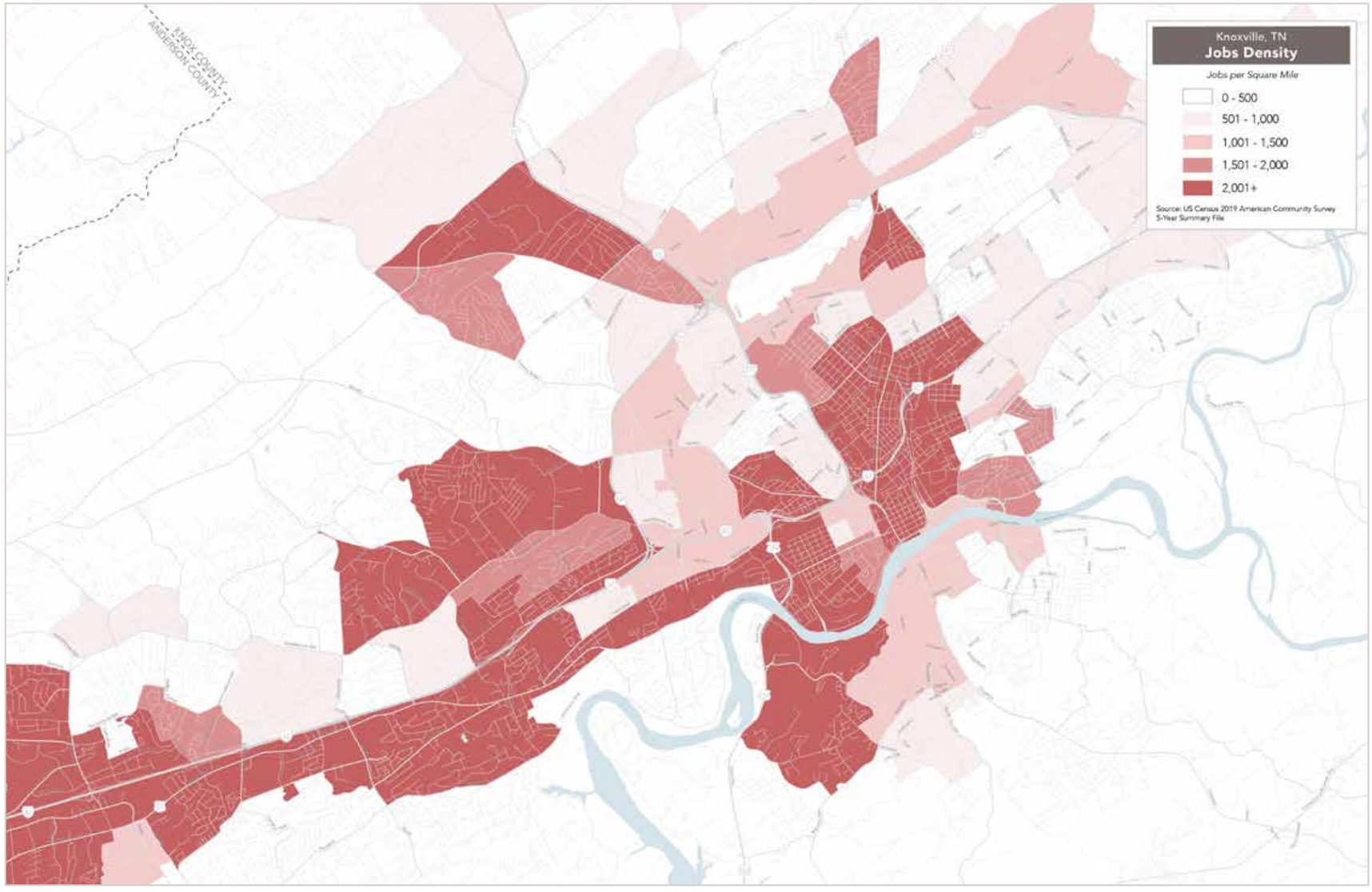


Figure 12: Employment density in the KAT service area.

Market: Activity Density

Resident and jobs density are both critical measures of a place's potential transit market relative to other parts of the service area. Those two measures can be combined in a single map that shows the activity density - the density of both jobs and residents. Activity density helps visualize the overall potential transit market of an area. The map on the right shows activity density in Knoxville.

Places with more residential density are shown in increasingly brighter shades of blue; areas of high employment density, in brighter shades of yellow. The areas shown with increasing shades of red are places where there are high densities of both jobs and residents, and where there is likely to be a strong market for travel for most or all of the day.

The mix of uses along a corridor affects how much ridership transit can achieve, relative to cost. This is because an area with a mix of housing, retail, services and jobs tends to generate more even demand for transit in both directions, throughout the day. Transit serving purely residential neighborhoods tends to be used in mostly one direction and mostly during rush hours—as residents leave in the morning, and return in the evening.

Large medical centers are often sources of all-day all-direction transit demand, because of how visitation and appointments are scheduled. Universities are also often sources of all-day all-direction transit demand. This is partly because they are dense with jobs and housing. It also relates to the type of "job" done there: students and staff come and go depending on their class schedules, from morning through the evening.

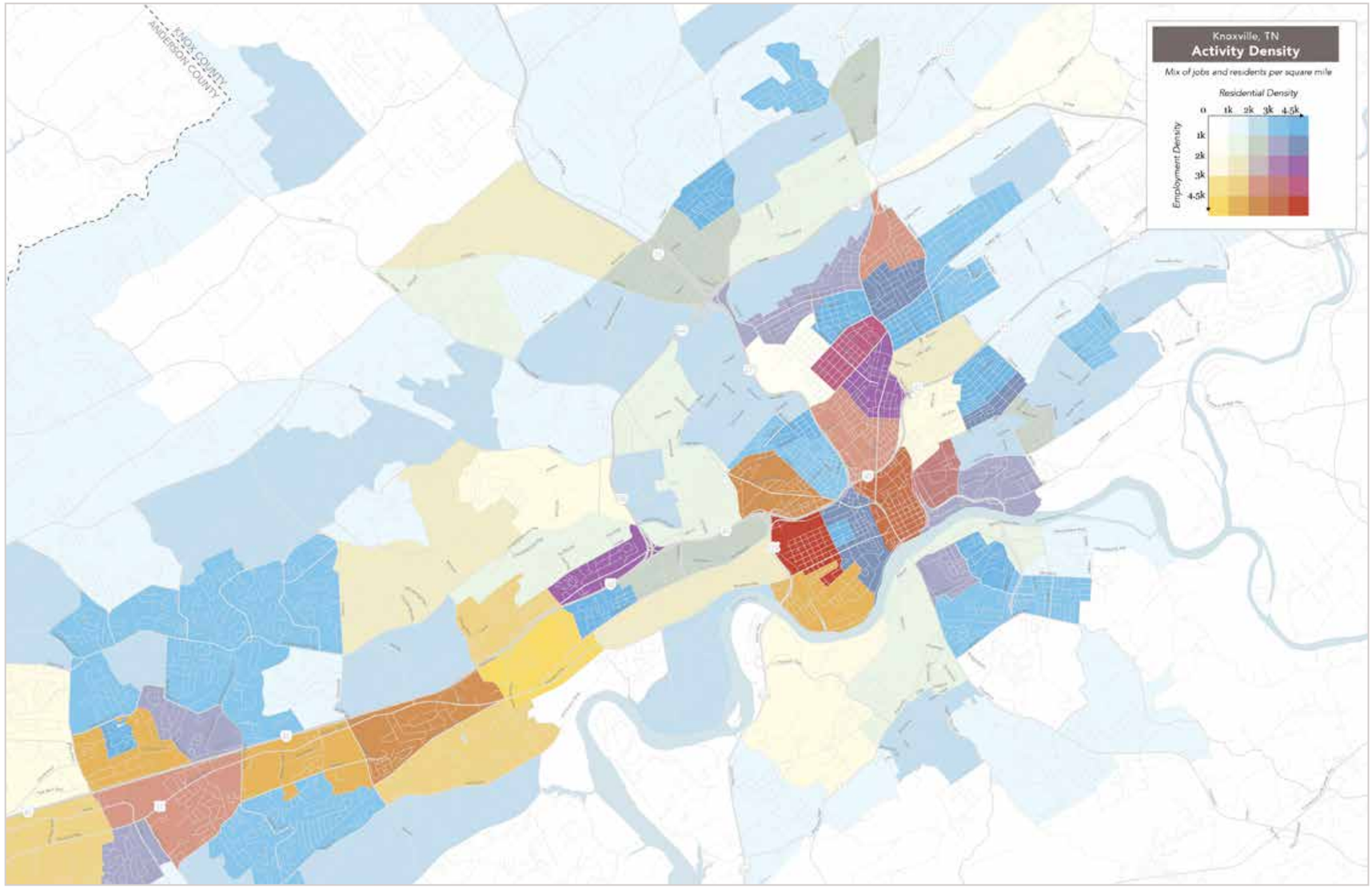


Figure 13: Activity density in the KAT service area.

Market: Walkability

In almost all cases, transit trips begin and end by walking. Therefore, the ability to walk to transit is very important. The street pattern determines how much of the area around a stop is truly within a short walking distance.

Areas with highly-connected street patterns provide short and direct path between any two locations. Areas with poorly-connected street patterns, often in "walled garden" developments, forces long and circuitous paths between locations and discourages walking. Low street connectivity tends to be accompanied by wide, fast arterial streets, because the few through-streets that exist have to handle all of the area's car traffic. A lack of sidewalks and safe crossings of major streets can also mean that fewer people and jobs are within a short walk of transit because people may have to walk further and less directly to cross the street to reach a bus stop.

For these reasons, walking distances to and from bus stops can far exceed "flying" distances. The map on the right shows the proportion of area within a half-mile radius of locations that is accessible through the street grid in that location. Darker areas correspond to contiguous grid-like layouts, while lighter areas represent barriers to walkability, including restrictive street patterns. In some cases the lack of street connectivity and limited walkability is a combination of both development pattern and natural topography that limits the ability to create more connected street networks.

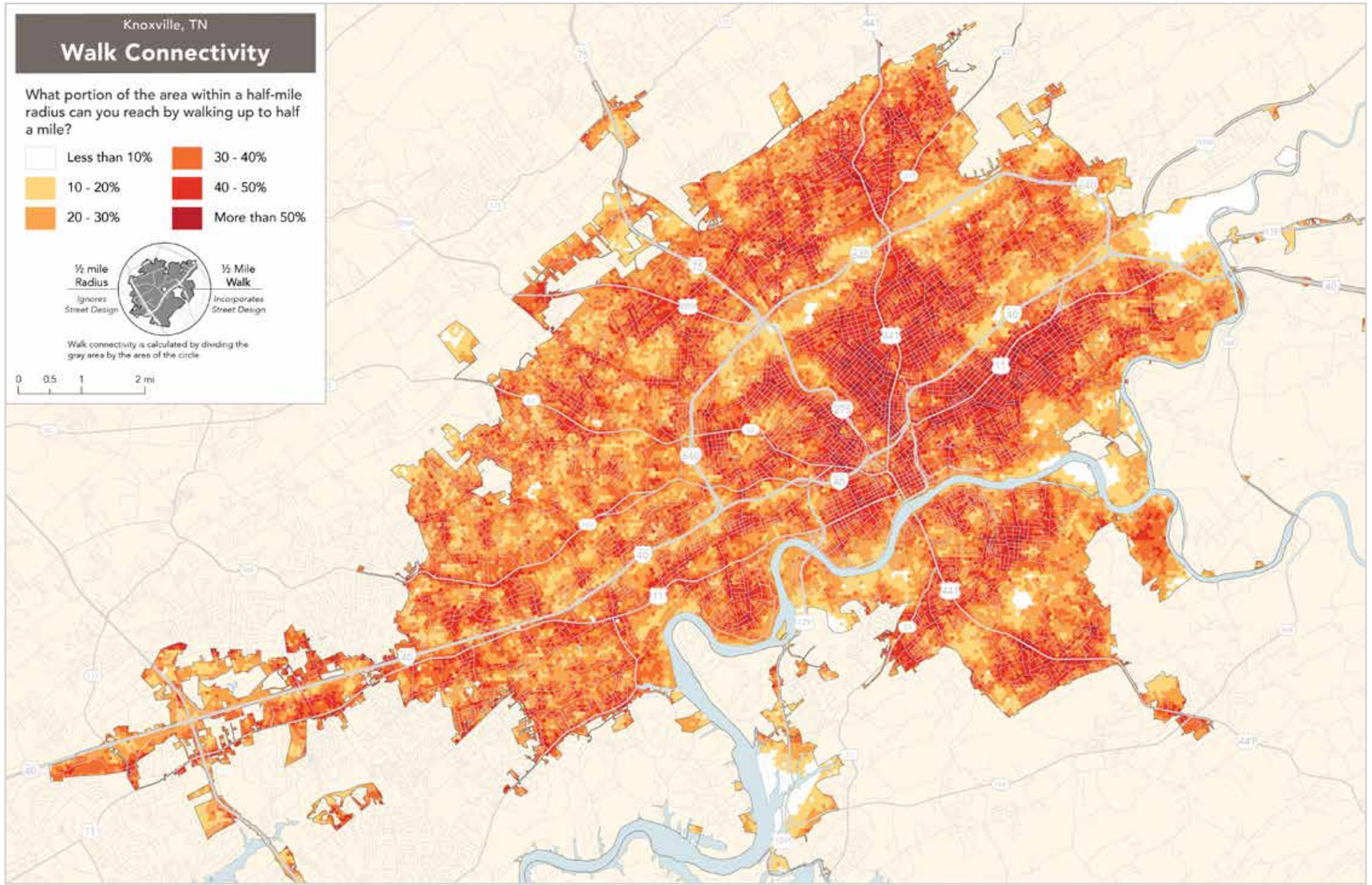


Figure 14: Walk connectivity in the KAT service area.

Examples of Density and Walkability

High Density & High Walkability

Fort Sanders is among the densest parts in the region. Adjacent to downtown and the University of Tennessee, the neighborhood is dense with students and other residents, retailers and restaurants, and multiple regional hospitals. Thus it features both, many jobs and many residents. It features a traditional street grid, many street crossings, and sidewalks on most streets, making it one of the most walkable areas of the city.

High Density & Low Walkability

The UT Medical Hospital is located across the Tennessee River from the main UT-Knoxville campus and with nothing else nearby. It sits off Alcoa Highway, a freeway like facility surrounded by a sea of parking. The hospital and associated UT buildings nearby have a very high density of jobs, but the facility and its layout is not walkable. Transit serving this facility is limited to only serving it, as no other destinations or uses are nearby.

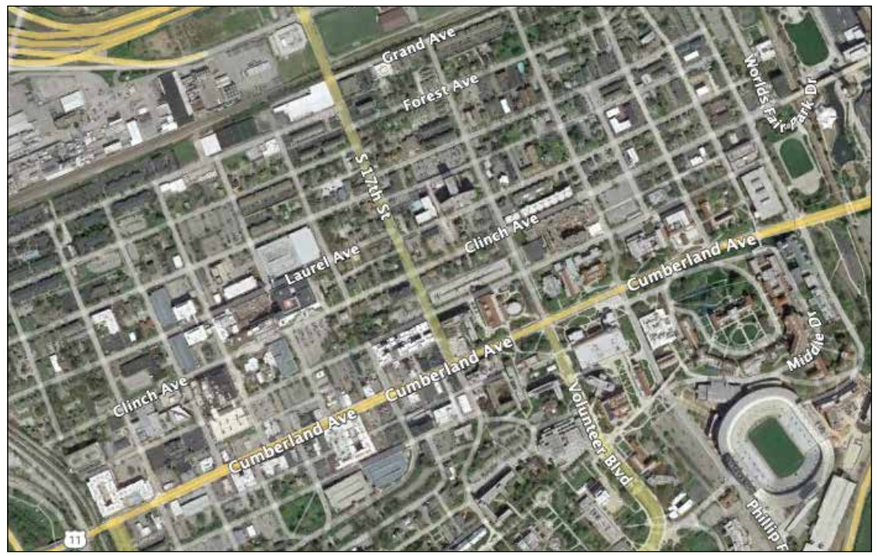
Low Density & High Walkability

Edgewood is a very walkable neighborhood with a gridded street network about 3 miles from downtown Knoxville. Due to being primarily single family housing with few businesses, it has a much lower density, and therefore lower ridership potential, compared to a place like Fort Sanders. Nevertheless, the highly walkable layout means it can more easily become a transit-oriented place than the UT Medical Center.

Low Density & Low Walkability

Most neighborhoods farther away from Downtown Knoxville were built with large lots with the presumption that most people would drive. Forest Brook off of North Shore Drive is an example of typical auto-oriented, single family residential areas with low street connectivity. These kinds of neighborhoods have very low transit ridership potential.

Fort Sanders
High Density & High Walkability



UT Medical Center
High Density & Low Walkability

Edgewood
Low Density & High Walkability

Forest Brook
Low Density & Low Walkability

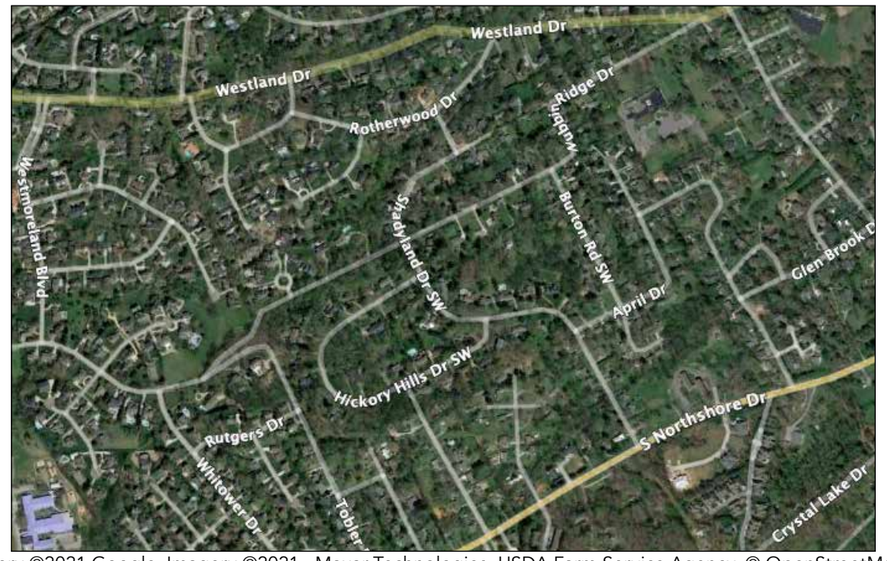


Figure 15: Examples of Density and Walkability in the region.

Market: Commute Patterns

Looking at how people are travelling today can tell us a lot about demand. The map on the right shows the number of people travelling today between any two census tracts using KAT service. A line is darker and thicker when there are more trips there are between the two points. Bigger dots also indicate more trips to or from that census tract.

Looking at this map, it is clear that Downtown is the largest destination or origin place for riders. The census tract that includes Downtown has the biggest dot and the thickest lines indicating that it has the most trips.

However, there also other places that have many trips. Thick lines that don't go Downtown show the importance of having an interconnected network. For example, there are many trips from Old North Knoxville and surrounding areas to Cedar Bluff in the far southwest part of Knoxville.

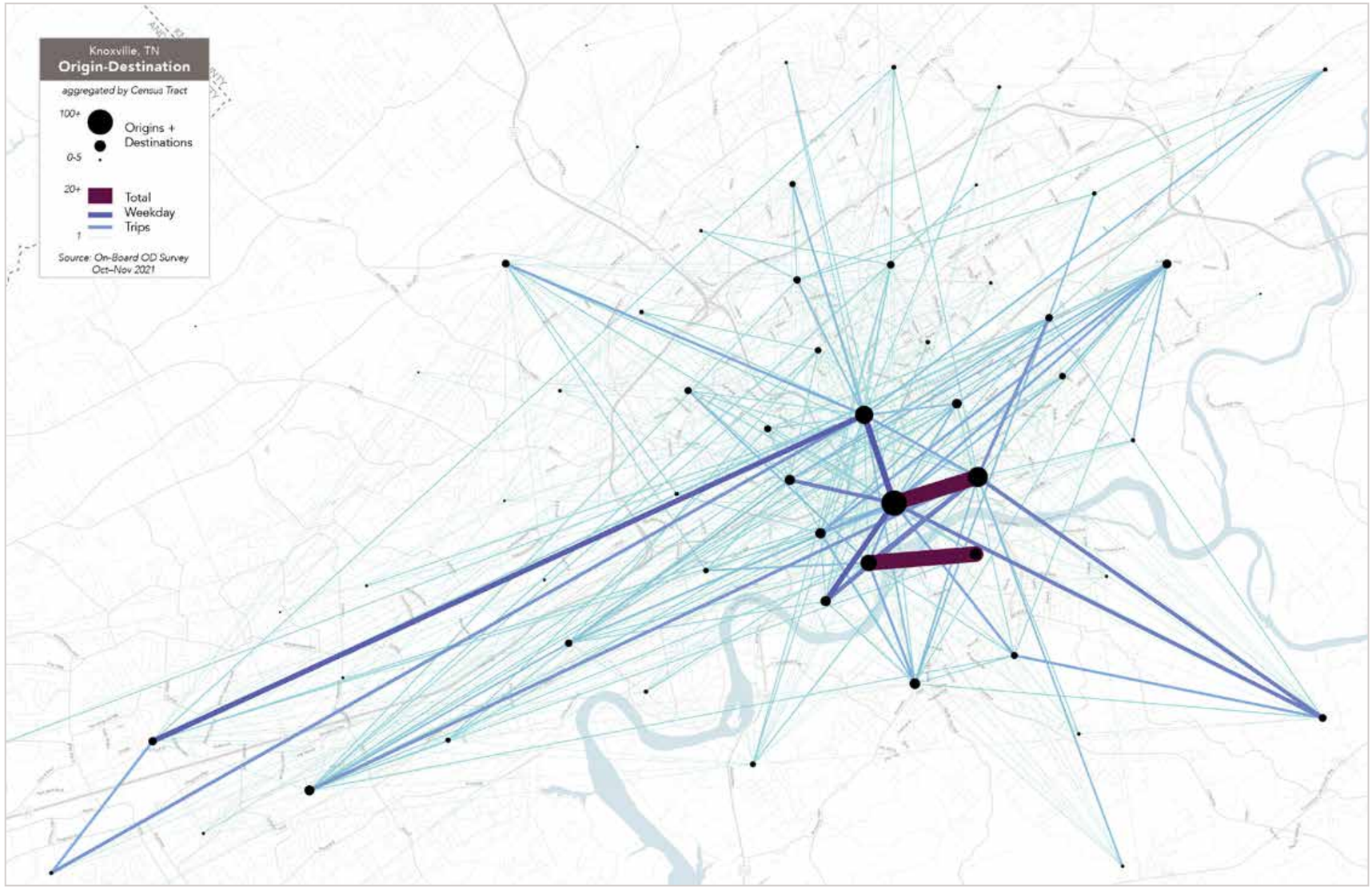


Figure 16: Commute patterns in the KAT service area.

Market & Need: Low-Income Residents

A frequently-cited goal for transit service is to provide affordable transportation for lower-income people, who are less likely to own cars. Understanding where low-income populations are located is also a key civil rights requirement.

Transit can be an attractive option for low-income people due to its low price. In medium to high density areas with walkable street networks, this can produce high ridership.

However, if transit doesn't actually allow people to make the trips they need in a reasonable amount of time, even lower-income people will not use it. They will seek other options, such as buying a used car or getting a ride from a friend, even if it causes financial or social stress.

The map on the right shows the density of residents with family incomes below the federal poverty level in Knoxville. Areas that stand out as having relatively high densities of people in poverty include,

- Much of East Knoxville including Parkridge, Morningside, Park City, Five Points and surrounding neighborhoods.
- Many areas north of downtown including Old North Knoxville, Belle Morris, and Lincoln Park.
- Neighborhoods to the northwest of downtown like Mechanicsville, Western Heights, and Lonsdale.
- West of downtown, Fort Sanders, the areas along Sutherland Pike from Concord Street to Highland Memorial Cemetery.
- Farther west there are additional pockets with concentrations of people in poverty often associated with individual apartment complexes in low walkability areas.

Figure 17: Density of residents below the federal poverty level in the KAT service area.

- South of downtown, across the river, around Davenport Road.

The pockets of poverty in Fort Sanders and south of downtown likely includes many University students. For many students, this type of poverty is a temporary circumstance, and while their independent income may be low or negligible, their spending power is likely higher due to family support. Nevertheless, university students are often likely to use transit on account of their low incomes.

Market & Need: Households without Cars

Another factor affecting transit's competitiveness and need in an area is the availability of personal cars. People in households without vehicles are not necessarily "transit-dependent" but do have a greater inclination toward transit use because they don't have a car in their driveway, always ready to go. Generally, people without vehicles have fewer options than those who do have access to personal cars. So if transit is a useful—reasonably fast, reliable, available when needed—and people can use it to reach the places they need to go, it can be a compelling option.

If transit does not present a realistic travel option, then people without cars will find other ways to reach the places they need to go, by getting rides from friends or family members, cycling, using electric scooters, walking, or using taxis or TNCs. Alternatively, some people may not travel, thereby limiting their access to the economic, social, and other opportunities in the region.

The map on the right shows the density of households without cars in Knoxville. Note that this map shows households, not individual residents like the previous demographic maps. There are corridors with a high concentration of household without vehicles that closely correspond to people in poverty.

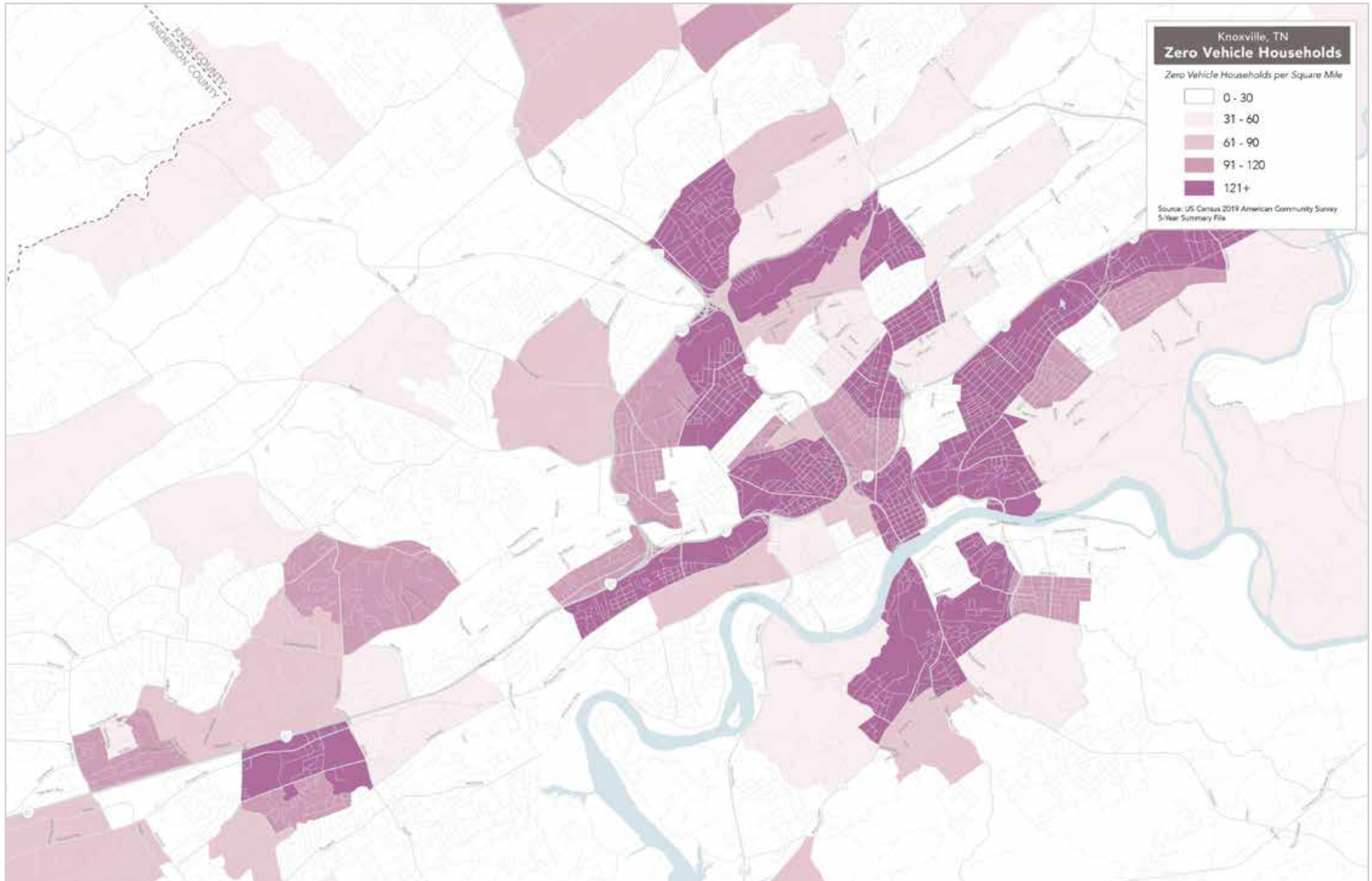


Figure 18: Density of households without cars in the KAT service area.

Need: Seniors

Seniors (persons age 65 and above) are an important constituency for transit because a major value of transit coverage is providing service for people who cannot drive, no matter where they live.

Some seniors cannot drive and may be more likely to use transit. And as a group, senior-headed households are less likely to own cars than the general population.

Seniors tend to have different preferences for transit than younger people. Seniors are more likely to be sensitive to walking distance. On average, seniors also tend to be less sensitive to long waits and slow or indirect routes, because many are retired and have relatively flexible schedules. Most riders who are employed, in school or caring for kids in school will find service with long waits and slow or indirect routes to be intolerable.

Due to these factors, transit service designed primarily to meet the needs of seniors rarely attracts high overall ridership relative to cost. **Thus, the amount of focus that transit agencies place on meeting the needs of seniors should be carefully balanced with the needs and desires of the rest of the community.**

The map on the right shows the density of senior residents in Knoxville. The density of seniors is generally higher in East Knoxville and is particularly high in Belle Morris. The density of seniors is also high in Sequoyah Hills, along Gleason Drive, and many neighborhoods along Middlebrook Pike in western Knoxville.

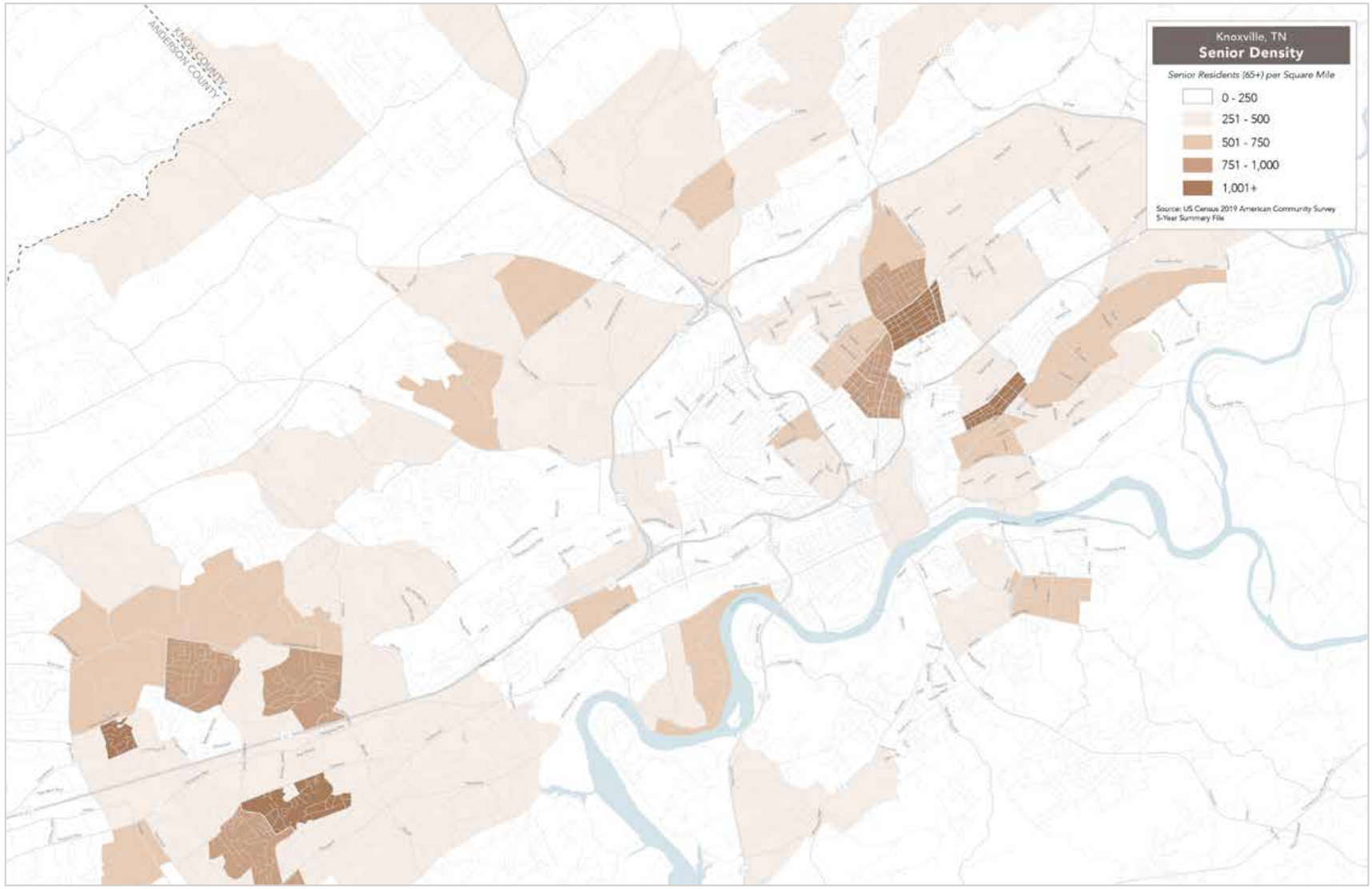


Figure 19: Density of senior residents in the KAT service area.

Need: Youth

Just as transit coverage can meet the needs of seniors who cannot or choose not to drive, transit coverage can also meet the needs of children and teenagers who are too young to drive.

The map on the right shows the density of residents under the age of 18 in Knoxville. Young residents are scattered all over the city, and their distribution tends to follow in areas that have a higher overall residential density.

Young people are like seniors in that they often live on a tighter budget than people of working age. For this reason, both are very sensitive to transit fares, and parents are sensitive to paying a fare for each child.

However, young people and seniors are very different in their ability and willingness to walk to transit service. Most young people can and will walk farther to reach service than seniors. Whatever effect an increase in price has on ridership among working age people, it will have an even stronger effect on ridership among young and old people. (This is why most transit agencies, along with movie theaters and other for-profit businesses, offer a discounted price for seniors and children.)

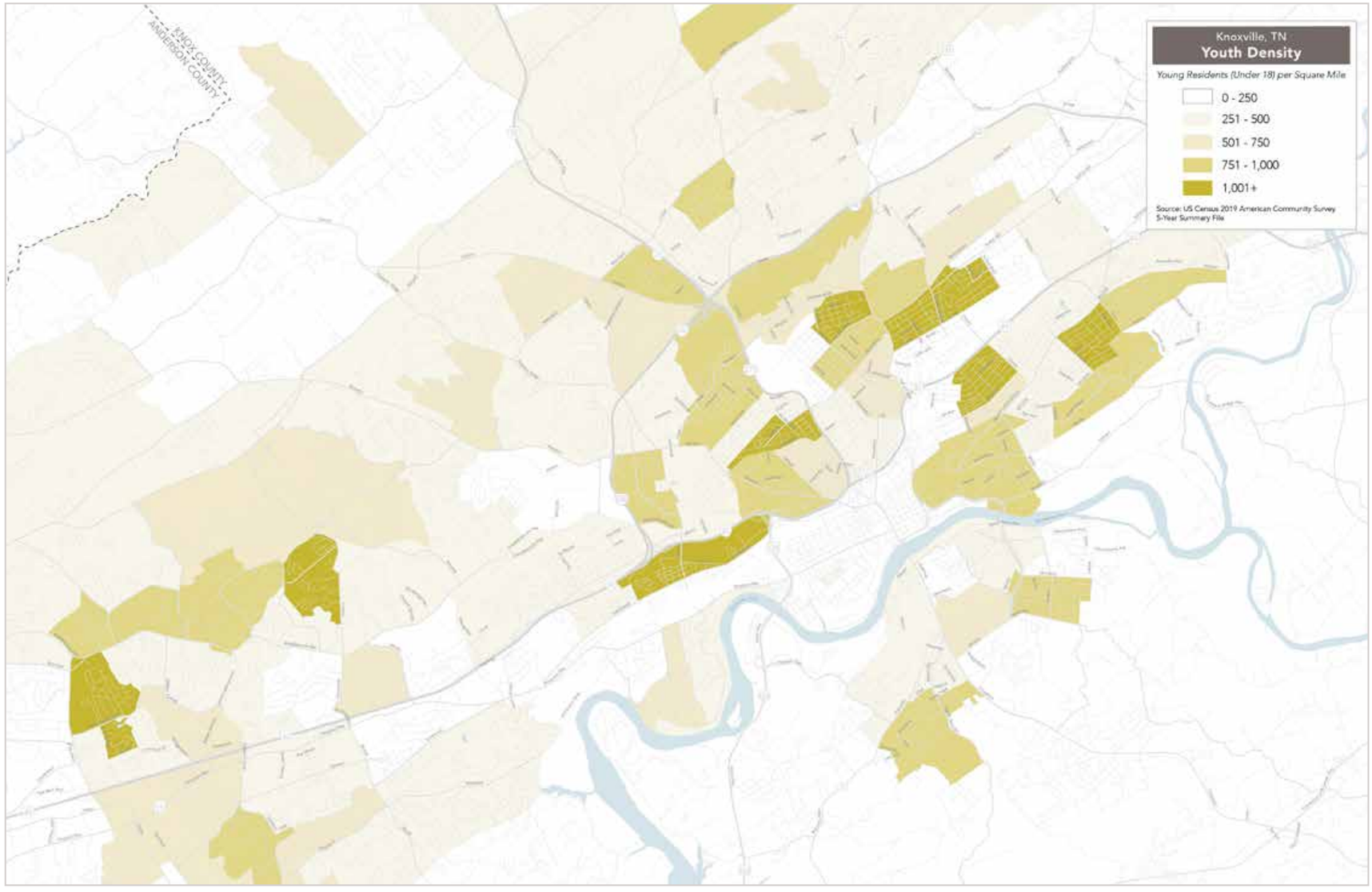


Figure 20: Youth density in the KAT service area.

Civil Rights: People of Color

While information about people's income tells us something about their potential interest in or need for transit, information about ethnicity or race do not alone tell us how likely someone is to use transit.

However, avoiding placing disproportionate burdens on people of color, through transportation decisions, is essential to the transit planning process. Transit agencies are also required by Title VI of the Civil Rights Act of 1964 to ensure that services they provide do not discriminate on the basis of race, color or national origin.

Equity-based transit goals are often articulated in terms of improving mobility or transit access for people of color, particularly in places where the existing development patterns and transportation network contribute to disparities in access to jobs and other opportunities.

The map on the right shows the distribution of people by race and ethnicity in Knoxville. Each dot represents 100 residents. Where many dots are very close together, the overall density of residents is higher. Where dots of a single color predominate, people of a particular race or ethnicity make up most of that area's residents.

The area near the University of Tennessee has a mixture of racial and ethnic groups. Some areas to the north and east of Downtown, regardless of density, are predominantly African-American. Hispanic residents appear more concentrated in inner neighborhoods closer to downtown. The Asian population appears slightly more concentrated on the western side of the city.

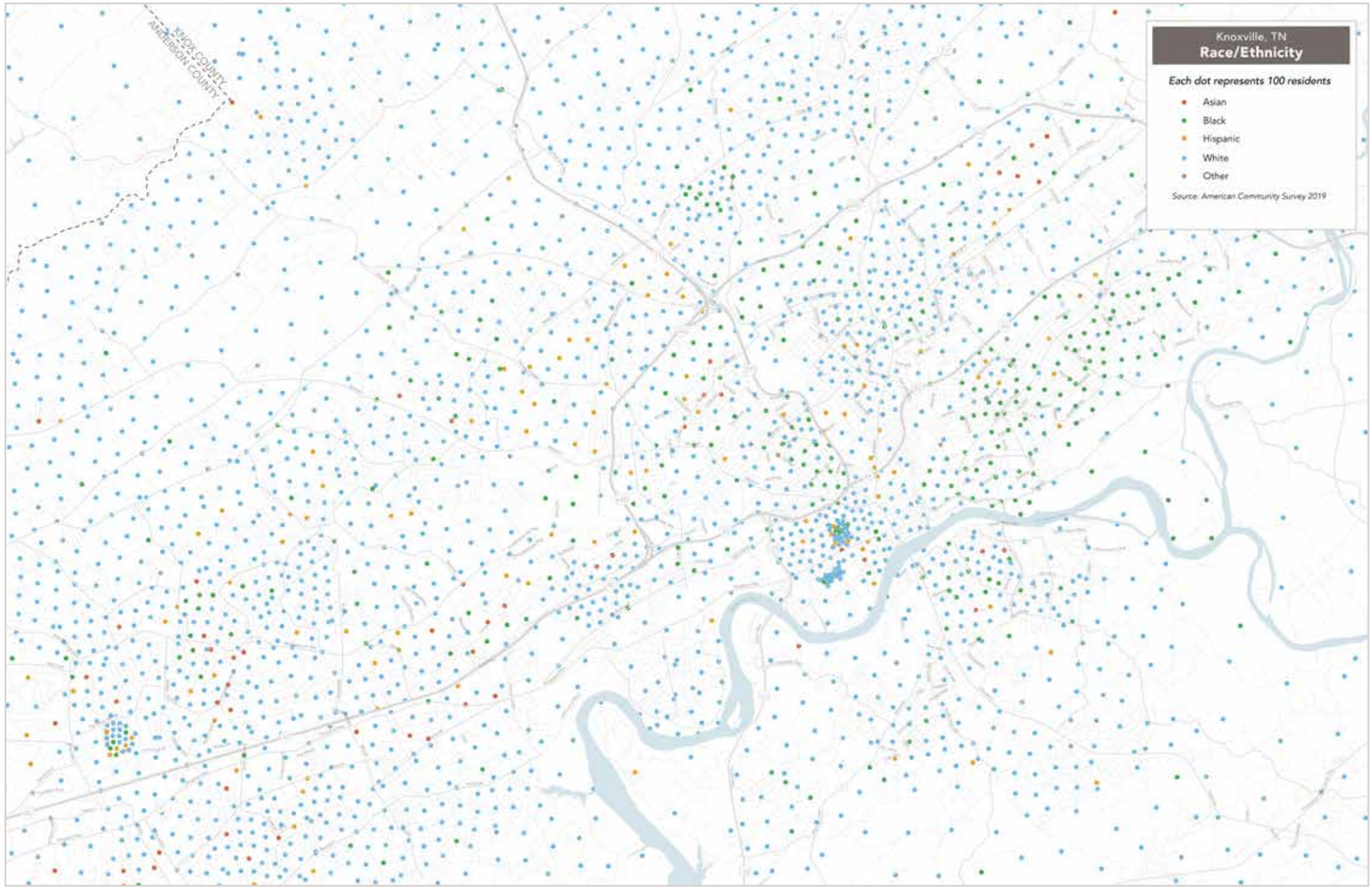


Figure 21: Racial and ethnic distribution in the KAT service area.

4 Existing Transit Network

Where is useful transit available today?

In transit conversations, there is always a great focus on **WHERE** transit is provided. Sometimes not enough attention is paid to when it is provided. The **WHEN** of transit service is:

- **Frequency** or **headway:** How many minutes are there between each bus? How long of a wait is required?
- **Span** or **duration:** How many hours of the day is service running? Does it run on weekends?

Low frequencies and short spans are one of the main reasons that transit fails to be useful because it means service is simply not there when the customer needs to travel.

Frequent service:

- reduces waiting time (and thus overall travel time),
- improves reliability for the customer because if something happens to your bus another one is always coming soon,
- makes transit service more legible by reducing the need to consult a schedule, and
- makes transferring (between two frequent services) fast and reliable.

The routes in these maps are color coded by their frequency during midday on a regular weekday.

Darker colors represent routes which run more frequently. **Dark Red** represents routes running every 10 minutes, **Bright Red** represents routes that run every 15 minutes, **Purple** represents routes that run every 20 minutes, **Dark Blue** every 30 minutes, and the **Light Green** represents headways of 60 minutes.

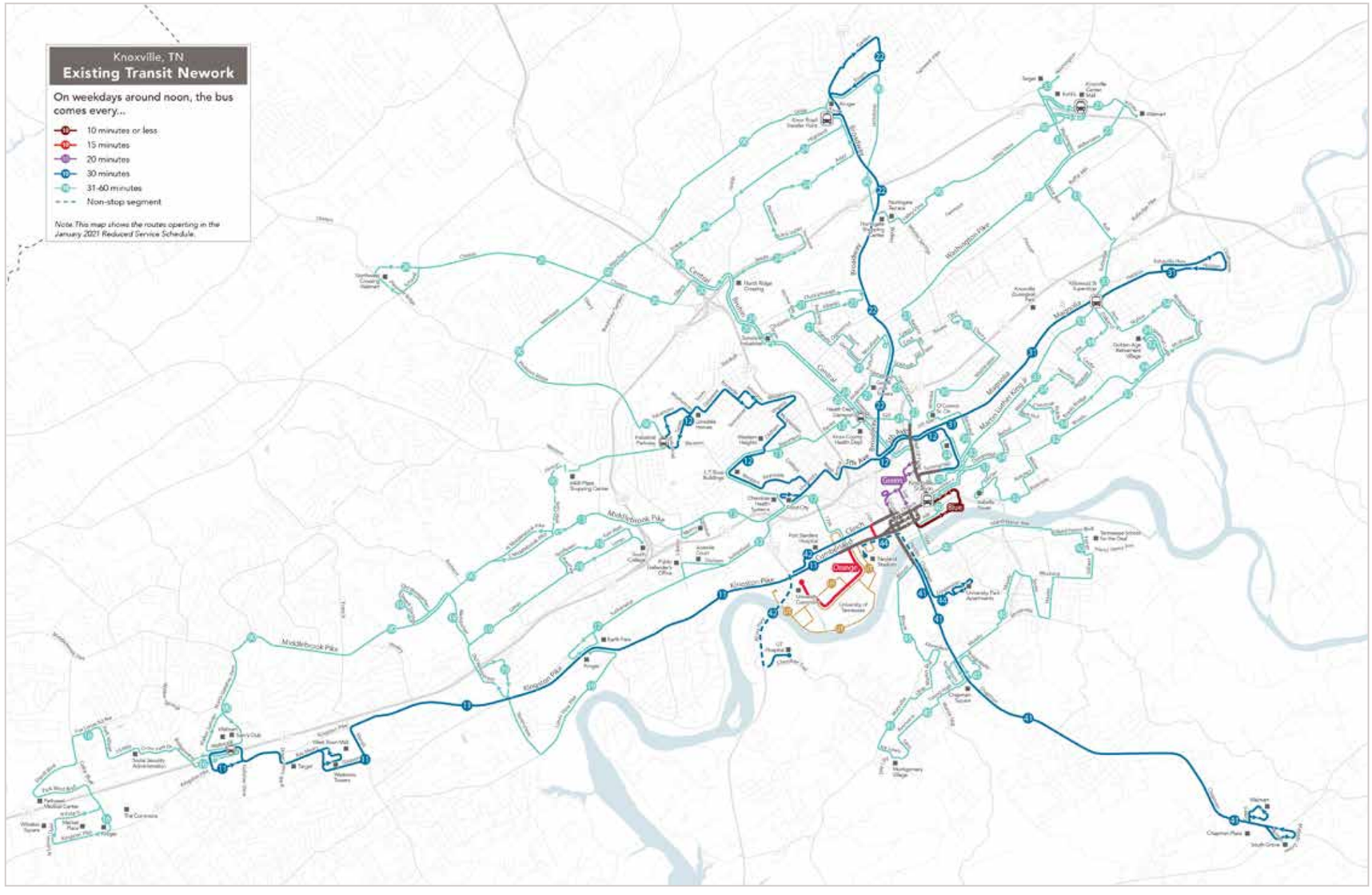


Figure 22: Existing KAT transit service (reduced service).

Pre-Covid Network

KAT is currently providing reduced service levels as shown on the map on page 31. The map on the right shows the service that was provided prior to Covid-19.

The ridership data shown on upcoming pag-espage 36 andpage 37, was collected in Fall 2021. Therefore, in analyzing that data, we are comparing the performance of routes based on their frequency on the map on page 31.

However, the rest of the analysis in this report was done using the Pre-Covid Network. This includes the proximity to transit analysis on page 35, access to jobs analysis start-ing on page 38. This Pre-Covid network is also the baseline assumption for what the network would look like in the future if KAT was not looking at changes through this KAT Reimagined process.

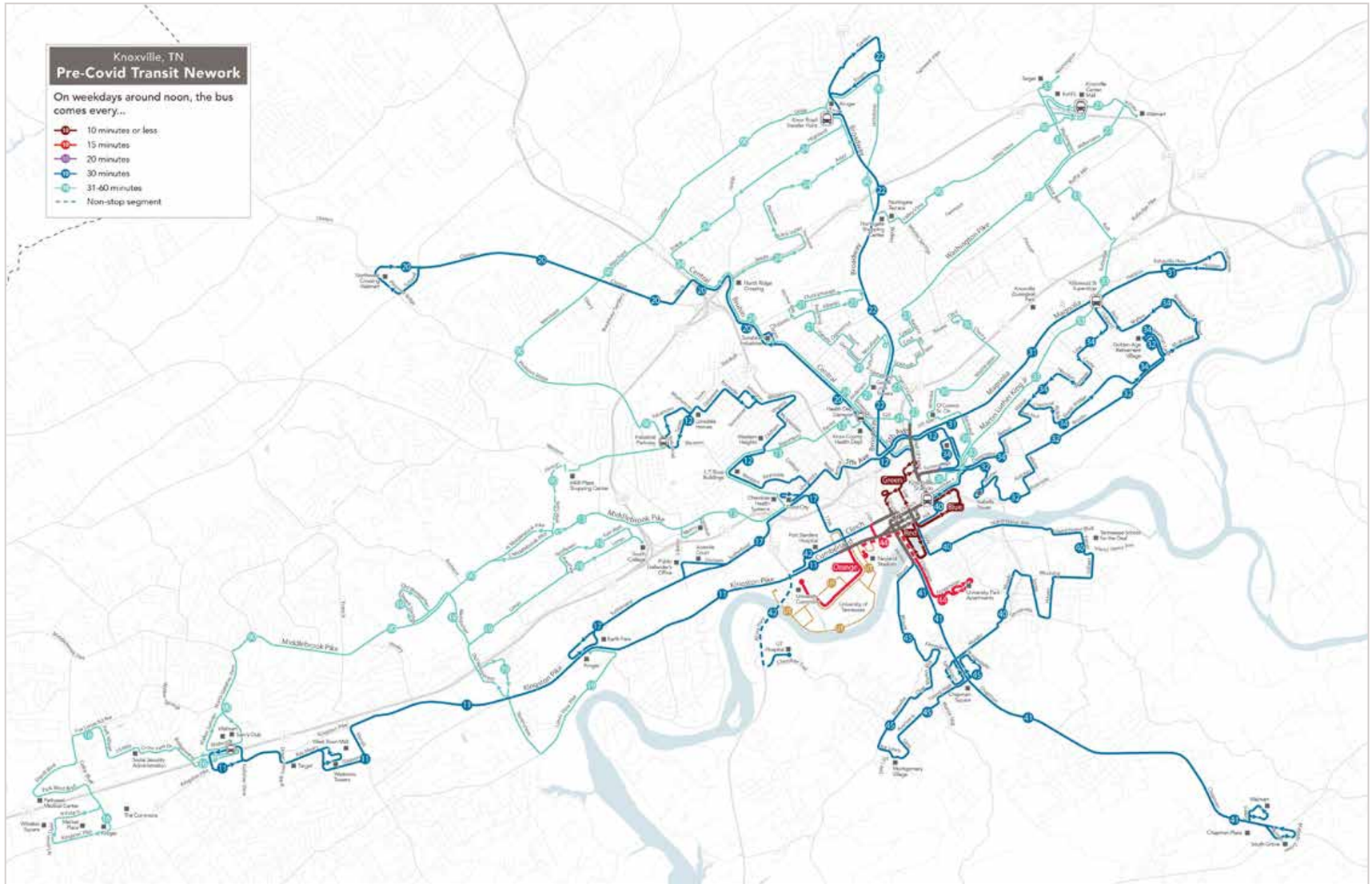


Figure 23: Pre-Covid KAT transit service.

When is service available?

The table on the right summarizes each route's **frequency** (how often a bus on the route comes) and **span** of service (what days and what durations the route operates). Each hour a route operates is shown by a single block, colored roughly according to the frequency offered in that period. From left to right, the columns of blocks show service for each route during weekdays, Saturdays, and Sundays, respectively.

Less Service on Weekends, Especially Sundays

Similar to the network maps earlier, the span-frequency chart in Figure 24 shows how KAT service consists of three frequent trolley routes, seven 30-minute routes and the rest are 60-minute routes.

For most routes, the frequency is consistent throughout the day. Route 10 is the only peak-only service provided, and Route 22 has more runs during the peaks, particularly the evening peak.

On Saturdays, the frequency of Route 44 declines to 60 minutes, and Routes 13 and 44 do not run at all. On Sundays, only ten routes run, all with a frequency of 60 minutes. The trolleys run on Saturdays but not Sundays.

Most routes start around 6am in the morning, but in the evening, spans are inconsistent. This adds some complexity that might discourage some riders.

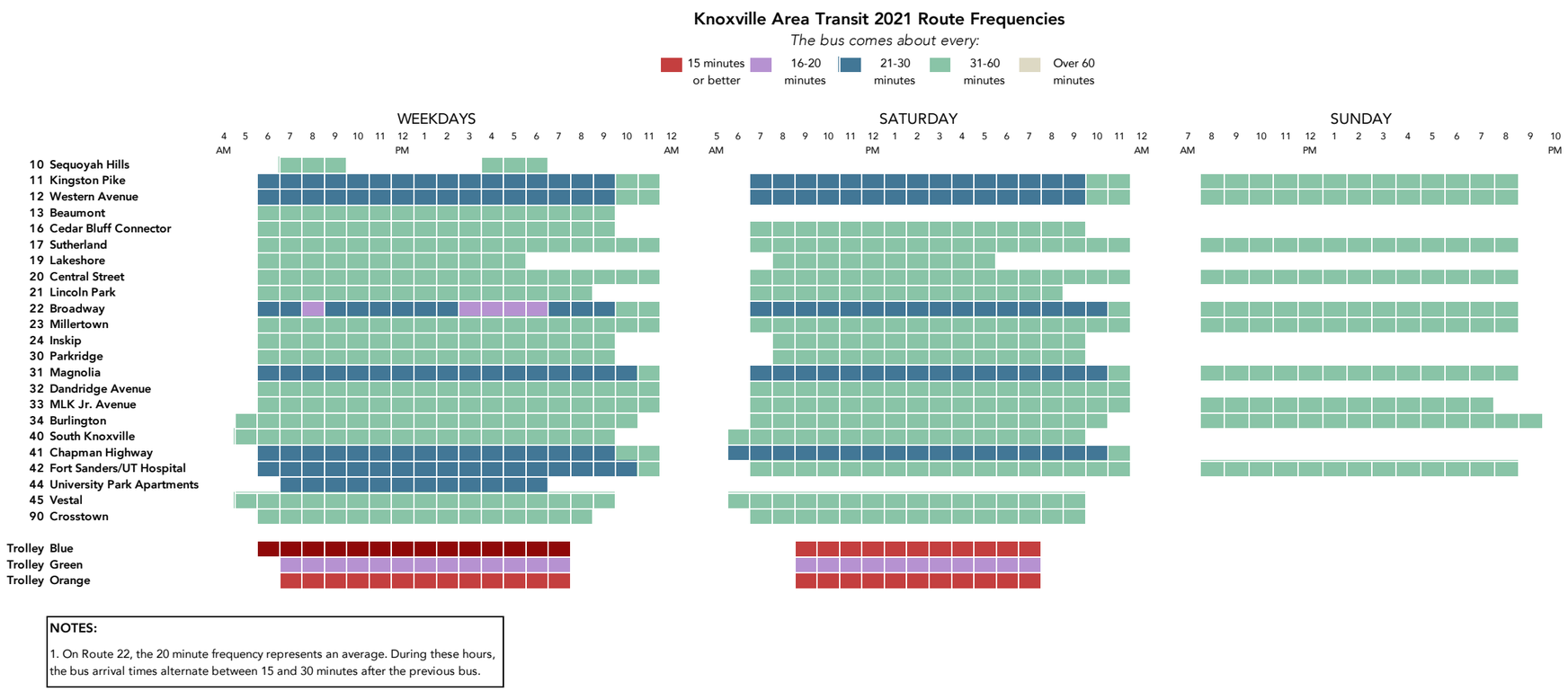


Figure 24: Spans and frequencies for all existing KAT routes.

Low frequencies on Saturdays and the limited service on Sundays make it less likely for transit to be useful for many retail and service sector workers.

Pre-Covid Span of Service

The chart on the right, shows the service level provided before Covid-19. You can clearly see that some routes that are running every 60 minutes today were running every 30 minutes before the pandemic. The trolleys also had higher frequencies before Covid. Even so, the Pre-Covid network still had very limited Sunday service and inconsistent evening service.

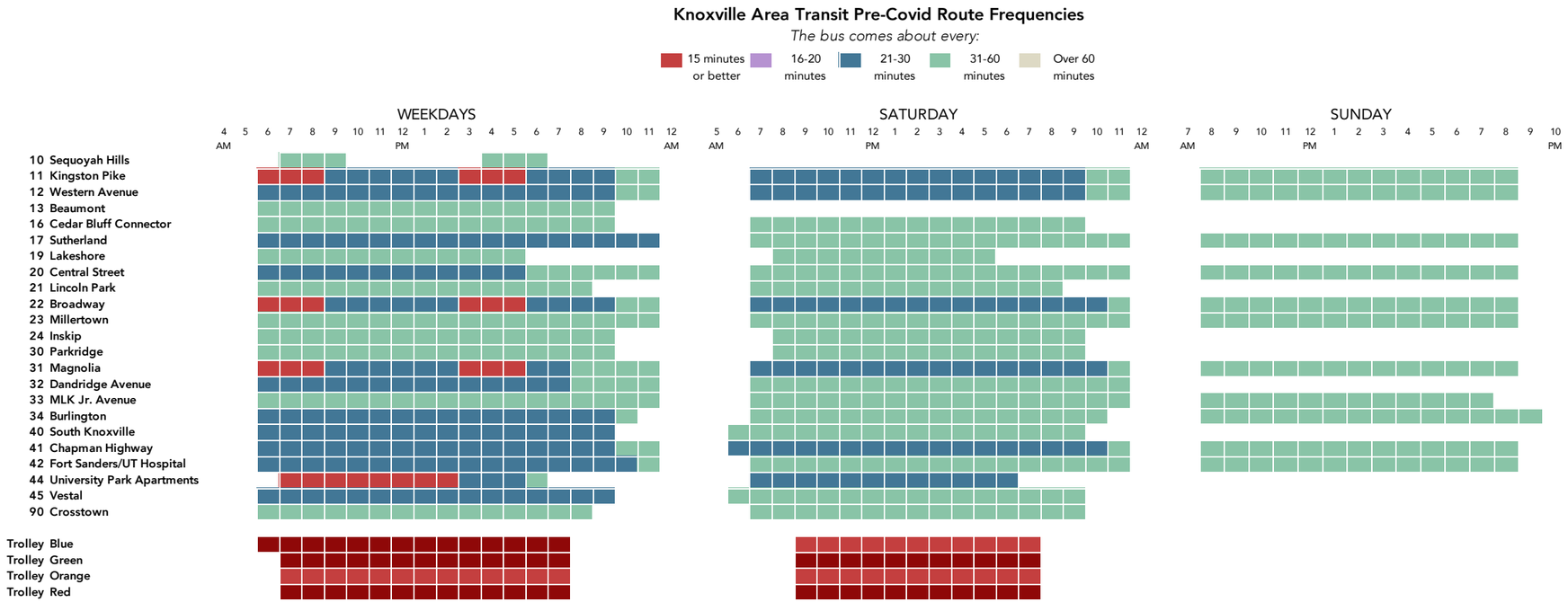


Figure 25: Spans and frequencies for all KAT routes before Covid-19.

How many people are near transit?

Coverage goals for transit are served when transit is available to people, whether or not they ride it in large numbers. Figure 26 shows the coverage provided by the existing KAT network to residents and jobs in Knoxville at midday on a weekday. The overall coverage is divided into coverage by transit of particular frequencies at midday.

56% of Knoxville's residents are within a half a mile of some level of transit service. Of these, 39% are within the ½ mile of 30-minute service or the frequent trolleys

Among people of color, 48% are near 30-minute services or better, while 65% are near transit which offers 60 minute frequency. This proportion is higher because there are some dense corridors served by transit that have high concentrations of residents of color (e.g. Five Points and East Knoxville). Residents in poverty are generally as likely as all residents to be near transit at various levels of frequency.

A large proportion of jobs are located in Downtown and around corridors like Broadway and Kingston Pike, which are served by routes 22 and 11, respectively. This means that 50% of jobs in Knoxville are near 30-minute transit service or better (compared to 39% of the population).

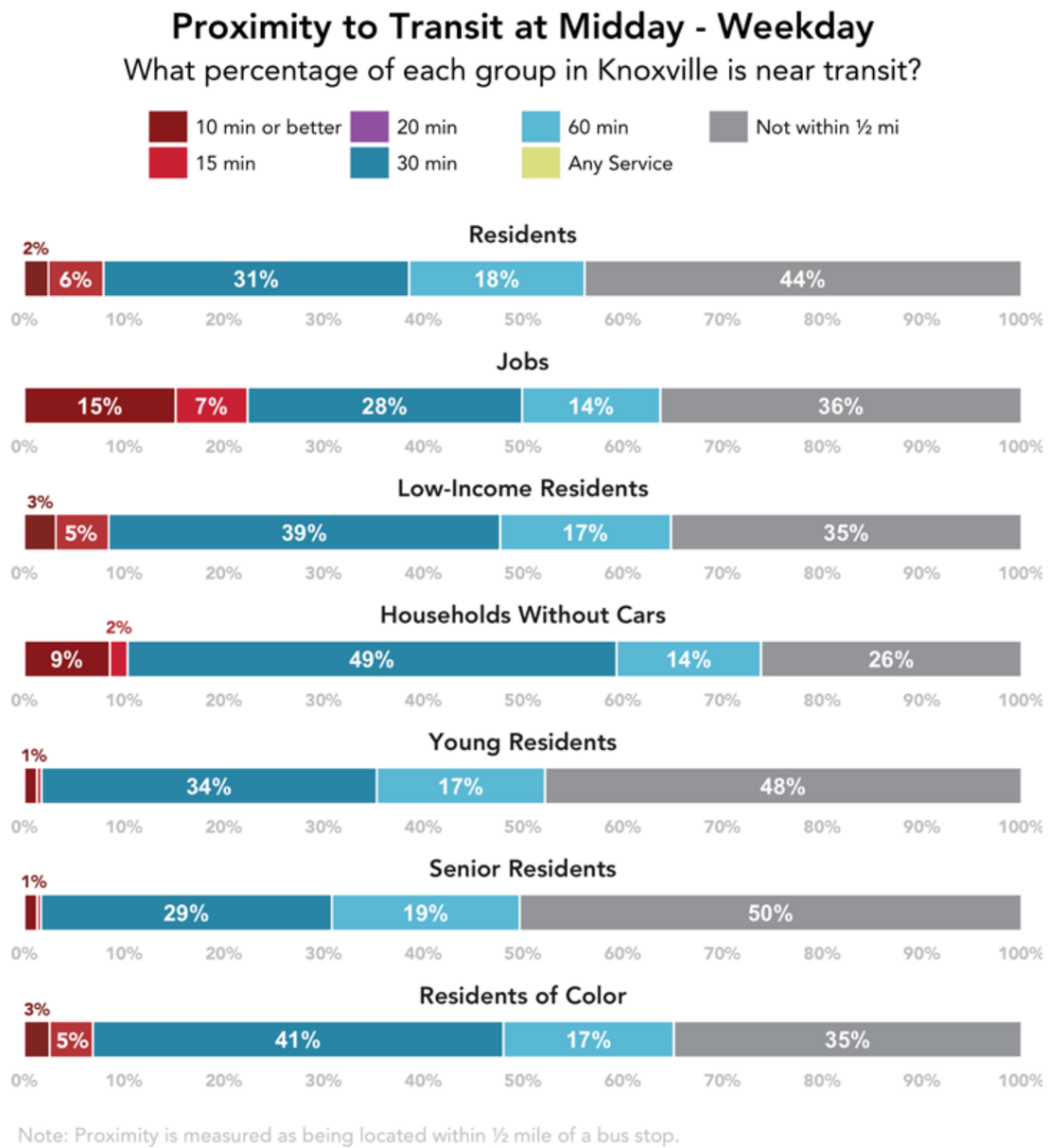


Figure 26: Proximity of residents, jobs, and communities of concern to transit.

Where are people riding transit?

One measure of transit performance is the sheer amount of ridership it attracts. This can be made visible with a map of boardings at each transit stop, as shown in Figure 27.

High ridership routes and areas can appear in two ways on this map: either as large dots or as multiple medium-sized dots that are very closely spaced. Looking for those patterns we can observe that the highest boardings occur:

- At hub stops where several routes converge or terminate and people can transfer between routes (e.g. Kirkwood and Knox Road Transfer Points)
- At intersections where routes cross (e.g. Western/Industrial, Western/University, Broadway/Fifth, Clinton / Merchant)
- Along higher-frequency routes like Routes 31, 22, and 11
- Along dense, linear corridors like Routes 20 and 24 on Central Street

The ridership dots shown on this map, and the route productivity shown on the following page, is from ridership data gathered in the fall of 2021, when ridership is down due to the Covid-19 pandemic. Many people have changed their travel habits during the pandemic as many office workers have worked from home or others have avoided large gatherings. Some of these people may return to old habits once the pandemic passes, while others may retain their new travel patterns. Regardless of when more people choose to ride again, no network can achieve high ridership without providing high access.

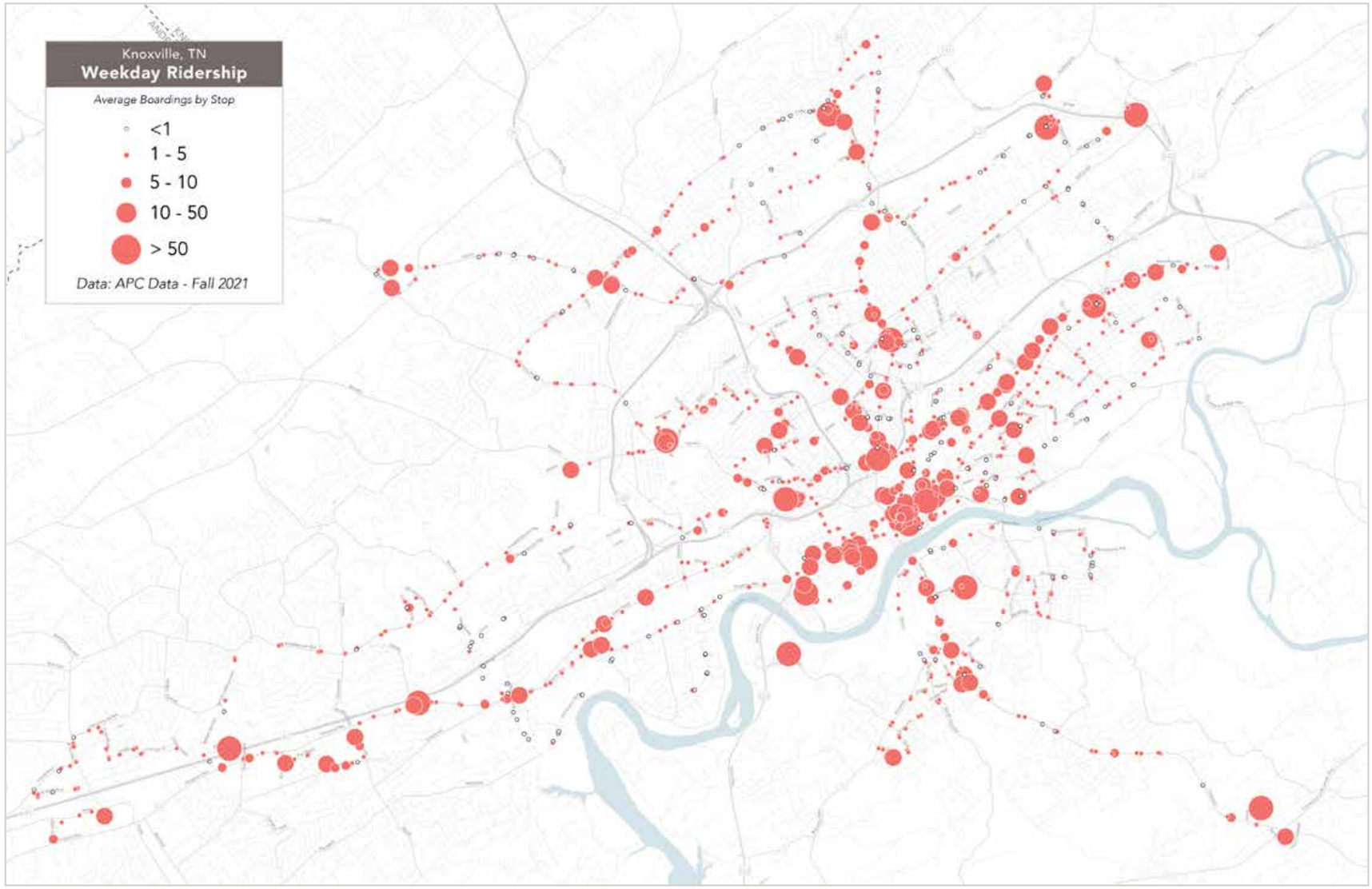


Figure 27: Average weekday boarding by stop.

Productivity and Frequency

Productivity and Frequency Relate

People who value the environmental, business, or development benefits of transit will talk about ridership as the key to meeting their goals. If that were the primary measure of transit's success, then our attention would be focused on the highest ridership routes.

However, because any transit agency is operating under a fixed budget, the measure they should be tracking is not sheer ridership but **ridership relative to cost.** They would not be satisfied simply by a large dot on the boardings map on the previous page until they knew what it cost the transit agency to achieve that large dot.

The cost of providing a service is in proportion to the quantity of service provided, and the primary measure of the quantity of transit available for customers to use is service hours. A service hour (also called revenue hour) is one bus operating for one hour.

The service hours on any particular route will depend on a few factors:

- The **length** of the route (a route covering more distance or running on more circuitous paths will require more vehicles to run).
- The **speed** of the bus (a slower speed means that covering the same distance takes more time).
- The **frequency** of service along the route (higher frequency is delivered by increasing the number of buses being driven on the route at once).
- The daily and weekly **span** of service for a route (how many hours it is available).

Ridership relative to cost is called "productivity." In this report, productivity is measured as boardings per service hour:

$$Productivity = \frac{Ridership}{Cost} = \frac{Boardings}{Service\ Hours}$$

The chart in Figure 28 shows the productivity (Y axis) of individual KAT routes plotted against their "baseline" weekday midday frequency (X axis).

The 30-minute routes are more productive than most 60-minute routes. This is a common trend across agencies (as shown in Figure 7 on page 13): higher frequency services often tend to have not just higher overall ridership, but also, higher overall productivity.

Productivity is strictly a measure of achievement towards a ridership goal. Services that are designed for coverage goals will likely have low productivity. This does not mean that these services are failing or that the transit agency should cut them. It just means that their funding is not being spent with the purpose of attracting high ridership.

Where Is Productive Service Today?

High ridership arises from the alignment of useful service and supportive land use. All except one of the routes gets less than 20 boardings per service hour on weekdays. Some relatively higher-productivity routes include:

- The Blue trolley route is the most frequent and the most productive route in the network.
- Routes 31, 22, 41, 44, and 11 are examples of higher-frequency routes which operate on relatively dense corridors.
- Route 20 provides less frequent service but is in a high-density corridor. Routes with lower service level serving a large transit market are good candidates for service improvements in the future.
- Route 19 provides service to Marble City, which is not very dense and out of the way from everything else.

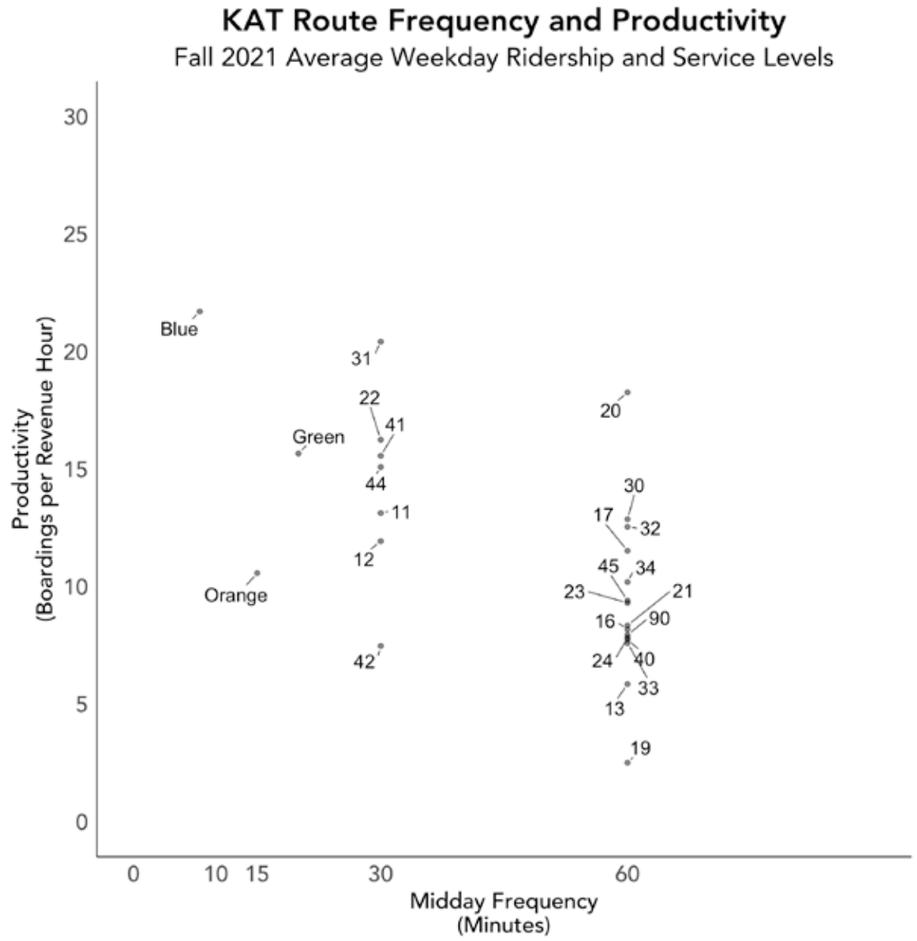


Figure 28: Productivity and midday frequency for all KAT routes in Fall 2021.

Freedom and Access

Elements of the service like frequency and span tell us a great deal about how useful transit is, but they do not tell us everything about how service interacts with where jobs, people, and destinations are in Knoxville. A different way of assessing transit is to ask: "How useful is transit for getting you to a lot of places quickly?"

A helpful way to illustrate the usefulness of a network is to visualize where a person could go using public transit and walking, from a certain location, in a certain amount of time. The map in Figure 29 shows someone's access to and from Five Points, at noon on a weekday. Areas they can reach in less than 60, 45, or 30 minutes are shown in light, medium and dark violet, respectively. The technical term for this kind of illustration of an "access bubble" is **isochrone.**

A more useful transit network is one in which these access bubbles are larger, so that each person is likely to find the network useful for more trips.

In these analyses, travel time estimates include:

- The walking time from the origin point to a nearby stop.
- Initial waiting time equal to 1/2 of each route's scheduled frequency.
- In-vehicle travel time based on an average speed of transit.
- Waiting time equal to 1/2 of a route's headway for any transfer to another route.
- Walking time equal to the remainder of the travel time budget after arriving at a stop. Note that for this analysis, the total walking time is limited to 30 minutes.

We always account for time spent waiting, because even if you time your departure just right and don't wait at the bus stop, a lower-frequency route often makes you wait at your destination because it can force you to arrive very early (rather than be slightly late). Very few people have the liberty of arriving when they please for all their trips, so for most people, riding transit means waiting somewhere. The more frequent the transit, the shorter the wait.

How Many Places Can You Reach Relatively Quickly?

An isochrone map, like the one in Figure 29 may tell you where transit can take you within a reasonable amount of time, but what really matters is how many destinations you can reach in that time. For that, we measure job access—the number of jobs within the 30- 45- and 60-minute purple isochrone areas.

We measure access to jobs because we have good data on job locations, but also because better access to jobs means more than potential places of employment. It also tends to mean more shopping, social, and educational opportunities can be reached, allowing for a richer life for people who choose to rely on transit. We can see that from Bethel and Wilder in Five Points, a person is able to reach about 64,400 jobs in an hour.

For a business trying to decide where to locate their storefront or office, they may be interested in comparing access to population, because higher access to population means a larger market of potential employees, and potential customers. From Five Points, a business is able to reach about 63,300 residents within 60 minutes.

The isochrone maps on the next page illustrate access to opportunity from different locations throughout Knoxville.

Five Points

Within...	Jobs	Residents
30 min	5,100	10,600
45 min	36,200	27,800
60 min	64,400	63,300

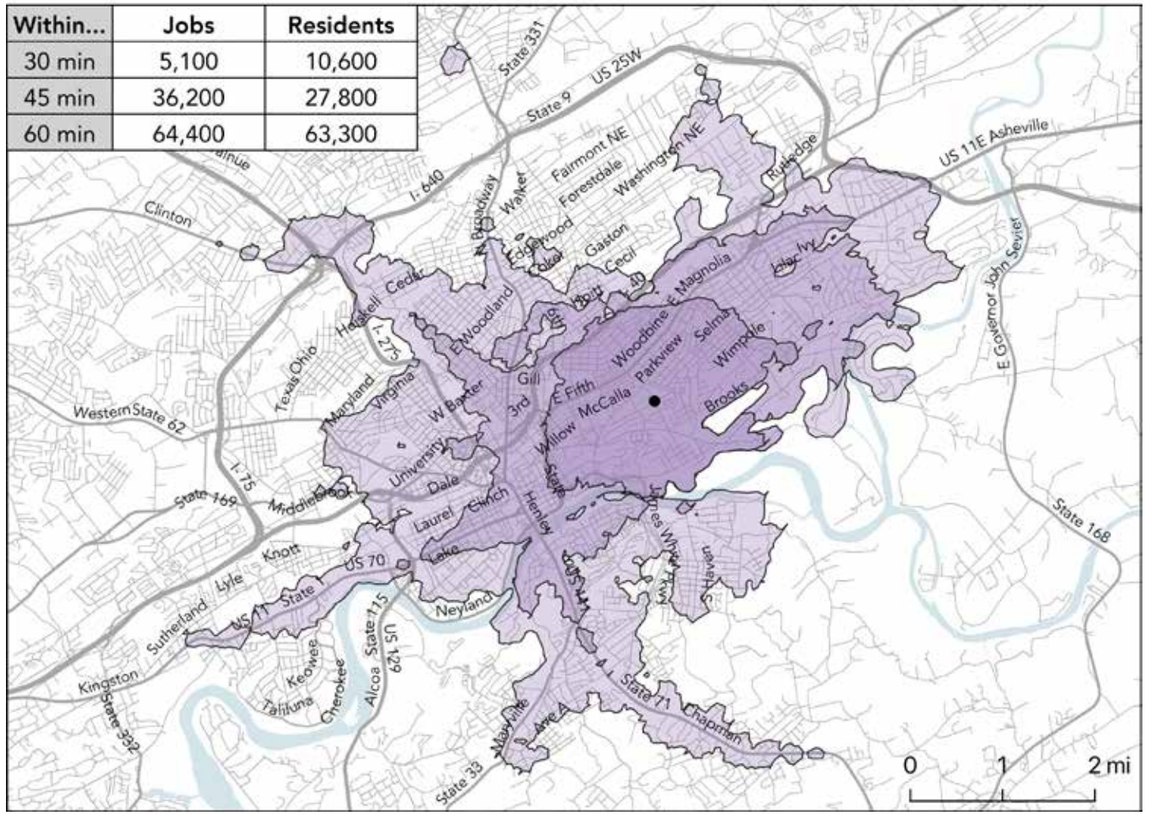
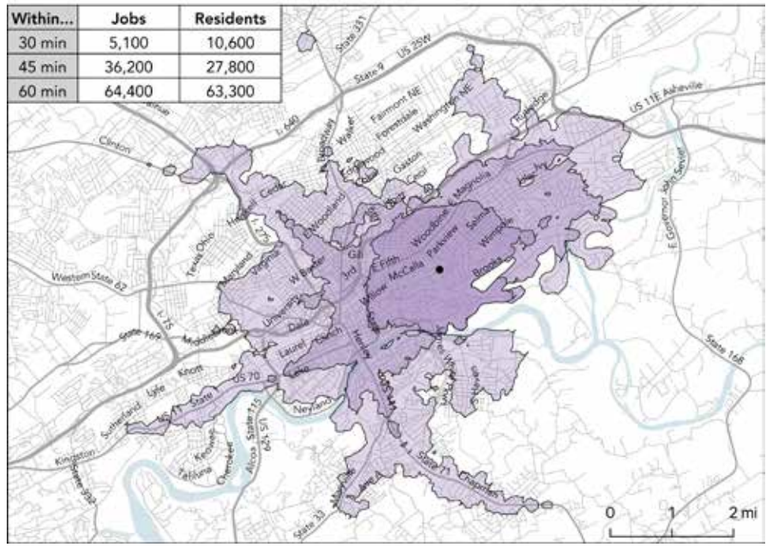


Figure 29: Where you can get to in 30, 45, and 60 minutes via transit and walking from Five Points with regular, Pre-Covid service.

Isochrones

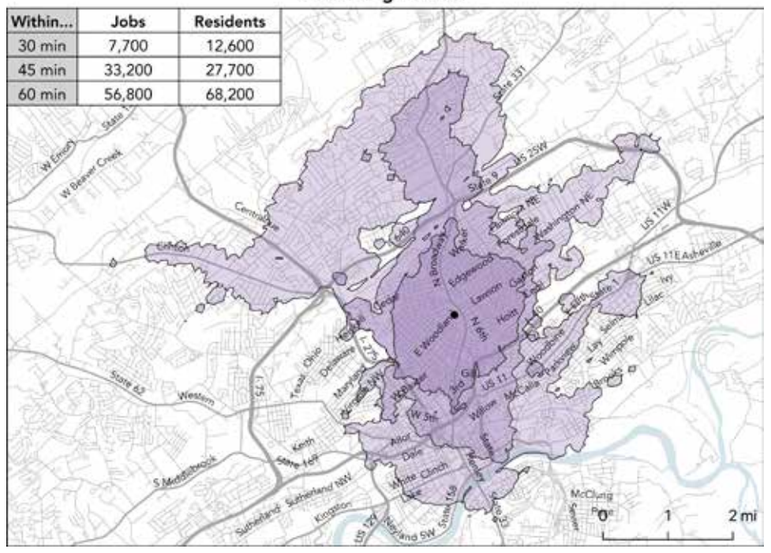
Five Points

Within...	Jobs	Residents
30 min	5,100	10,600
45 min	36,200	27,800
60 min	64,400	63,300



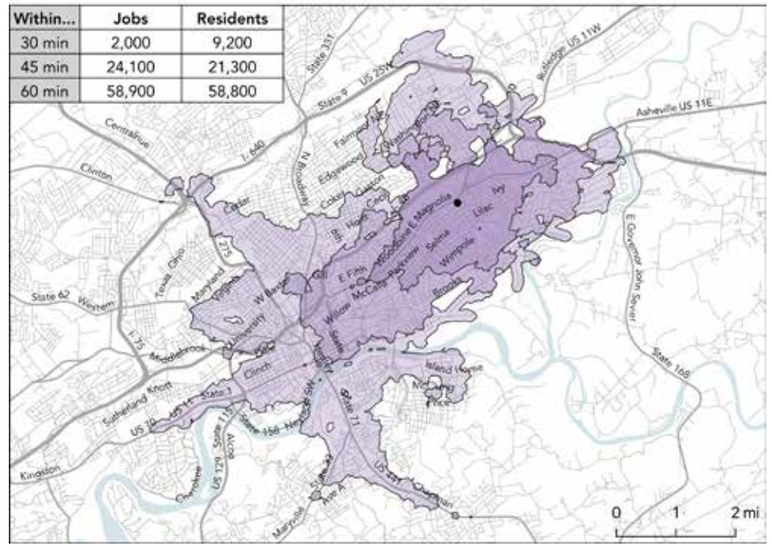
Fulton High School

Within...	Jobs	Residents
30 min	7,700	12,600
45 min	33,200	27,700
60 min	56,800	68,200



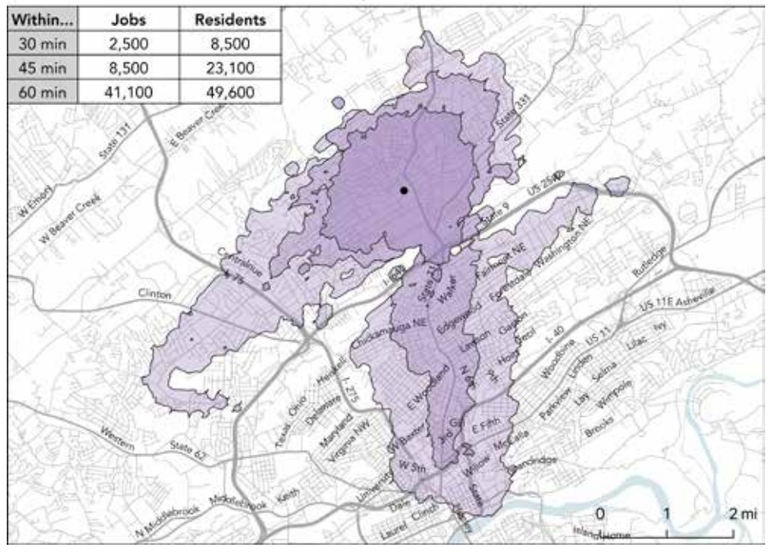
Kirkwood Transfer Point

Within...	Jobs	Residents
30 min	2,000	9,200
45 min	24,100	21,300
60 min	58,900	58,800



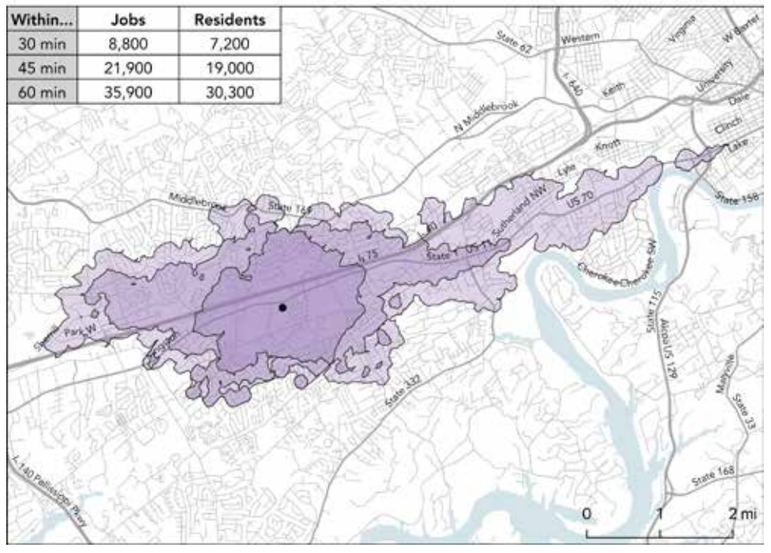
Fountain City Transfer Point

Within...	Jobs	Residents
30 min	2,500	8,500
45 min	8,500	23,100
60 min	41,100	49,600



Knoxville VA Medical Center

Within...	Jobs	Residents
30 min	8,800	7,200
45 min	21,900	19,000
60 min	35,900	30,300



PSCC (Magnolia Ave Campus)

Within...	Jobs	Residents
30 min	19,500	12,000
45 min	51,300	45,000
60 min	72,700	79,300

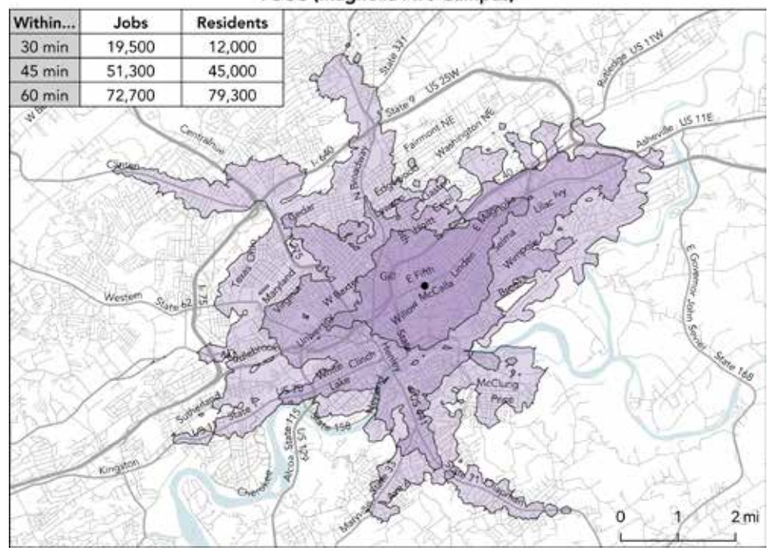


Figure 30: Isochrones showing how far people can go in 30, 45, and 60 minutes from various locations with regular, Pre-Covid service.

Access to Jobs

Isochrones can show us the freedom and access for a given place, but to see the total freedom a network provides across the entire region, we have to run the isochrone measure for nearly every place and display the results by color. Figure 31 shows this result.

People who live in the darkest purple areas can reach more than 50,000 jobs in 45 minutes by walking and transit. In the lightest blue areas, residents can reach less than 1,000 jobs.

The number of accessible jobs is related to both the distribution of jobs in and around Knoxville as well as the usefulness of transit service from a particular location.

Areas close to the 30 minute-frequency routes show up in as darker shades of purple as these routes have shorter waits and therefore there is more time to travel and reach more jobs. Yet even along 30 minute routes in East Knoxville, the darker shades of purple fade to lighter shades quite quickly as one travels eastward. This is because there are relatively few jobs along these corridors, so to reach many jobs one must travel to and beyond downtown. Contrast this condition with the conditions along Kingston Pike where areas farther out still show up in darker shades of purple because there are simply a lot of jobs along that corridor, so you don't have to travel far to reach many jobs.

Most areas along an hourly route do not show up in darker shades, at least beyond the core area of the city. On a 60-minute route 30 minutes is spent just waiting for a bus to show up, so there is relatively little time to travel and reach many jobs.

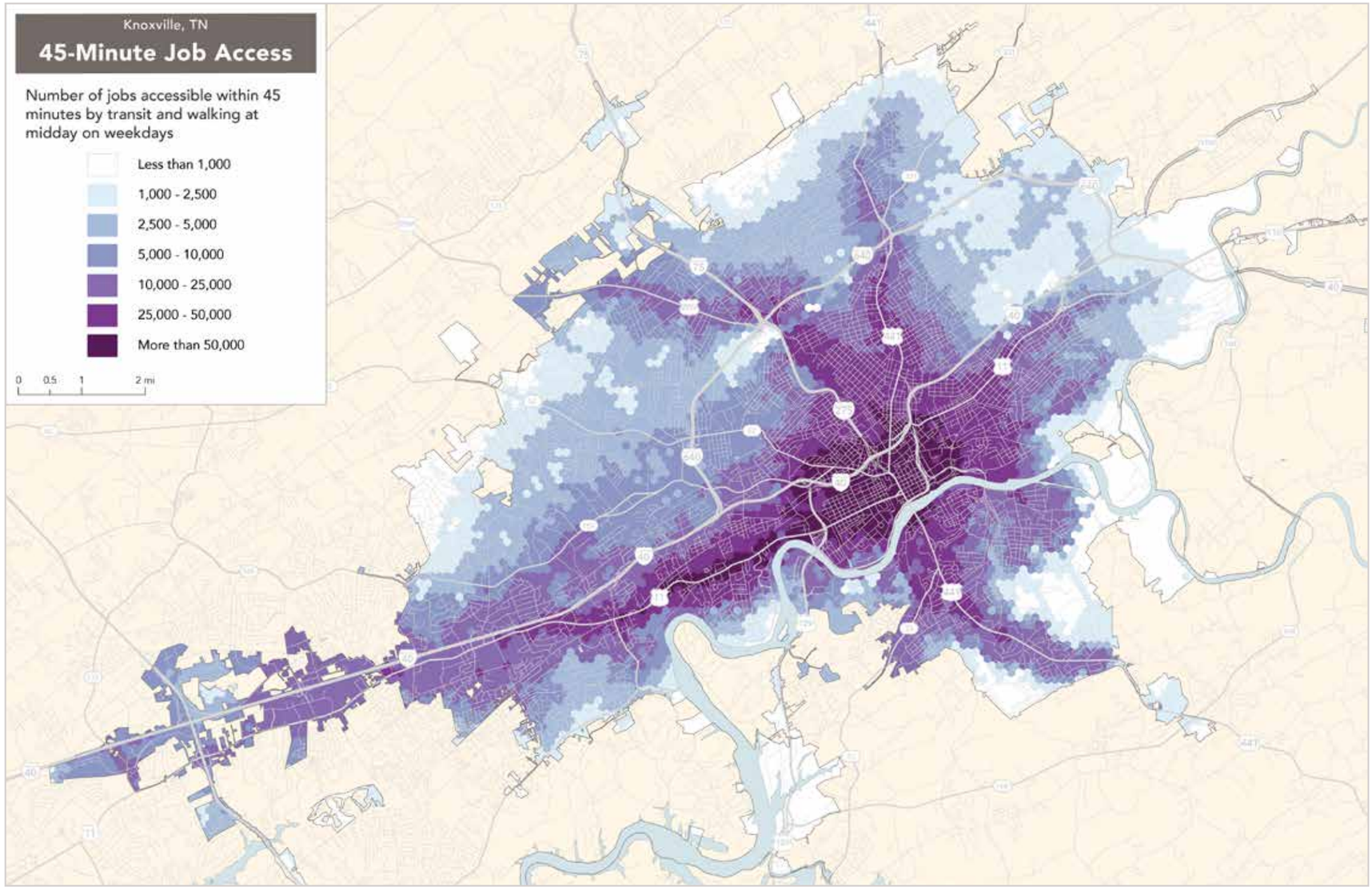


Figure 31: 45-minute job access.

Access to Jobs for the Typical Resident

By taking the information in the map on page 40 and combining it with the demographic information shown in previous maps, we can assess how many jobs each person in the KAT service area can reach. From that we can also assess how many jobs the typical, or median, person can reach and the same for various subgroups. By typical, or median, resident we mean the experience of the middle person in the distribution of people by how many jobs they can reach.

Figure 32 shows the median number of jobs accessible to the different sub-groups of people in Knoxville. People of color, residents in poverty, and those without cars tend to have a slightly higher access to jobs compared to the number of jobs accessible by all residents on average in 60 minutes.

If Knoxville wishes to maximize its transit ridership, then a key goal would be to increase the number of jobs accessible to the median person, and it would do that by increasing the number of jobs accessible to the areas that have the most people in them.

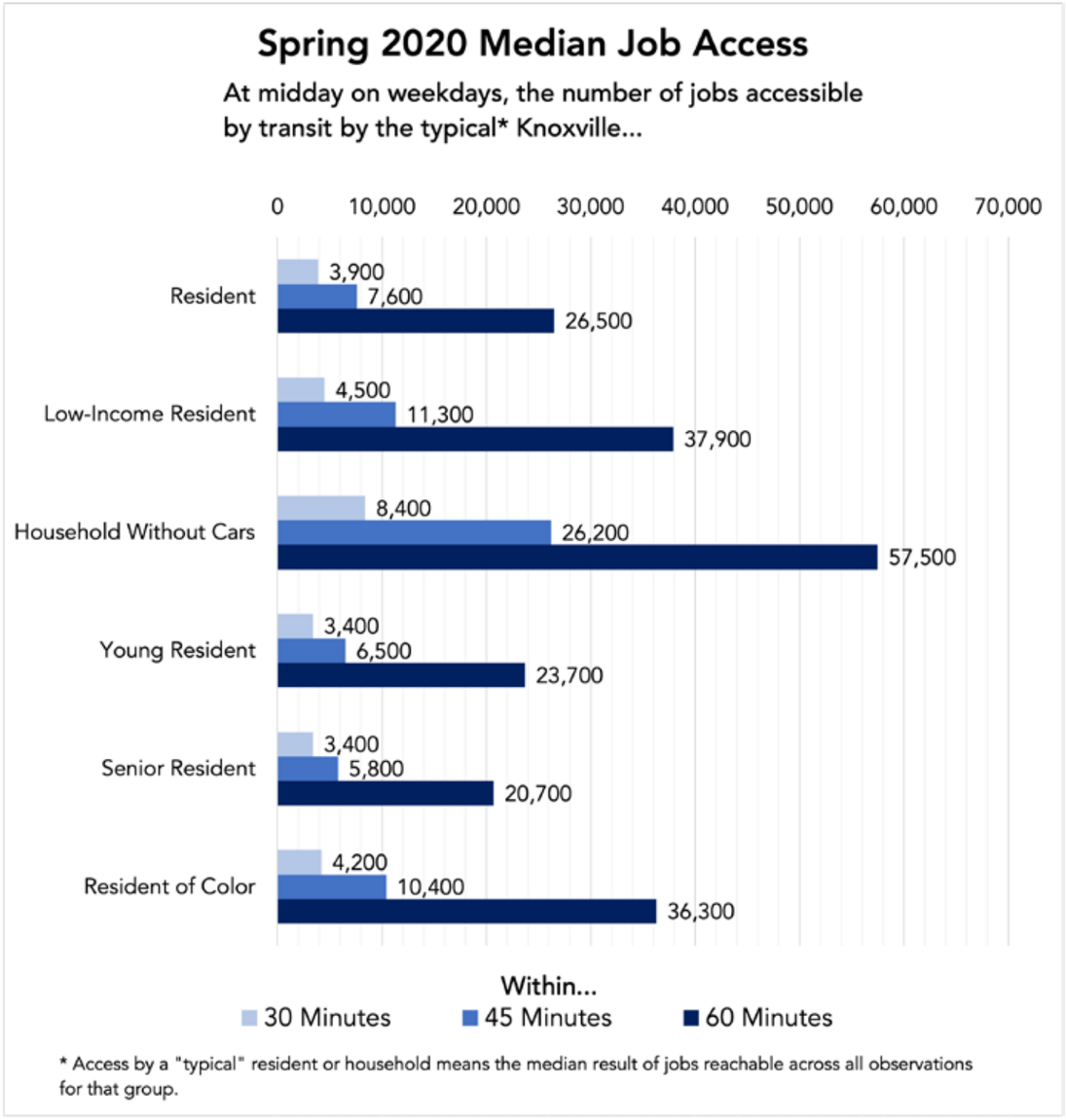


Figure 32: Job access for the median resident of different communities of concern.

Access by transit compared to walking

Figure 33 compares job access by transit in 45 minutes to job access by walking 30 minutes. In other words, the dark areas on this map show places where the existence of transit makes it possible to reach many jobs beyond those reachable by walking alone.

In this map, Downtown is light because there are already a lot of jobs within walking distance, so transit doesn't get you to many more jobs.

The frequent corridors are darker, indicating that those are places where transit provides a much greater access to jobs than walking. Particularly, the south and east, along Routes 40, 41, and 32, come up as places where transit provide much more job access than walking alone. In particular areas south of the river show up as quite dark, indicating that there are very few jobs reachable by walking alone.

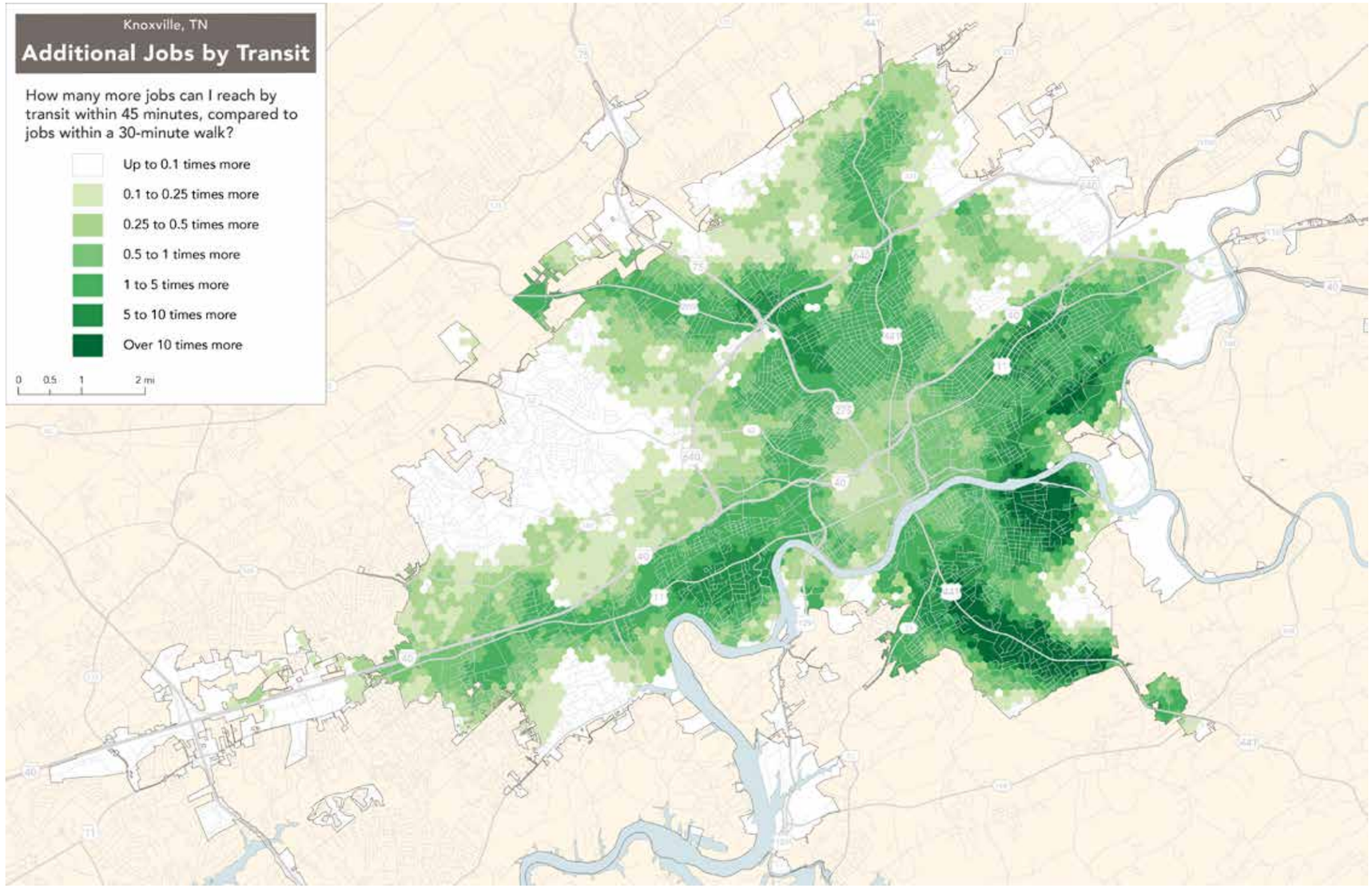


Figure 33: Additional jobs reachable by transit in 45 minutes compared to a 30-minute walk.

Downtown Knoxville

Downtown Knoxville has the strongest offering of transit service in region, this is due in part to the radial design of the system. Most routes come into Knoxville Station to provide an opportunity for customers to transfer from one route to another. This convergence of lines means that Downtown Knoxville is where most transfers in the KAT system happen. Adding to this concentration of radial routes, KAT operates three trolley routes within the city's core. The Trolleys are short, relatively frequent routes which circulate passengers in and near Downtown Knoxville.

Downtown Trolleys

- **The Blue Line** is a large one-way circulator route that provides 8 minute service passing through Downtown, the waterfront pathway, and Knoxville Station.
- **The Green Line** travels a short distance north to connect Downtown to Old City every 20 minutes.
- **The Orange Line** goes to the University of Tennessee every 15 minutes terminating at the Commons.

A key feature of these shuttle routes is that they are free to ride. Decreasing transit fares is known to increase ridership, even when service levels are held constant. Reducing fares to zero has a particularly big impact on ridership because it reduces two kinds of costs for potential riders: the dollar cost of the fare itself, and the hassle of getting information about the fare and then finding a way to pay the fare. It also speeds up bus service by reducing the time it takes riders to board, part of the dwell time at stops, which allows the transit provider to run more efficiently.

Although the trolley routes do not directly overlap for their entire lengths with other routes in the KAT network, there is a good deal of overall duplication happening in the downtown area between regular KAT routes and the trolley routes. This effectively creates competition between routes in the KAT system. The trolleys are designed and marketed primarily toward moving people just within the downtown areas. By separating out this service from the rest of the system, the market for transit downtown is being divided into smaller, potentially less productive segments. In transit, specialized services tend to dilute the market whereas generalized services tend to get the highest ridership across the entire system.

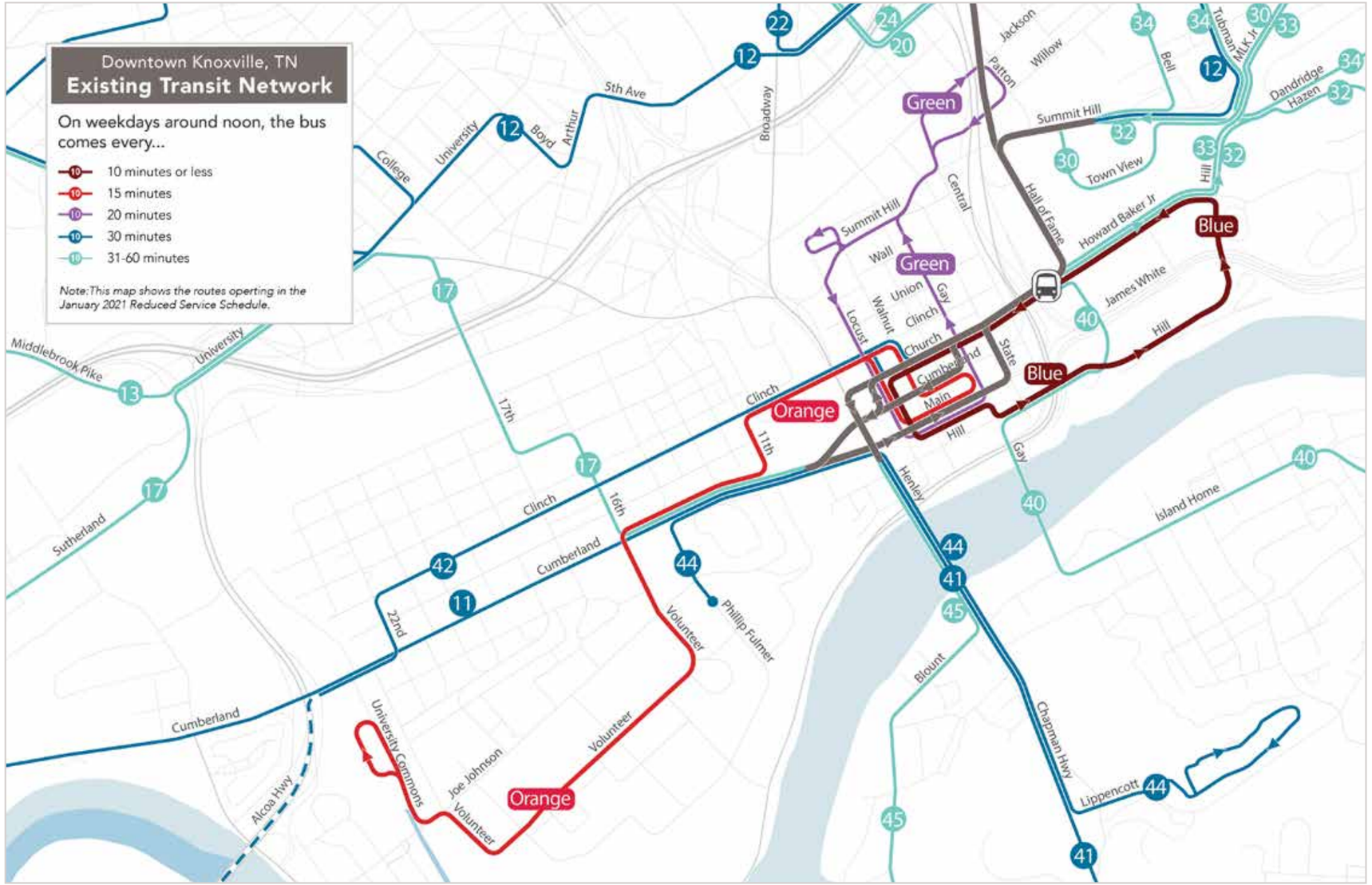


Figure 34: Existing network in Downtown Knoxville

Connections and Pulse

It's unlikely that all the places you might want to go will be located on the bus line nearest to your home. Connections allow people to travel in many directions to reach more destinations. To facilitate connections between routes, KAT has a timed transfer, also called a pulse.

Normally, the amount of time a transfer takes depends largely on the frequency of the connecting routes. For an un-timed connection, transferring to a route that comes every 60 minutes requires a 30-minute wait, on average, and in the worst case a 59-minute wait.

In Knoxville, many routes reach Knoxville Station at the same time and depart five minutes later. These five minutes allow passengers to connect between routes easily.

Different sets of routes depart from Knoxville Station at different times to allow connections between them. For example, Routes 20 and 17, depart at 15 minutes past each hour while Routes 24 and 32 depart 30 minutes past each hour. This means that connecting from Route 17 to Route 20 is very easy and you only need to wait 5 minutes. However, transferring from Route 17 to Route 32 is more difficult and requires a wait of 20 minutes.

The maps on the right show the sets of routes the pulse together every half hour or hour.

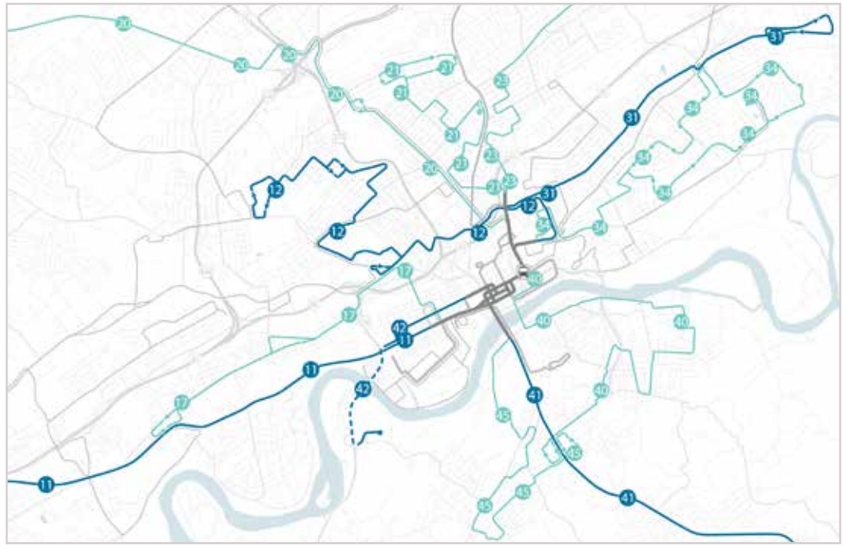


Figure 35: Pulse at 15 minutes past each hour

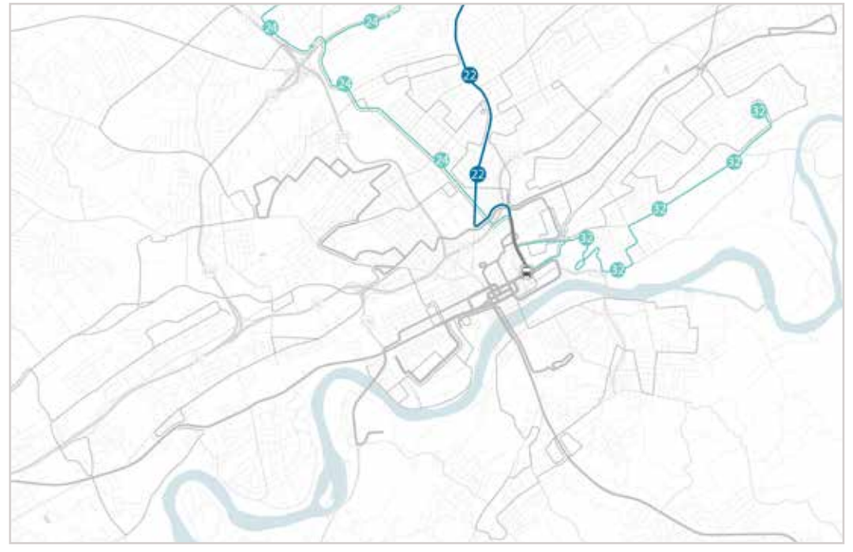


Figure 36: Pulse at 30 minutes past each hour

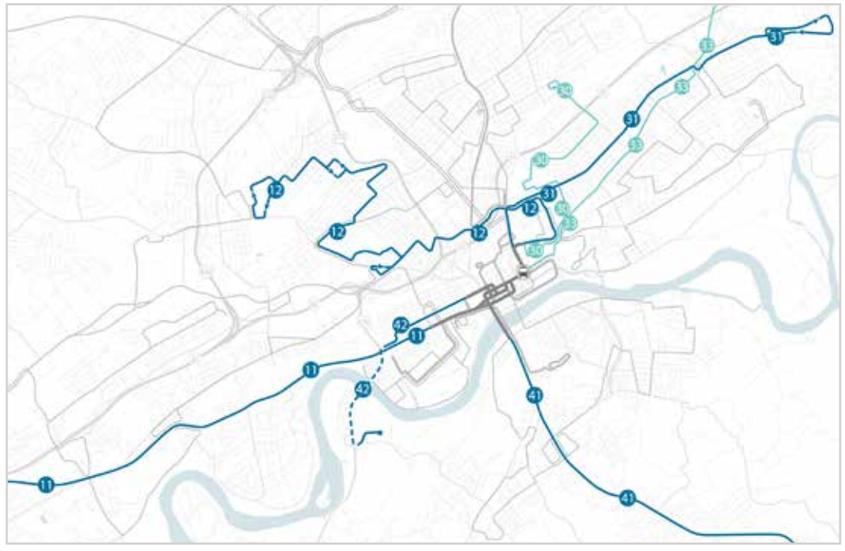


Figure 37: Pulse at 45 minutes past each hour

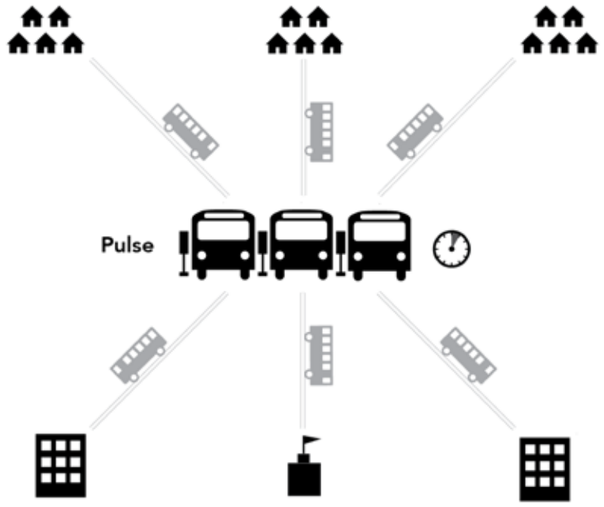


Figure 38: At Knoxville Station, routes arrive at the same time, dwell for a few minutes so that passengers may transfer among them, and then depart again.

One-Way Loops

One-way loops are sometimes put at the ends of long routes, because they are easy ways to turn around a bus. At the end of a long route, buses tend to be empty, so very few people end up riding around the loop.

But sometimes one-way loops are used to provide coverage: access to service that doesn't result in much ridership. One-way loops sacrifice directness and travel time in order to cover a larger geographic area.

How does a passenger experience this sacrifice? It may be that on their way out, they can get on the bus and it goes in the direction they are traveling, so the trip feels fairly direct. But on their return trip (as illustrated below), they must ride around the loop the long way, out of direction, to get back to where they started.

KAT's network includes one-way loops near the end of some routes, including Routes 24 and 34 as shown on the right. These loops are large, so they cover a large area for a low cost. However, trips to and from these loops, will always have one leg that is not very direct and has a longer travel time. The next page shows an example of a trip using Route 24.

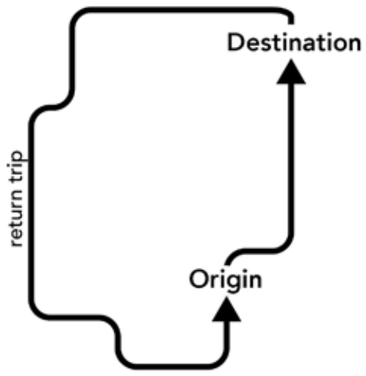
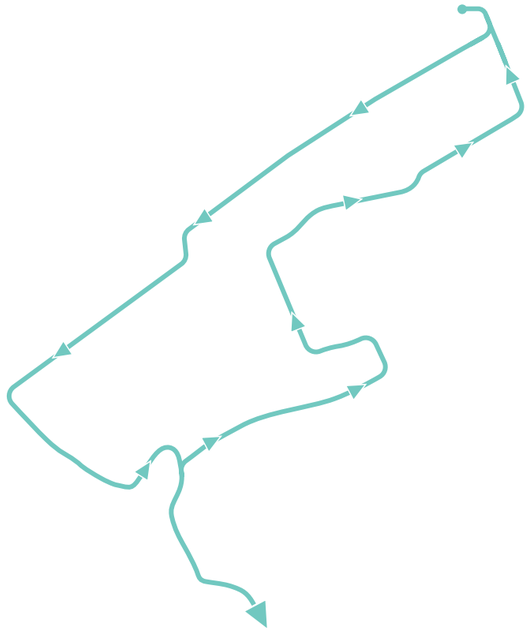
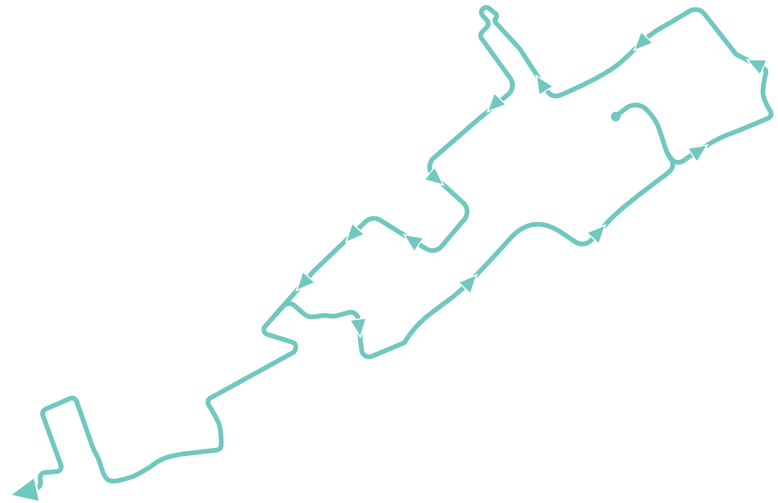


Figure 39: In a one-way loop, the more direct the service from A to B, the more circuitous it's likely to be on the return trip.



Route 24



Route 34

One-Way Loops, Trip example

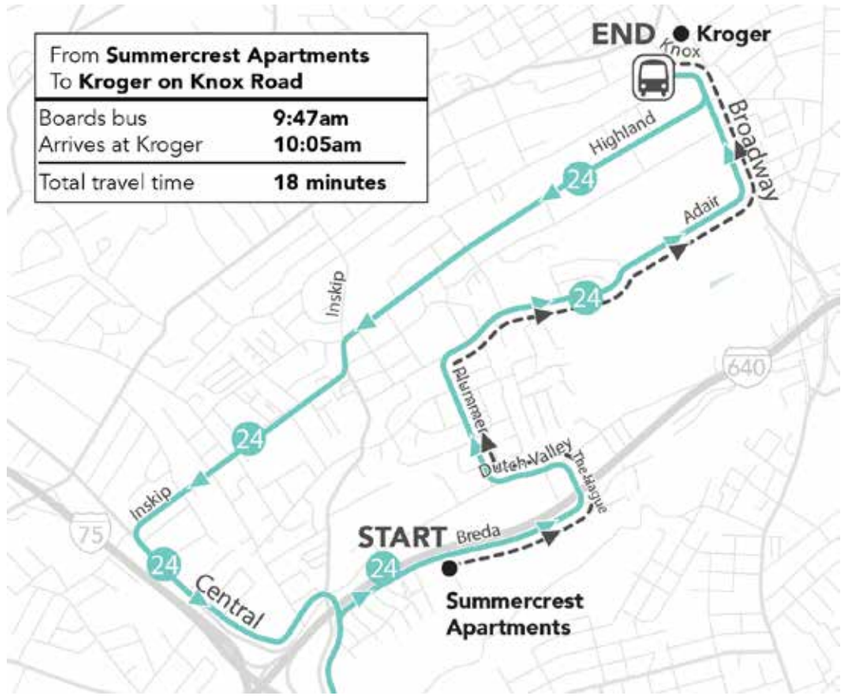
In Knoxville, Route 24 has a one-way loop that affects how people travel in each direction.

If Susan lives in Summercrest Apartments and wants to go to Kroger for grocery shopping, she needs to take Route 24. If she plans ahead, and leaves right when the bus is coming, she can board the bus at 9:47am. The bus takes her straight to Kroger along Breda, The Hague, Dutch Valley, and Adair. She arrives at 10:05am, so her trip took 18 minutes. The first map on the right shows this trip.

When she is done shopping and leaves the store, she needs to wait for the bus. The average wait for a 60 minute route is 30 minutes. For this example, let's assume that the bus is coming right when she needs it. She can get on the bus at 11:05am, but she can't get straight home on that same bus, because her origin and destination are on the wrong ends of the one-way loop.

Therefore, Susan must ride to the stop at Bruhin and Brenda to transfer to a northbound Route 24 bus. She waits 25 minutes for the bus, and gets home at 11:47am, 47 minutes after she boarded the bus leaving Kroger. The second map on the right shows this trip.

Because of the one-way loop of Route 24, Susan's trip home from Kroger took 24 minutes longer. One-way loops can cover a larger area, but inevitably require longer travel times for many trips.



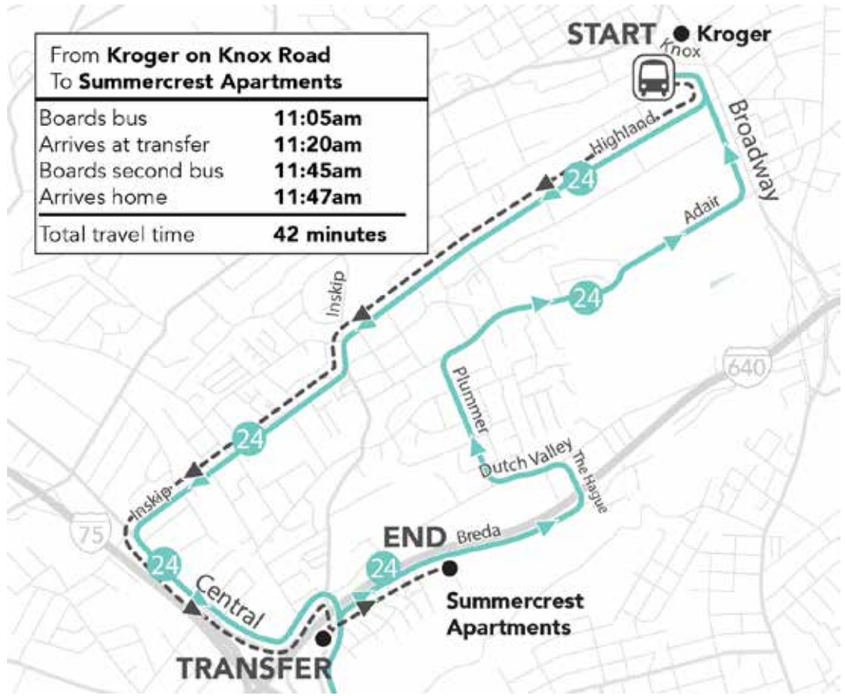


Figure 40: Trip example using Route 24

Deviations and Complexity

Routes with deviations on them can only feel direct to the people who are bound to or from the deviation—for most other riders, they often feel like a waste of time. People almost never want to be taken out of direction when they are on their way somewhere. This is part of the reason that linearity is one of the four development patters that affect ridership, as described on page 14.

The other reason linearity is an indicator of high ridership potential is that circuitous and deviating routes are simply longer, and therefore cost more to operate. The longer a route is, the lower the level of service it can offer for the same cost. The shorter a route is, the more can be spent on frequency or long spans. Deviations are often used as a coverage tool. They bring service close to a larger number of people and places. They reduce walking distances to bus stops. In most cases, they discourage more ridership than they attract, but ridership is not the goal of a coverage service.

In KAT's network some routes, like Routes 12 and 21, travel using indirect deviating paths. Since these routes are not very linear, they are not expected to get very high ridership. Instead, they provide service very close to some residents, decrease the distance that riders have to walk to get to a bus. This relates to the Coverage versus Ridership trade-off discussed on page 8. These routes serve the goal of providing some service to many people, even if that service is not very useful and doesn't yield much ridership.

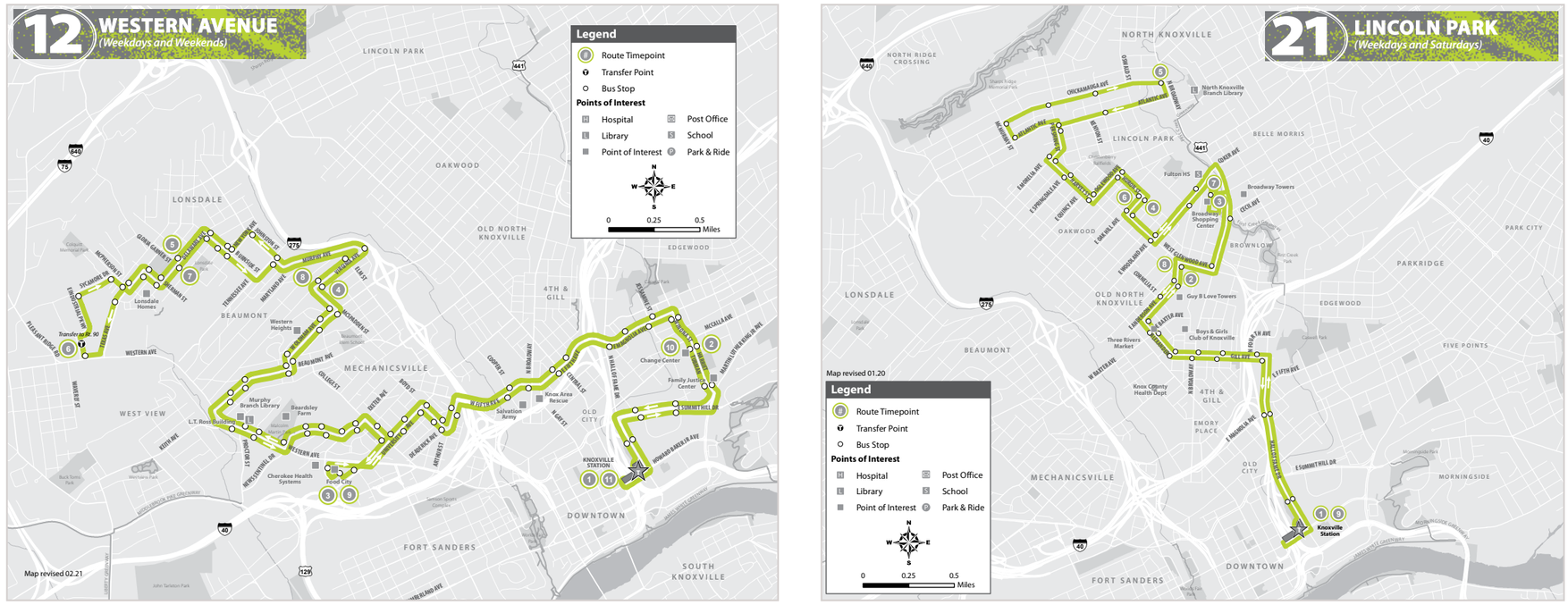


Figure 41: Routes 12 and 21 have indirect paths.

Figure 42: Route 12 provides duplicative service as it approaches Knoxville Station.

Shorter Walks or Shorter Waits

Transit service being divided among more streets inevitably leads to lower frequencies on each street, and therefore longer waits. This is used as a coverage tool to get buses as close to people as possible. However, if someone misses their bus, the wait is quite long.

If parallel routes can be consolidated onto a few main streets, frequency can be made better and waits can be shorter. However, longer walks would be required. This is why walking distance and waiting time are linked in any transit network, and trade-off against one another.

If two routes on parallel street come every 30 minutes, then they can be combined onto the same street to arrive exactly 15 minutes apart, and someone traveling a short distance could wait at a single stop for either bus. This is exactly the case with Routes 11 and 42 as they traverse Clinch and Cumberland in Fort Sanders where they are only 650 feet apart. If they were combined, they could provide more frequent service. This is one approach to increasing frequency on some corridors without significantly sacrificing coverage.

Figure 43: Routes 11 and 42 are only 650 feet from each other through Fort Sanders.

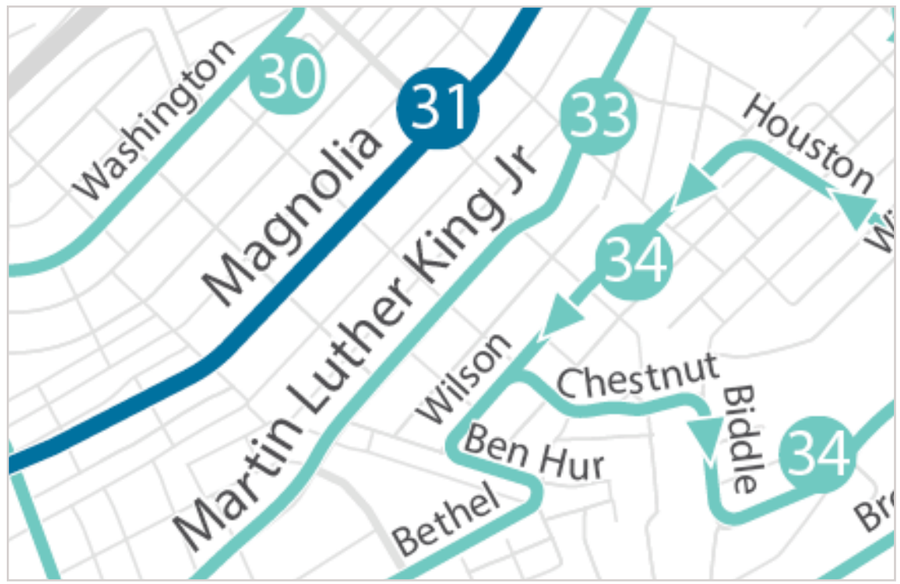


Figure 44: Some routes are Five Points are within walking distance of each other.

Circulator and Orbital Routes

The street grid in Knoxville has a radial pattern, which suggests that the bus network should also follow a radial pattern. To connect between routes, most people have to travel to Knoxville Station. This is fine for short distances, but what if someone wants to travel between two points far from Downtown?

While radial routes go Downtown, orbital routes connect radial routes together without having to go through Downtown. The KAT network has Route 90, which functions as an orbital route.

Orbital routes generally work well if they are frequent and follow development patterns with high density and high walkability. If an orbital route is not very frequent, riders might be better off traveling Downtown to connect to other routes, particularly if that connection is timed so that transferring is fast.

Route 90 comes every 60 minutes and travels through some areas that are not very dense. While it is connecting some destinations far from Downtown, its low frequency requires long waits and provides less useful service. The network could potentially be designed without an orbital route and only rely on transfers Downtown. Given the relatively meager resources that KAT has to spend serving the city, a more frequent orbital service is unlikely to be a high productivity investment.

Routes 13, 16, 19, and 44 don't go Downtown either, but they don't function are true orbitals either. They are mostly providing coverage in hard to reach places as circulator routes. While the name circulator sounds useful and helpful, most short, low frequency routes tend to have lower productivity and are generally less useful because they do not directly connect to the downtown pulses.

There is potential to redesign these routes to provide more useful service. For example, Route 13 could be redirected to go Downtown instead or terminating at Central Street. By going Downtown, people going traveling to or from Route 13 can connect to many other routes and reach more places. Some circulator routes, like Route 16, are primarily providing coverage service in very hard to reach places. **IF** KAT wishes to focus more on Ridership goals, then routes and route segments like Route 16 would likely disappear from the network map.

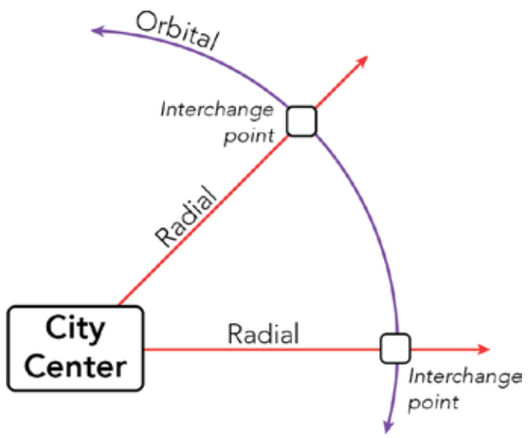


Figure 46: A radial network with orbitals

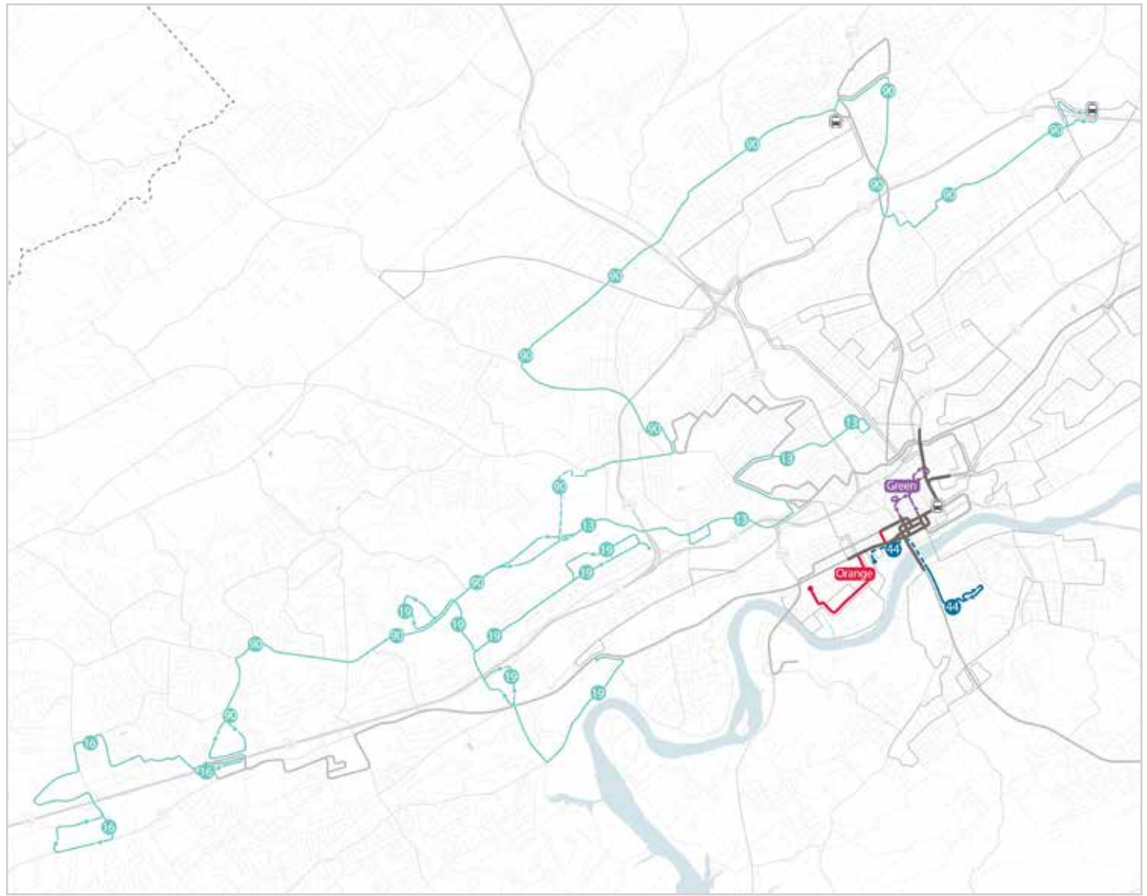


Figure 45: Circulator and Orbital Routes

On Time Performance

On-time performance is a measure of how reliably buses depart when customers expect them to depart. Reliability is particularly important when a transit network is built of infrequent routes. If another bus is not coming soon, the timeliness of each bus is extremely important.

On an infrequent route, an early departure can be much worse than a late one. If a route that comes every 60-minutes is 5 minutes late, someone might be 5 minutes late to work, and that is bad. But if it is 5 minutes early, they probably weren't at the bus stop in time to catch it, and they have to catch the next bus—which means they are now 60 minutes late to work.

Generally, a bus is considered "on-time" if it arrives at a timepoint at most 1 minutes before or 5 minutes after the scheduled time and departs at most 5 minutes after the scheduled time. The chart in Figure 47 shows the percentage of times each route was observed to be on time, early, or late on weekdays in Fall 2021.

Of note, Routes 10, 19, and 41 are late more than 30% of the time they depart a timepoint. Routes 11, 17, 45, and 90 are also relatively late, with late departures 20-30% of the time. Most routes have very few early departures and no route shows early departures more than 10% of the time.

For transfer points like Knoxville station where routes pulse, on-time arrival is critical to minimizing wait times. Figure 48 show the percent of trips that are at most 3 minutes late and those more than 3 minutes late at Knoxville station. Based on this analysis, it appears that Routes 32, 34, and 41 are late arriving at Knoxville station about 1 out of every 4 or 5 trips.

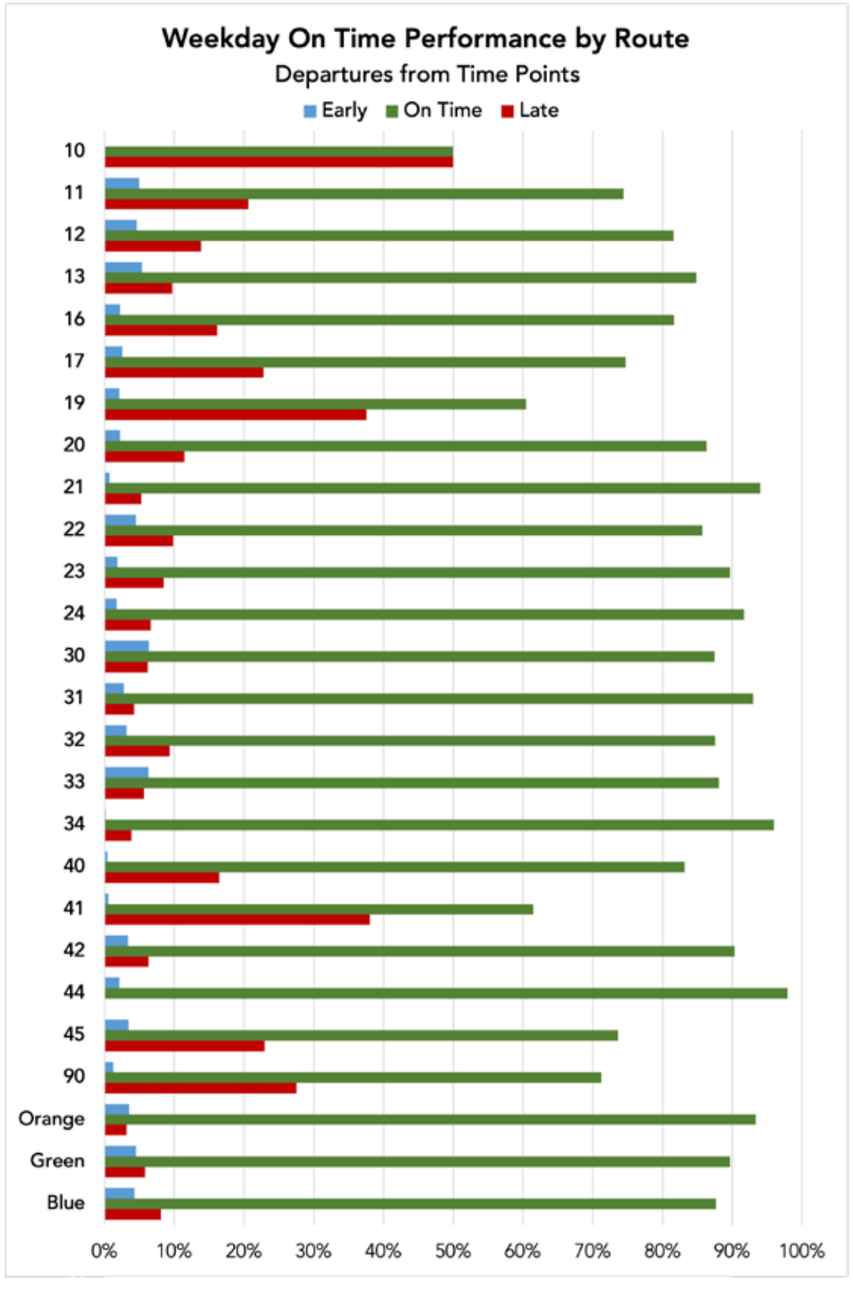


Figure 47: Weekday on-time performance by route.

On-Time Performance by Route at Knoxville Station

Weekday Arrivals at Stop

Route	At Most 3 Mins Late	More Than 3 Mins Late
11	90%	10%
12	92%	8%
17	83%	17%
20	88%	12%
21	90%	10%
22	88%	12%
23	97%	3%
24	98%	2%
30	81%	19%
31	95%	5%
32	75%	25%
33	93%	7%
34	80%	20%
40	94%	6%
41	80%	20%
42	90%	10%
45	89%	11%

Figure 48: Weekday on-time performance by route at Knoxville Station.

5 Key Choices

Ridership or Coverage?

Knoxville has a unique opportunity to rethink the purpose of the transit network, and how transit relates to other ways of getting around such as walking, cycling and driving. KAT Reimagined is an opportunity for everyone to carefully consider how Knoxville is spending its transit budget, and the goals and priorities for transit.

The focus of KAT Reimagined is on what can be done in the next few years, so we can't assume that any new resources are available. This means some hard choices have to be made. This does not mean that Knoxville thinks that the resources available to provide transit service today are adequate. Nor does it mean that transit couldn't be expanded in the future.

We would like the community to help us decide on the best use of the funds currently dedicated by Knoxville to transit. Beyond this, Knoxville sees great value in identifying new funding sources for transit and increasing the number and scope of partnerships to expand and improve transit in Knoxville.

Ridership or Coverage?

KAT Reimagined is a unique opportunity for Knoxville to consider and clearly define the right balance between desirable but competing goals for transit.

The current transit network is a legacy of past generations, and has accrued years of good intentions, good ideas, stop-gap measures, and special requests. Much of the existing network may be worth keeping as is, perhaps because it suits Knoxville and its values, or perhaps because it is known and familiar to riders, which is a value in and of itself.

It is also possible that since this transit network was last re-designed, Knoxville has changed enough to justify a fresh start. Transit networks are intricate, interwoven, living things, and adapting them incrementally over time is very difficult.

The most difficult choice for the public, elected officials, and stakeholders will be between providing high frequency, long-span services in order to attract high ridership and providing wide coverage.

Recall that high ridership serves several popular goals for transit, including:

- Competing more effectively with cars, so that Knoxville can grow without increasing traffic congestion.
- Collecting more fare revenue, increasing the share of the transit budget paid for by fares.
- Making more efficient use of tax dollars by reducing the cost to provide each ride.
- Improving air quality by replacing single-occupancy vehicle trips with transit trips, reducing greenhouse gas emissions.
- Supporting dense and walkable development and redevelopment.
- Extending the most useful and frequent services to more people.

On the other hand, many popular transit goals do not require high ridership in order to be achieved, and instead are achieved by providing transit coverage of many places. These include:

- Ensuring that everyone in the service area has access to some transit service, no matter where they live.
- Providing basic transit access for people who cannot use personal vehicles.
- Serving newly developing places, even if they don't yet have the size or density to constitute a large transit market.

This choice is not binary. A transit agency can pursue high ridership and extensive coverage at the same time, but the more it pursues one, the less it can provide of the other. Every dollar that is spent providing very high frequency along a dense mixed use corridor is a dollar that cannot be spent bringing transit closer to each person's home or reaching residential areas in the less dense parts of Knoxville, and vice versa.

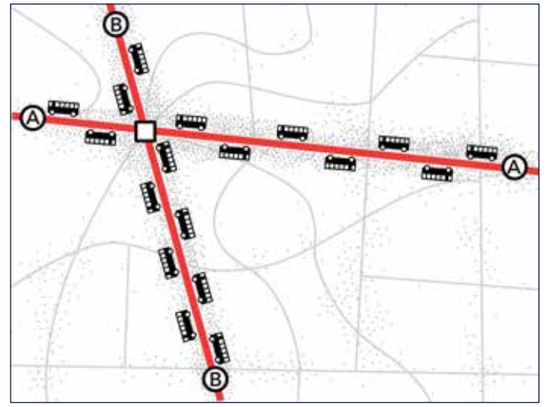
Making the Decision

In a network designed solely for high ridership, a lot of service is concentrated in the places which have the strongest market for transit: more density, walkability, linearity, and proximity. Transit runs frequently and longer during the day to provide useful service. A few routes can be extended to other dense areas in Knoxville or places with high ridership potential, but most low-density places have very little, or no, transit service.

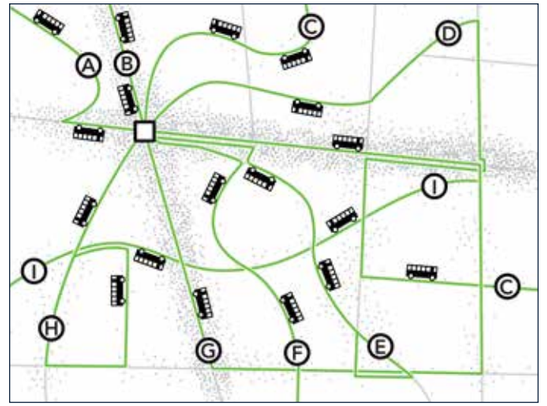
In the network designed solely to maximize coverage, many routes serve a large proportion of the developed area of Knoxville, but are not very frequent. Most people have some transit service very near to them, but they have to wait longer for the bus to arrive.

No public transit agency focuses solely on either of these goals. Most transit agencies have some direct, frequent, long-span routes on which ridership and productivity are high, and others which run at lower frequencies and more limited times, for specific coverage purposes. We suggest that people think about this choice not as binary, "yes-or-no" decision, but as a point on a sliding scale that the community can help to set.

Ridership Network



Coverage Network



How much of Knoxville's transit budget should be spent on the most useful service in pursuit of high ridership? How much should be spent on providing coverage?

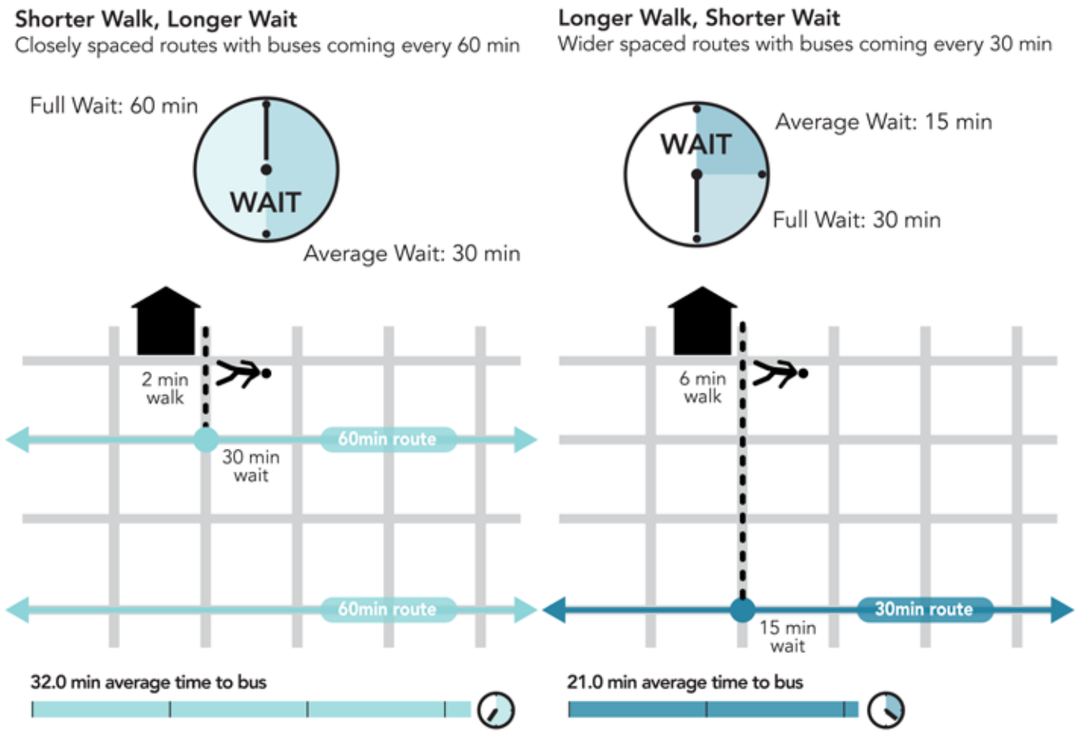
Walking or Waiting?

Walking or Waiting?

Another way to think about the question of ridership and coverage is to think specifically about how far a person should have to walk to reach a bus stop, and how long they should have to wait, on average, before the next bus comes.

Walking and waiting are important to consider on their own, because both of these activities add time and inconvenience to any transit trip, and different people have a wide variety of preferences regarding each.

For example, a young person without disabilities who is in a hurry might have no problem walking over a half-mile to a bus stop if the bus is always coming soon. An older person or person with a disability might prefer to have a bus stop much closer to their front door, even if it means they need to memorize the bus schedule or risk waiting a long time.



Connections or Complexity?

Most transit networks start out as networks with relatively few transfers between routes (we often call these Direct Service networks). Yet, as a community grows bigger, Direct Service networks become massively complex. At some point, cities make a transition from a Direct Service network to a Connective one, a transition that often requires severing direct links that people are used to in order to create a structure of very frequent service that is more broadly useful and legible.

The current KAT system is very complex, with many long infrequent routes designed to minimize transfers across the large service area. The network also includes many shorter routes designed to provide service within a few areas, such as Route 16. There is a lot of overlap and inconsistent spacing between routes in some areas.

Connective networks reduce total trip time over a broad area, provide better frequency, and are simpler because they have fewer routes. We do not want to imply, however, that connective networks, which require more transfers, have no downsides.

The largest disadvantage is simply the effort required. Partway through your trip, you must gather your things, exit the bus, possibly walk to another stop, and wait for another bus. The walk will be very short, and the high frequencies mean that the wait will be short as well. Excellent shelter and information will also be provided. But it will still be an inconvenience. The level of effort may also be greater for people with limited mobility.

The second disadvantage is that transferring can compound risks associated with reliability. There is always the fear of missing a connecting bus and being stuck at the transfer hub. In a connective network, this will only occur in cases of major disruption. In routine operations, there should be so many buses along each route that waits would be short. This advantage is not available to lower-frequency networks which depend on pulsing for transferring.

Because they involve consolidation of service to increase frequency, Connective networks also mean that more walking is required to access higher frequency service. As such, the connections-or-complexity question is related to the waiting-or-walking question as well as the broader ridership-or-coverage question.

In the **Direct Service Option**, on the left, there are nine routes in the network and everyone has a one-seat ride, but everyone must wait, on average, 30 minutes for a bus and therefore fewer people find service useful.

In the **Connective Option**, on the right, there are only three routes and only one-third of trips have a one-seat ride, but the average wait for a bus is now only 10 minutes, and even if you must transfer, your total waiting time is only 20 minutes, 33% less than in the Direct Service Option. So more people find the service useful.

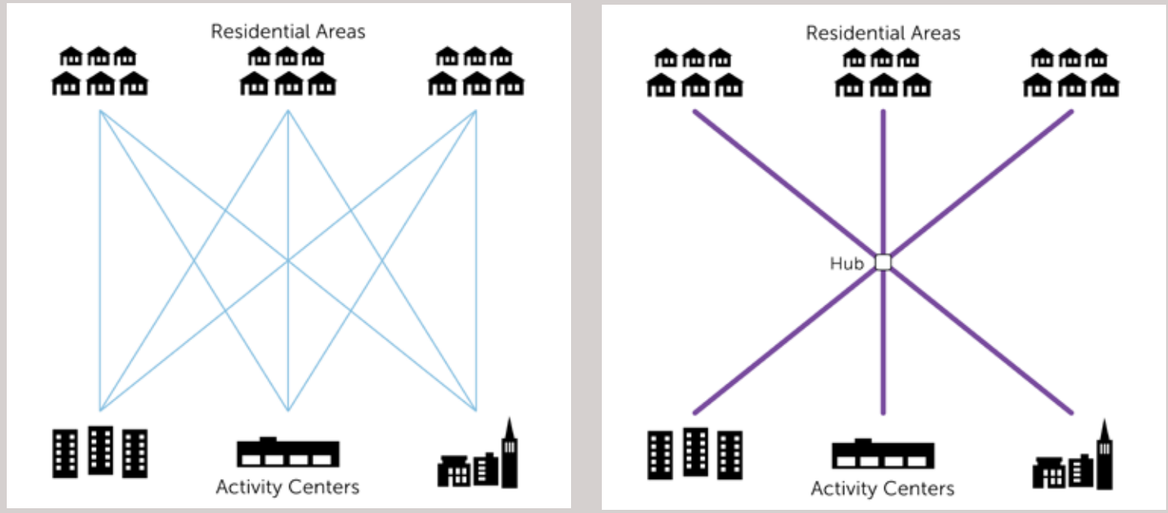


Figure 49: Example of the Connections versus Complexity Trade-off for a simple town.

Transit Supportive City and Region

As discussed throughout this report, the built environment has a strong affect on transit ability to succeed:

Density: How many people, jobs and activities are near each bus stop?

Walkability: How many of the people near the bus stop can actually walk to the bus stop?

Linearity: Can transit reach large numbers of people by traveling straight, direct paths?

Proximity: Can transit reach large numbers of people without crossing long, low-demand gaps?

Transit agencies are commonly placed in a very challenging position. They are expected to provide transit service but they have very little influence in how a city or region chooses to develop. Establishing a clear goal and direction for transit service, including a desired percentage balance of ridership and coverage services, and an agreement with the community on the level of service to provide, can allow a transit agency to more clearly communicate and work with partners in directing future development to be transit supportive.

Once clear direction on transit's goals are set, it becomes easier for the city agencies and regional partners to see how their policy, or land-use decisions will encourage or discourage transit's ability to succeed, business developers will have a clear message on where and how best to build if they want the best access to transit, and the community will have clearer understanding about where and when their transit network is working its best.

Critically, setting a permanent frequent transit network and a planned future frequent network can be a very powerful tool for the transit agency and city to communicate to the public, developers, businesses and others about where transit is a priority and where people and business should locate if they wish to have the best transit access possible.

One area in particular where this issue stands out is the unbalanced distribution of jobs and opportunity across Knoxville and the region. The University of Tennessee and the jobs-rich Kingston Pike corridor are both on the west side of the city. Some of the largest industrial job opportunities are in relatively far outlying communities like Maryville to the southwest. Many job opportunities are in far off Oak Ridge, to the northwest. By contrast, the highest concentrations of people in poverty and people of color are in East Knoxville and North Knoxville, quite far from these areas of opportunity.

Even in a future with expanded bus service, someone has to pay the price of distance. The Knoxville region has apartments, low-wage jobs and essential services spread across enormous distances. Every time new developments are put far away from existing development and existing transit, the people of the region bear the cost of that distance:

- Transit riders spend hours on transit, and hours waiting, to cover that distance.
- KAT or ETHRA or Knox CAC spends more of its budget on distance, which means less can be spent on high frequencies or long hours of service. This undermines ridership potential.
- More people have to own and maintain cars, to access opportunities that in other regions are accessible by transit.

A long cascade of social, health, economic and environmental problems follow from those. The grim news is that transit cannot solve this problem. At current transit funding levels KAT and its partners at Knox CAC and ETHRA can hardly make a dent. Distance must be crossed, which takes time and money that can't be spent towards other things people value.

This planning process will examine ways that transit access can be increased, or valuable coverage can be added, despite the high cost of distance.

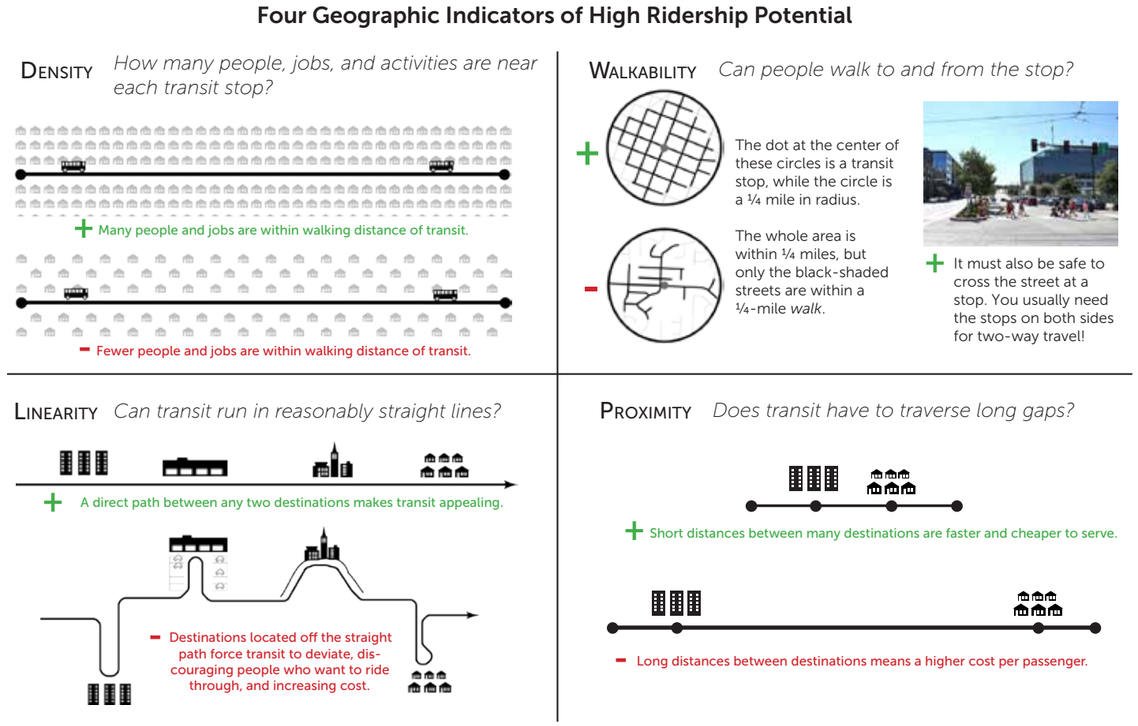


Figure 50: Community Geometry - Four Geographic Indicators of High Ridership Potential

6 Concepts

Introduction to the Network Concepts

To help the community understand how different goals would result in different network designs, this chapter introduces two concepts to show different outcomes under different goals. The two concepts, the Ridership and Coverage Concepts, have the same amount of service, but they show different ways to allocate these same resources.

The concepts differ in the degree to which they emphasize Ridership and Coverage goals. The Ridership Concept puts more resources toward Ridership goals and less towards Coverage goals. The Coverage Concept in this report puts more resources toward Coverage goals and less toward Ridership goals.

The concepts shown in this chapter represent a spectrum of possibilities, and are not intended to be an either/or proposition. By showing the public, stakeholders, and decision-makers the range of possibilities, KAT is asking: "Now that you see the outcomes of emphasizing one goal over another, how should we balance the Ridership and Coverage goals? In other words, if you want better service, what is your definition of better?" When comparing these concepts and their outcomes, the choice is not "Pick one of these two"; rather, it is "Where on the spectrum of possibilities should The KAT bus network be?"

Concepts, Not Proposals

At this stage, the study team is not proposing any specific changes to the network. The public conversation about the concepts will help guide the development of an actual network proposal.

Some features are common to all conceptual networks, but even these are not proposals yet. In designing the Concepts, we are highlighting the Ridership-Coverage trade-off, and to do this, we made a single choice about matters that were unrelated to that trade-off, and kept that choice constant across both concepts. Different choices could have been made, and we welcome public comment about these features of the plan.

None of the staff from KAT, Knoxville, counties, other partners, nor the consultant staff have a preference among the concepts shown in this report.

The most important word to remember is **"if"**. The Ridership Concept shows what might happen if KAT chose to shift toward Ridership goals as the primary goal. No decision has been made yet. The Coverage Concept shows what might happen if KAT chose to provide more network coverage.

The Big Picture Matters More than Details

These concepts have been designed so that they could be implemented with minimal adjustments, yet they are not a binary choice. Their purpose is to illustrate choices at a high altitude. Based on public feedback to the concepts, a final plan will be developed, and details will be filled in, like exact stop locations and turnarounds for the ends of routes.

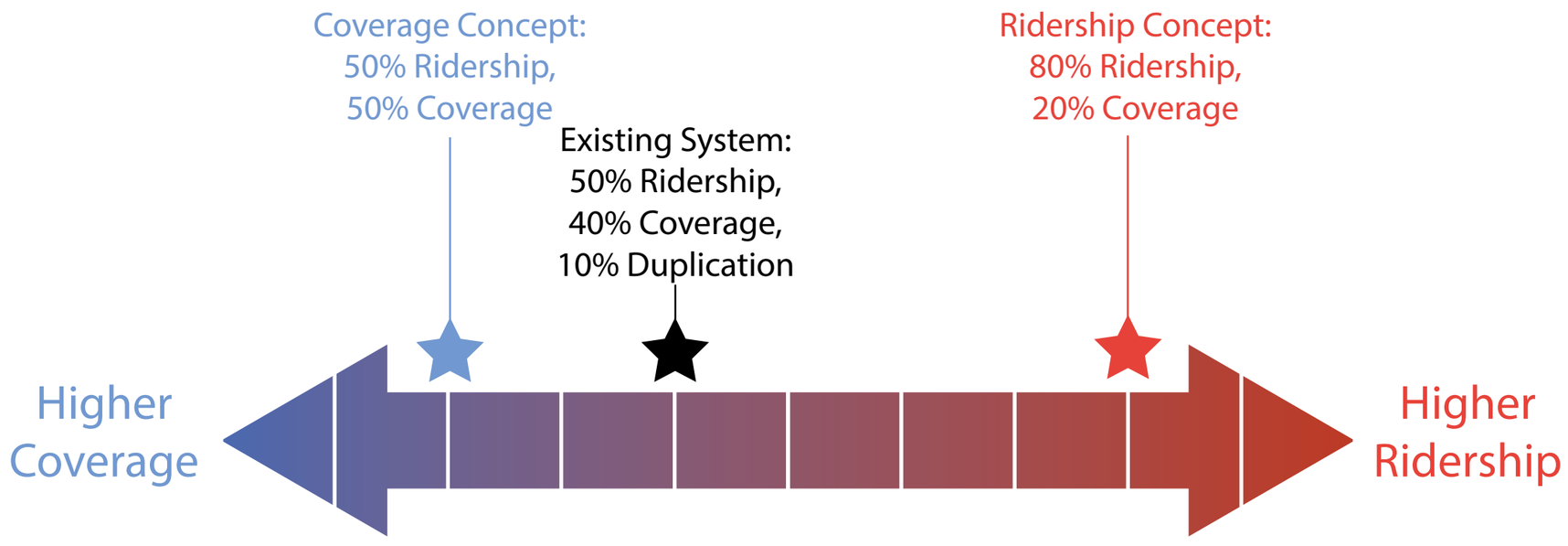
In general, these concepts are intended to be complete descriptions of the predominant midday pattern of services.

No Additional Budget

This is a budget-neutral bus network reimagining, meaning that both the Ridership and Coverage concepts assume the same amount of bus service as was provided in the Pre-Covid Network. Specifically, this is quantified in the total service hours. One service hour is one bus operating for one hour on the street.

This does not mean that the study team thinks that this amount of service is adequate or sufficient to meet all the needs and demands of Knoxville. Instead, these concepts help everyone understand what Knoxville can afford with its current budget for transit.

Figure 51: Spectrum of Transit Choices for the KAT Network. The diagram represent how resources are divided between Ridership goals and Coverage goals/ duplication in each scenario.



Pre-Covid Network

To help the reader compare the Existing Network to the other concepts, maps of each are shown on the following pages.

In each network map, routes are color-coded by midday frequency. The choice of midday, rather than morning or evening rush hour, is intentional. While travel often peaks at rush hour, many people need to travel at midday. Retail and restaurant industries change shifts throughout the day, particularly in midday and later evening. Office workers may need to travel for meetings or personal appointments. College students often attend midday classes. Parents may need to pick up a sick kid from school.

In the network maps, colors make all the difference:

- **Dark Red lines** represent routes that operate every 10 minutes or less;
- **Red lines** represent routes that operate every 15 minutes;
- **Dark blue** lines every 30 minutes;
- **Light blue** lines every 60 minutes.

Pulsing

The existing network includes pulses at Knoxville Station in downtown and at key locations in outer areas. These routes are scheduled to arrive and wait several minutes before departing together, to facilitate quicker, more convenient transfers at these locations. Pulsing is an important strategy to help a lower frequency transit network achieve higher freedom outcomes as it drastically reduces the time needed to transfer. Without a pulse location downtown, it would require much more time to get across town. More information about pulsing can be found on page 44.

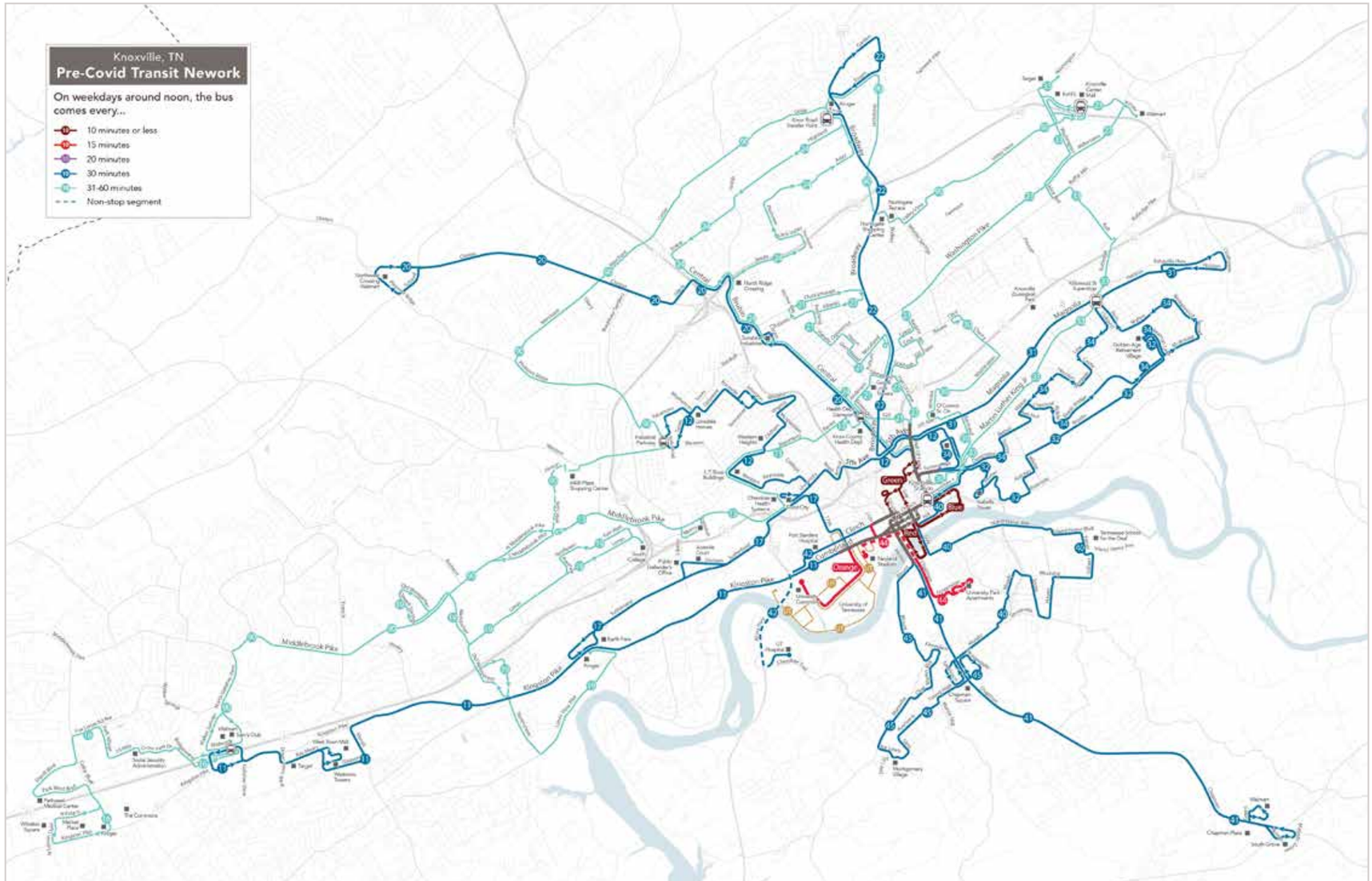


Figure 52: Pre-Covid bus service by mid-day frequency in Knoxville.

The Existing (Pre-Covid) network in Knoxville devotes about 50% of resources to high ridership goals, 40% to coverage goals, and 10% is duplication

Coverage Concept

In the Coverage Concept, all areas served today would still be served by fixed-route service, but this means service is spread thinly. The concept is designed to provide a greater coverage level as the Existing Network.

The map on the right is meant to provide a high-level view of service available across the city and overall design of the network, rather than minor routing details.

To explore this network and its relevance to your life, you can:

1. Find a place you care about on the map using the labeled streets.

2. Note which routes are nearby, by number and by color.

3. Look at the legend to learn weekday frequencies of these routes.

4. See where else the routes go. They may go farther than your routes do today. Changing line colors does not mean riders would have to change buses.

Other information about this concept that you may want to review:

- The table on page 63 shows each route's frequencies, how they change throughout the day, during what hours each route operates, and whether a route runs on the weekend.
- The charts starting on page 65 show the number of residents and jobs served by frequent service and by any service in this concept.
- Maps illustrating how people's travel time would change from various locations around the city compared to the Existing Network, starting on page 69.
- This network includes existign Route 10, which morning and afternoon peak service for

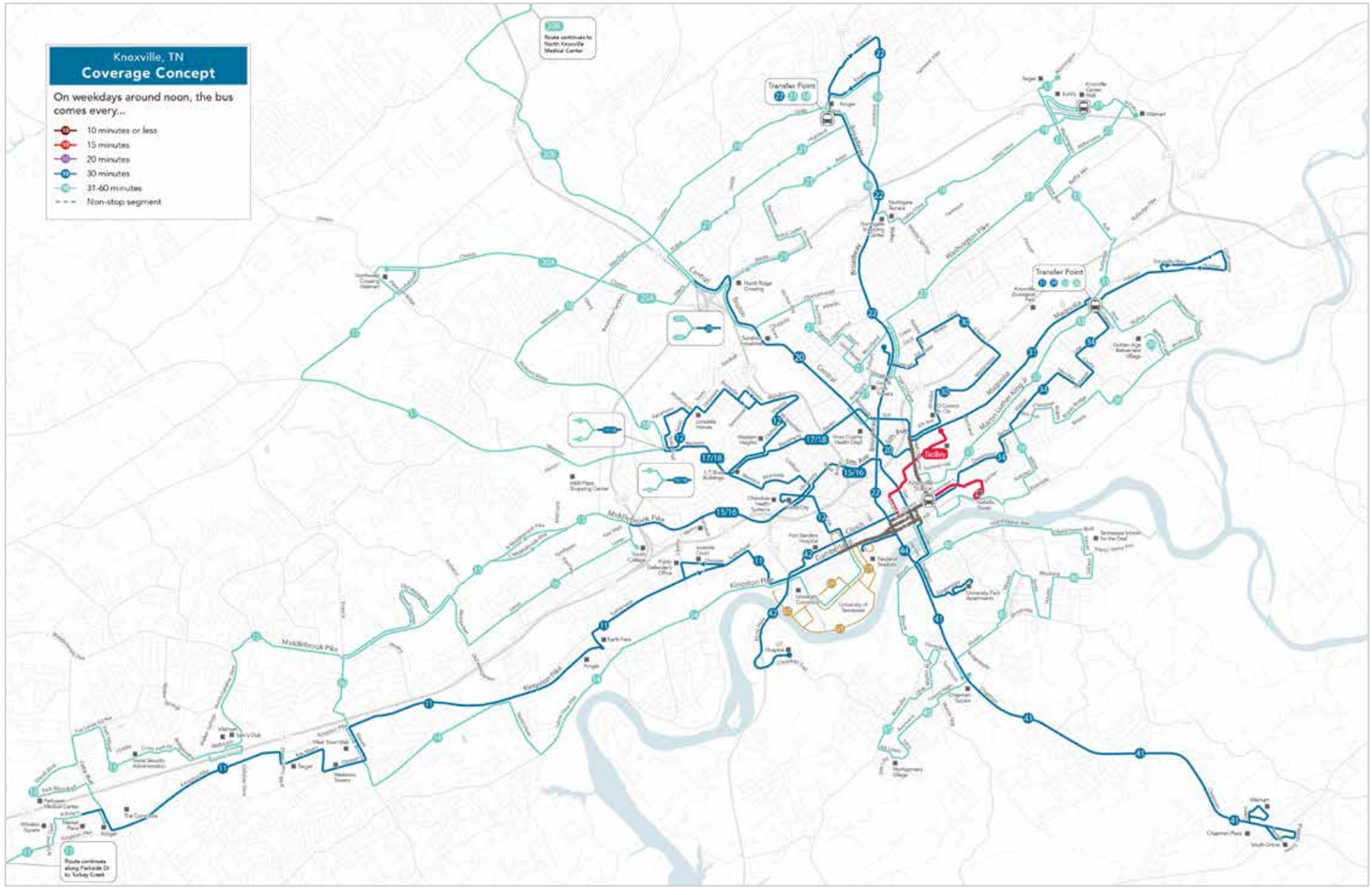


Figure 53: The Coverage Concept showing the mid-day frequency of service.

The Coverage Concept would devote about 50% of resources to high ridership goals and 50% to coverage goals.

Ridership Concept

The Ridership Concept, shown on the right, concentrates more frequent service where there are more people, jobs, and opportunities. This dramatically increases how many useful destinations an average resident can reach in a given amount of time, which is the key to increasing ridership. Concentrating service into fewer but more frequent routes means that some lower-demand areas would be a longer walk from transit service, or not have service at all, in this concept.

This concept concentrates frequent service on the most dense and active corridors, with frequent service on Cumberland/Suthernland, Western, Broadway, Magnolia, and some parts of Kingston Pike. It also provides 30-minute service on corridors that have less frequency today, like Valley View and inner portions of Middlebrook Pike.

The cost of these investments in service is that some outer areas would lose service. For example, the Ridership Concept provides no service to areas along Washington Pike, served by Route 23 today, and the western part of Middlebrook Pike, served by Route 90 today.

The map on the right is not meant to be specific about the details. Instead, it is meant to provide a high level view of the overall picture of frequent and infrequent service available across Knoxville and the overall design of the network.

The project team is certain that, were the Ridership Concept to be implemented, it would get higher ridership than the Coverage Concept. Why are we so certain? Repeated, wide-scale research has shown that higher frequencies and longer spans of service are correlated with major increases in ridership. In other words, people choose transit if it is workable given their destination and their time constraints, so making more destinations accessible within less time for a large number of people is a straightforward way to attract more riders.

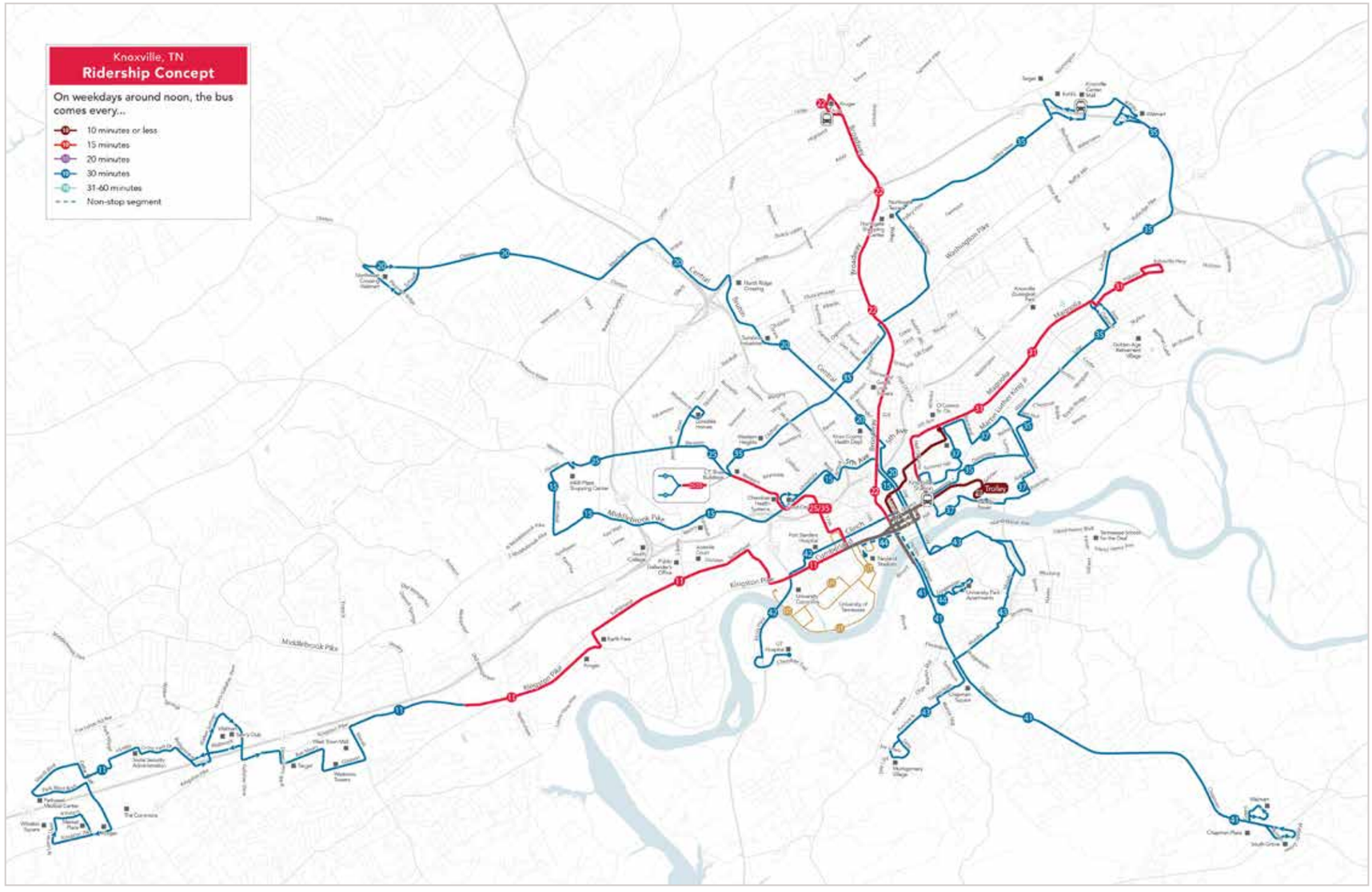


Figure 54: The Ridership Concept showing the mid-day frequency of service.

The Ridership Concept would devote about 80% of resources to high ridership goals and 20% to coverage goals.

Coverage Concept - Downtown

The network of routes through Downtown would generally have simpler patterns than today's network, making it easier for a rider to figure out how to get around downtown. Within downtown, the existing trolley routes are replaced with a new 15-minute trolley route that does something similar to what the Green and Blue are doing today. Apart from the trolley, all other routes are either every 30 minutes or every 60 minutes.

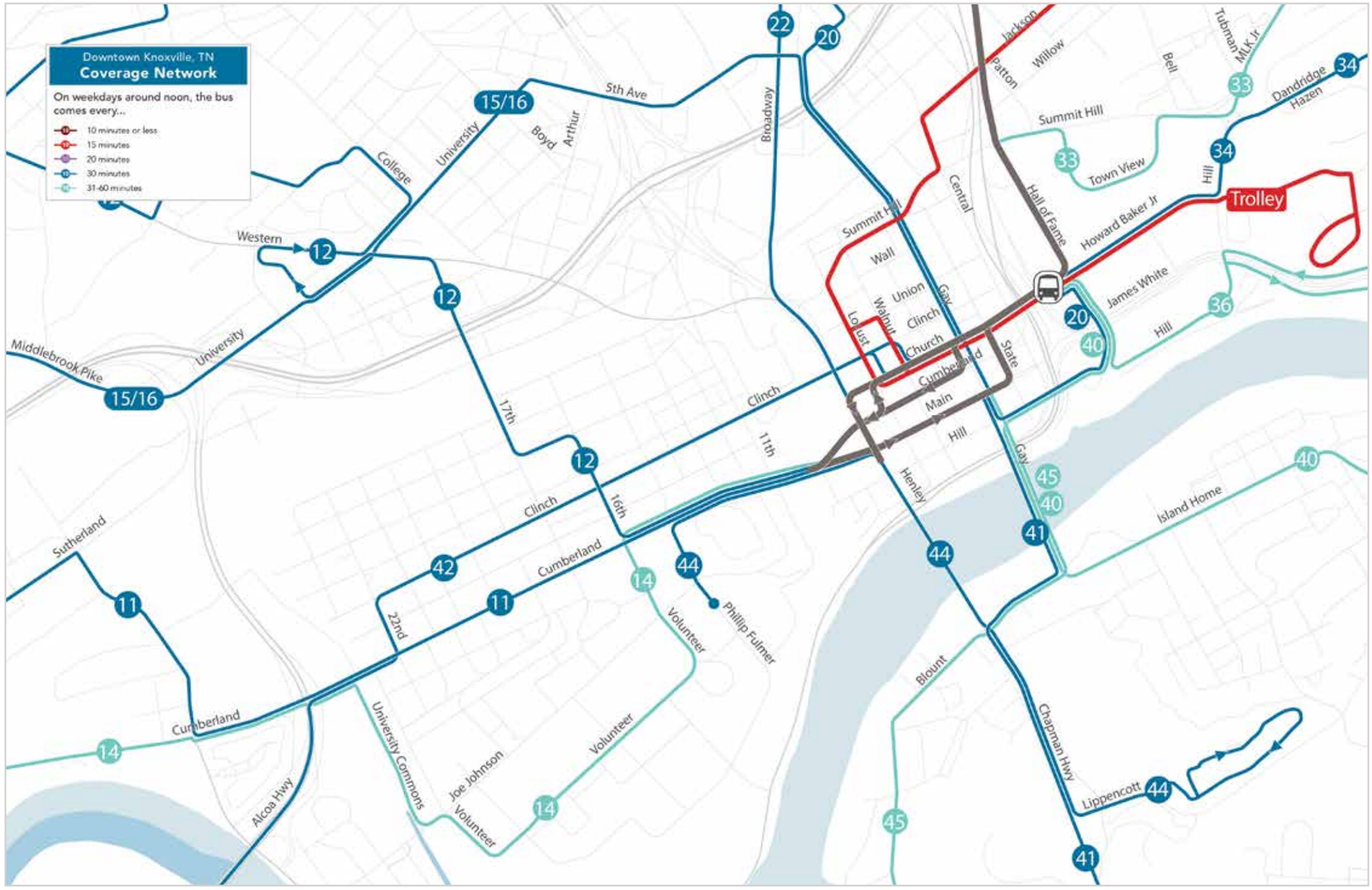


Figure 55: The Coverage Concept in the downtown area showing the mid-day frequency of service.

Ridership Concept - Downtown

In the Ridership Concept Downtown would be served by five high-frequency routes and an even simpler network. Like in the Coverage Concept, the existing trolley routes are replaced with a new trolley route that does something similar to what the Green and Blue are doing today, but it runs every 10 minutes.

Having so many corridors in Downtown with 15-minute routes means that many of the densest parts of Knoxville will have high frequency service and there would be multiple options for connecting across downtown and nearby destinations with relatively frequent service. For example, in this network, the combination of Routes 11, 25, and 35 would provide 8 buses per hour from downtown to the University of Tennessee. Therefore, many more people will find the transit useful.

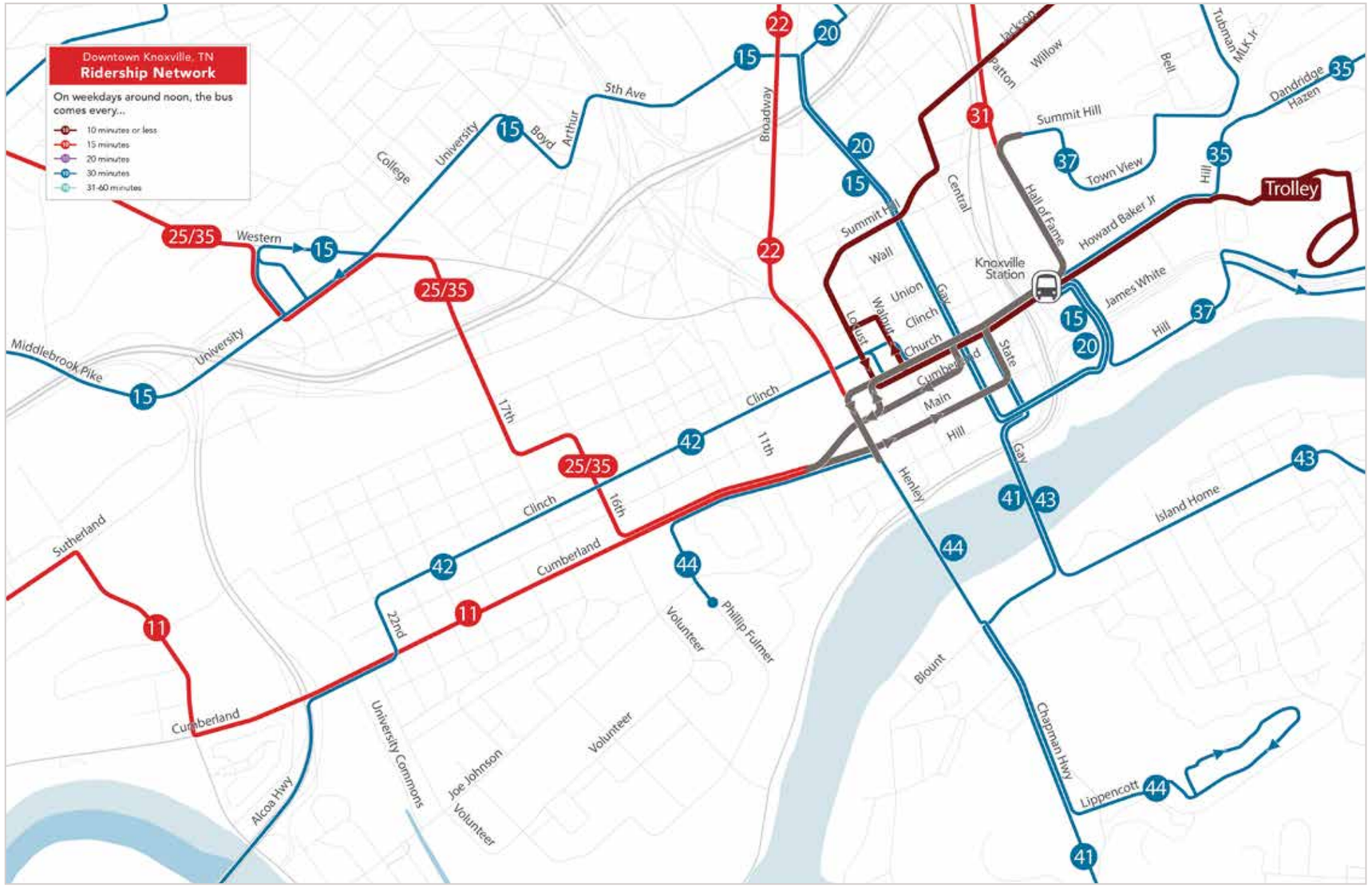


Figure 56: The Ridership Concept in the downtown area showing the mid-day frequency of service.

Span of Service

Coverage Concept

The chart on the right shows the frequency by time of day for the routes in the Coverage Concept. It is intended to closely reflect the frequency of the existing network.

Similar to the Existing Network, the span of service on most routes in the Coverage Concept begins around 6am and ends about 10pm on weekdays. However, the spans are more consistent than in the existing network. Like the Existing Network, though, many routes don't have service on Sunday.

Ridership Concept

The chart on the right shows the frequency by time of day for the routes in the Ridership Concept. It generally has greater spans than the Existing Network and the Coverage Concept. It also consolidates service into fewer routes and proposed higher frequencies on most routes.

The Ridership Concept would include 15-minute service throughout most of the day on routes 11, 22,25/35, 31, and the Trolley. Fewer routes would provide 15-minute service on weekends but all routes would run every 30 minutes instead, still a significant improvement over weekend frequencies in the Existing Network.

This increase in all-day and weekend frequencies reflects the fact that more and more jobs are on nontraditional schedules requiring shifts on weekends or that start in the midday and end later than 6pm. This trend is especially pronounced for lower-wage jobs in retail, healthcare, restaurants and personal services, so improving weekend and evening service helps improve the lives of people with lower incomes.

Many people may be reluctant to use transit because of its inconsistent availability. If someone buys a car to get home after evening or weekend work shifts when transit is unavailable, they may feel that they might as well drive on weekdays too. They are also are much less likely to take transit at all, even if their bus comes every 15 minutes then.

Figure 57: Table of Frequency by Time of Day for the Coverage Concept.

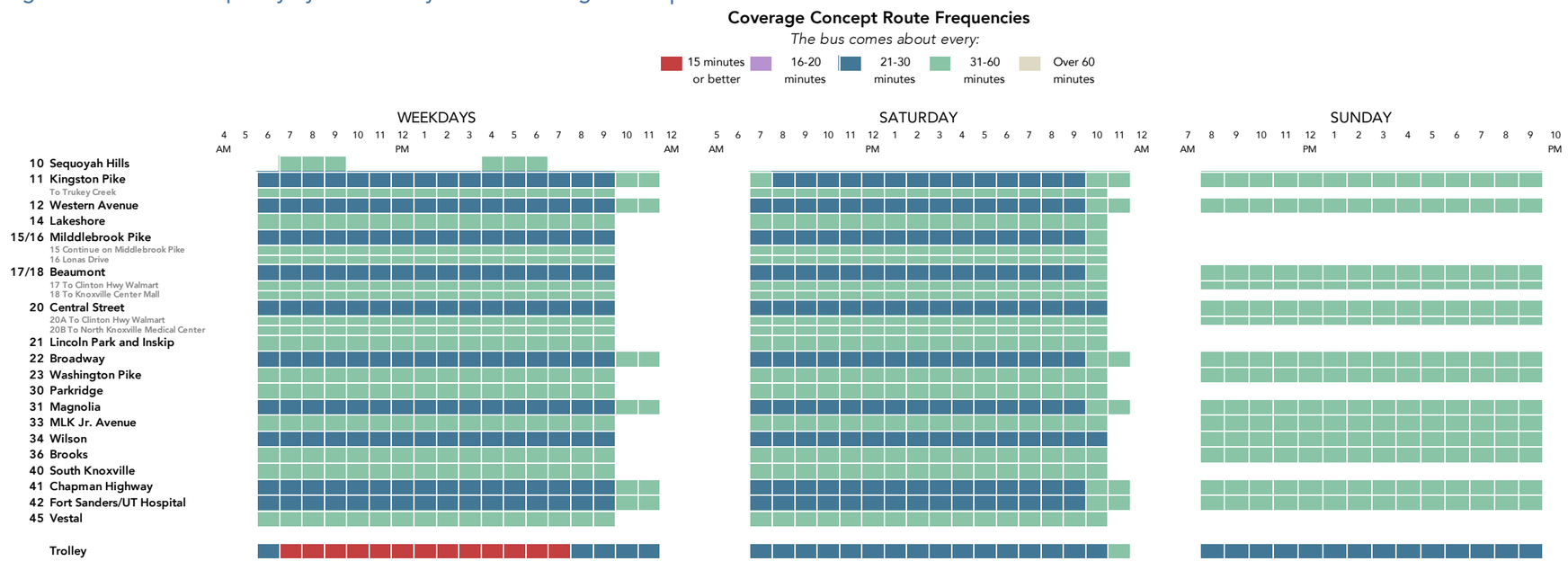
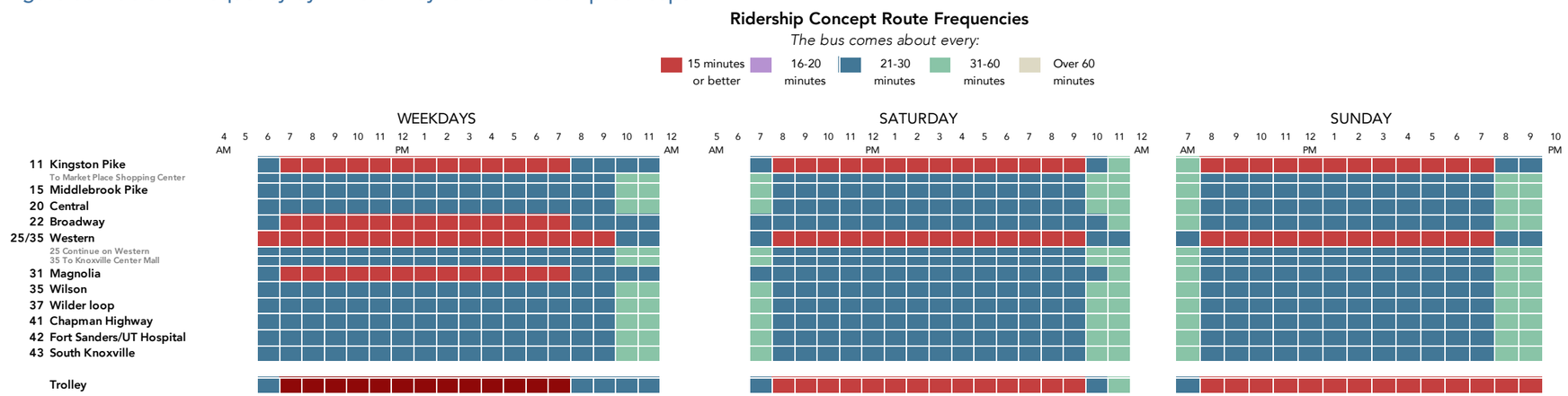


Figure 58: Table of Frequency by Time of Day for the Ridership Concept.



Comparing Outcomes

The design of the networks and when and where service run are important to thinking about how service changes might affect individuals and their trips, but they tell us only so much about the overall affects of these networks. In this section, we look at three different ways of measuring the potential outcomes of the concepts. These measurements are not forecasts. They do not make assumptions about how culture, technology, prices or other factors will change in the next few years. These are simple arithmetic measures that combine existing distance, time and population information to show the potential of each Concept and how they each differ from the existing network.

Proximity outcomes measure how a network achieves coverage goals.

Proximity

The first measure reported, on the next page, is very simple: *How many residents and jobs are near transit?*

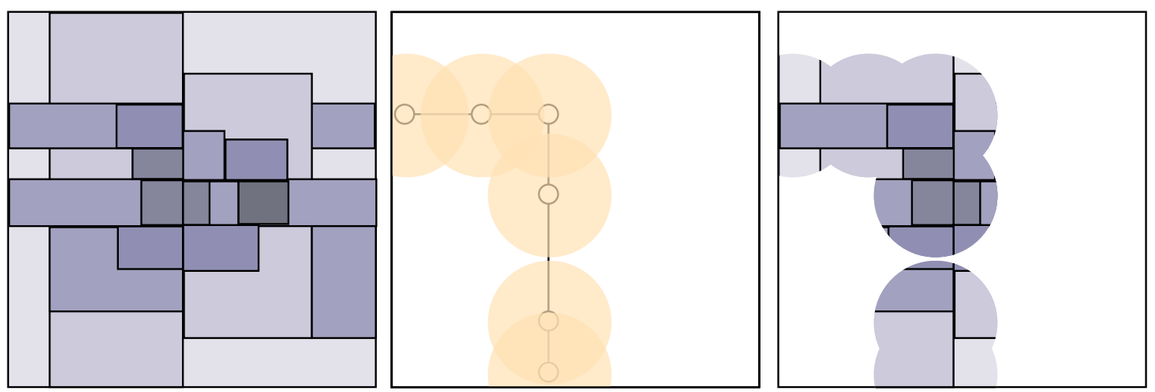
Proximity tells us about how well transit is achieving coverage goals. It does not tell us how useful people will find transit service, only that it is nearby to them. We also report on proximity to frequent transit service, to provide a little more information about how many people are near service that they are more likely to use.

Wall Around Your Life

To understand the benefits of a network change, consider this simple question: *Where could I get to, in a given amount of time, from where I am?*

This question refers to the physical dimension of liberty and opportunity. If you can get to more places in a given amount of time, you will be more free and have more opportunities outside your neighborhood.

Figure 59: Example of how proximity to transit is measured.



Residential Density | Transit Stops and 1/2 Mile Buffers | Residents within 1/2 Mile

Isochrones provide a visual explanation of how a transit network changes peoples' freedom to travel, on foot and by transit, to or from a place of interest. A few examples are included in this report beginning on page 38.

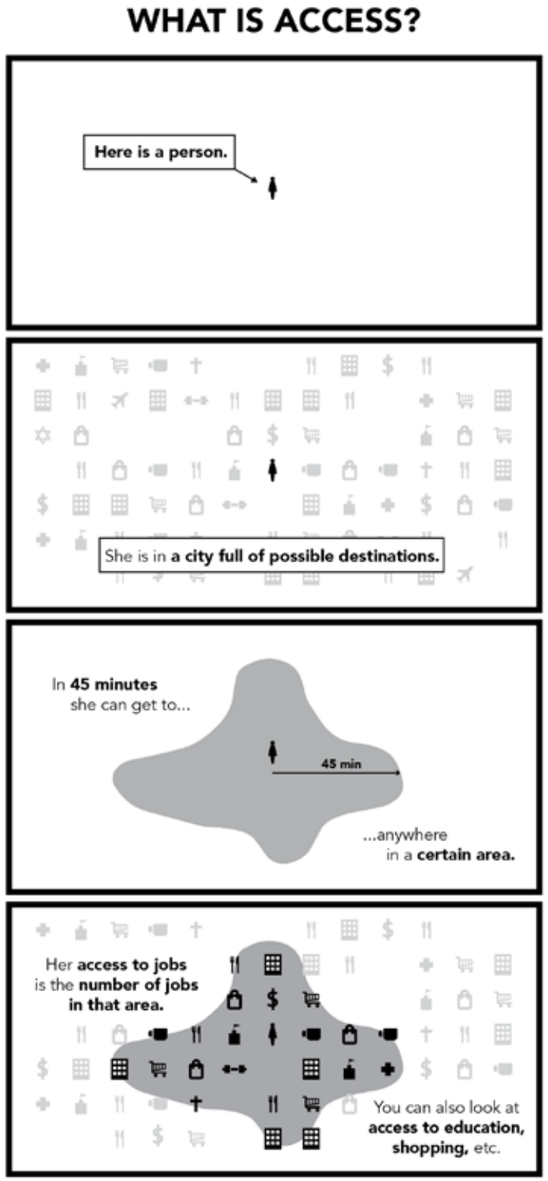
Access

Isochrones display the change in access that a person would experience to or from a particular place. By summing up the isochrones for every single part around Knoxville, we can describe how access to jobs would change for all residents of the service area.

This is a good proxy for a ridership forecast, because it describes the part of ridership forecasting that is basic math and highly predictable: *Could more people access more jobs (and other opportunities) by transit, in less time?* If the answer is "Yes," that implies higher ridership potential.

Access outcomes measure how a network achieves ridership goals.

Figure 60: How transit service creates access to opportunity.



Proximity to Transit

The charts on the right shows the change in residents and jobs near transit in the Existing Network compared to the Coverage and Ridership Concept.

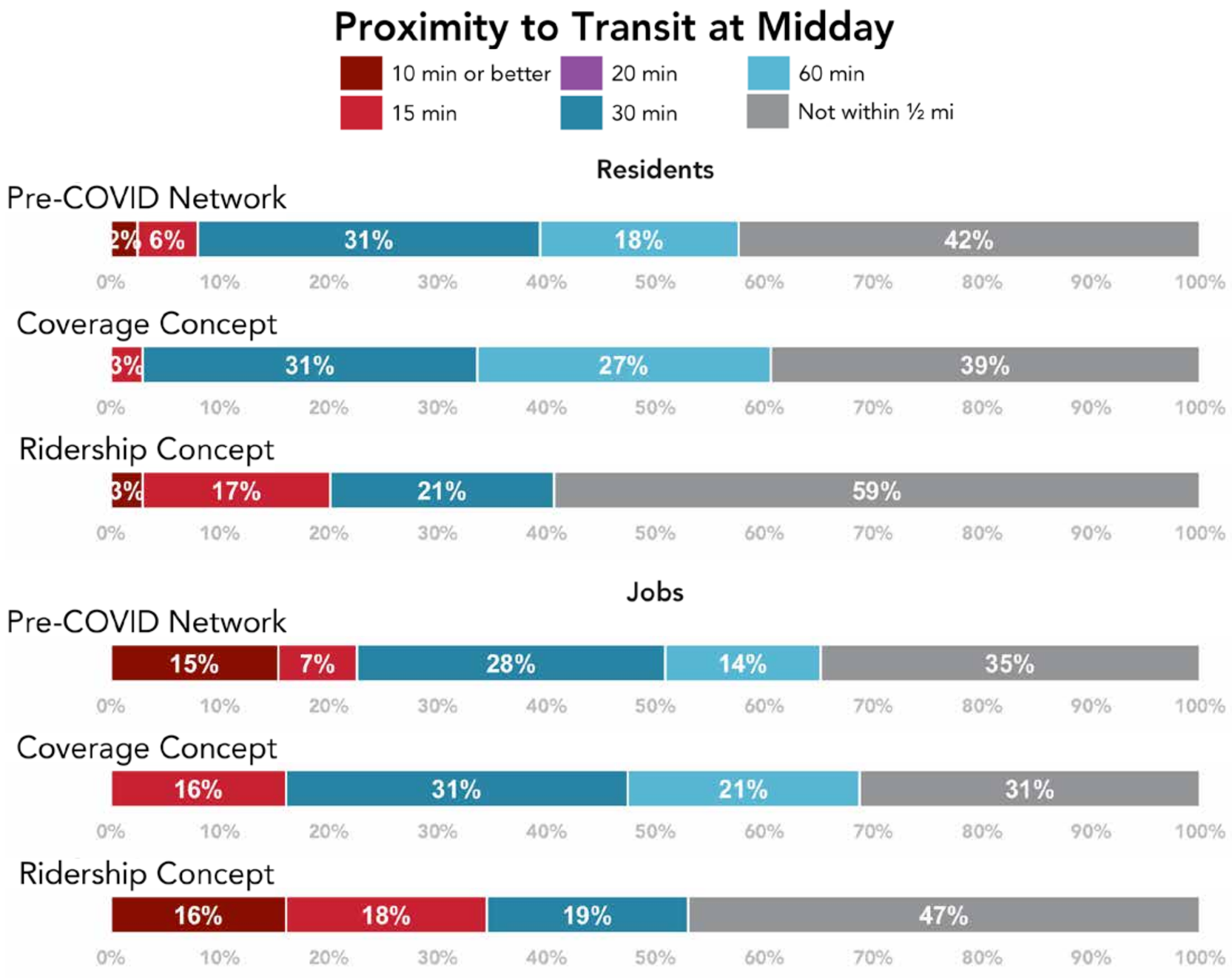
Today, 58% of residents are near transit service and in the Coverage Concept that would increase to 61%. In the Ridership Concept, the percent of residents near service declines to 41%, but of those, 20% would be near frequent transit. So the trade-off for the Ridership Concept is that while fewer people are near service, those that are near service have relatively high frequency service.

For jobs, in today's network, 65% of jobs are near some service, with 22% near 15-minute service or better. In the Coverage Concept, total jobs served increases to 69% of jobs, yet fewer of those jobs (16%) would be near frequent (15-minute or better) service.

In the Ridership Concept fewer jobs are near any service, with only 53% near some service, but many jobs are served by high frequency service, with 34% of jobs near a bus route coming every 15 minutes or better.

In the Ridership Concept, fewer people and jobs are near any transit service, but those with service have much more frequent service.

Figure 61: Chart of the percent of people and jobs in Knoxville served by transit in each concept.



Proximity to Transit: Disadvantaged Populations

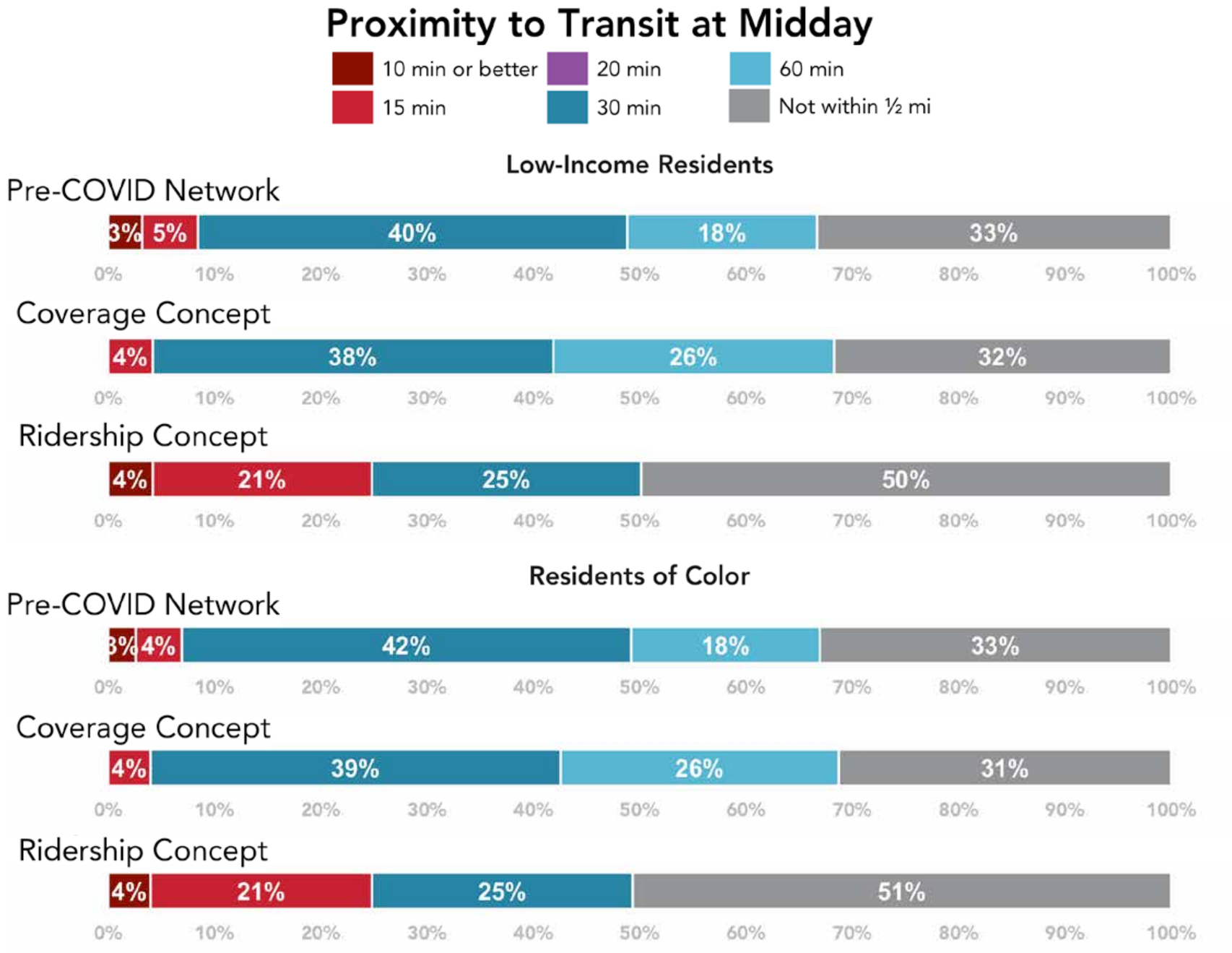
Transit is often tasked with providing affordable transportation for low-income residents, which is why agencies provide service to some people and areas, regardless of ridership potential. Federal laws also protect those with low incomes from disparate transportation impacts, which is why agencies sometimes provide transit service in places where poverty is high, even if this does not maximize ridership. Similarly, federal Civil Rights laws require that transit agencies assess the impacts of changes to service on people of color to ensure there are no disproportionate negative impacts.

The charts on the right show the differences in proximity to service for Low-Income Residents and Residents of Color for the Existing Network and both Concepts. Today, 67% of Residents in Poverty are near any transit service. Under the Coverage Concept, this would increase to 68%, but fewer Residents in Poverty would be near a bus coming every 15 minutes. These shifts are similar to how all residents are affected. Under the Ridership Concept, the percent of Residents in Poverty near any service would decrease to 50%, but 25% of these residents would have access to a bus coming every 15 minutes or better. These shifts are similar to how all residents are affected by the Ridership Concept.

The Coverage Concept affects residents of color in similar ways as all residents, a slight increase in residents who are near any service and a decrease in those near frequent service. Similarly, the Ridership Concept affects Residents of Color in similar ways as it treats all residents. Residents of Color near any service declines from 67% to 49%, but the percent near frequent service increases from 7% to 25%.

Since each concept affects Residents of Color and Residents in Poverty in roughly similar ways to all residents, it is unlikely that these concepts, if implemented, would result in a Title VI disparate impact or disproportionate burden.

Figure 62: Chart of the percent of People in Poverty and People of Color in Knoxville served by transit in each concept.



Freedom, Access, Usefulness

People ride transit if they find it useful. High transit ridership results when transit is useful to large numbers of people. A helpful way to illustrate the usefulness of a network is to visualize where a person could go using public transit and walking, from a certain location, in a certain amount of time.

The maps on the right show someone's access to and from the Kirkwood Transfer Point in 45 minutes, at noon on a weekday in the Ridership and Coverage Concepts. Each concept is compared to the Existing Network. The technical term for this illustration is "Isochrone". A more useful transit network is one in which these isochrones are larger, so that each person is likely to find the network useful for more trips.

In the Coverage Concept Isochrones, the dark gray represents areas that are reachable today and would remain reachable in the corresponding concept. Areas that are newly reachable are shown in light blue, and areas that would no longer be reachable are shown in light gray.

In the Ridership Concept Isochrones, the dark pink represents areas that are reachable today and would remain reachable in the corresponding concept. Areas that are newly reachable are shown in light pink, and areas that would no longer be reachable are shown in light gray.

Not Just the Area – Also What is Inside the Area

The real measure of usefulness is not just how much geographic area we can reach, but how many useful destinations are in that area. The maps show that for trips beginning from the Kirkwood Transfer Point, the Ridership Concept would increase access to residents over the existing network by 49% and increase access to jobs by 73%. The Coverage Concept would slightly increase access to residents and jobs (by 6% and 28.5% respectively).

Ridership arises from service being useful, for more people, to get to more busy places. That's why predictive models of ridership do this very same analysis behind-the-scenes.

When reviewing these maps remember that waiting time counts, and in most cases, a longer walk to a high-frequency route can get people farther and faster, than a shorter walk to an infrequent route. Also remember that some of the access shown in these maps isn't reached on a single route, but requires a transfer. Especially in the Ridership Concept, some places are reachable quickly even when the trip involves a transfer.

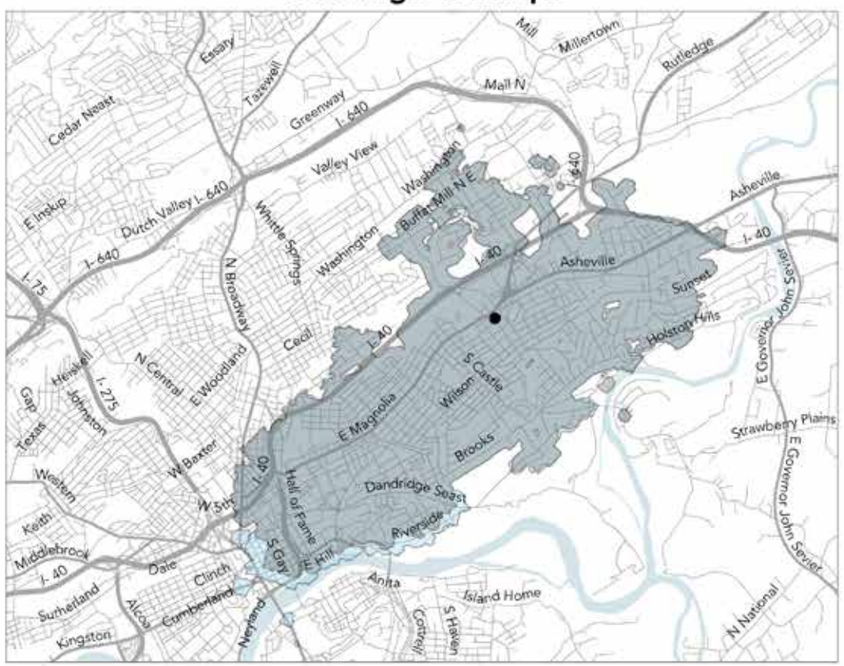
Figure 63: Isochrone maps comparing the access to and from Kirkwood Super Stop in the Coverage and Ridership Concepts compared to the Existing Network.

How far can I travel in **45 minutes** from

Kirkwood Transfer Point

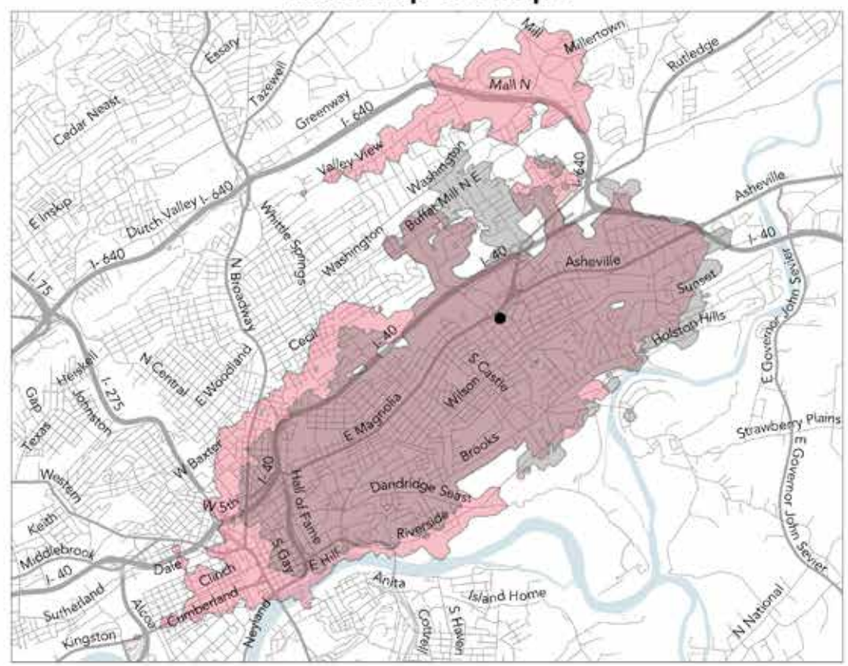
on Weekdays at noon using the:

Coverage Concept



	Change	% Change
Jobs	+6,200	+28.5%
Residents	+1,300	+6.0%

Ridership Concept



	Change	% Change
Jobs	+16,000	+73.0%
Residents	+10,200	+49.0%

Isochrone Examples

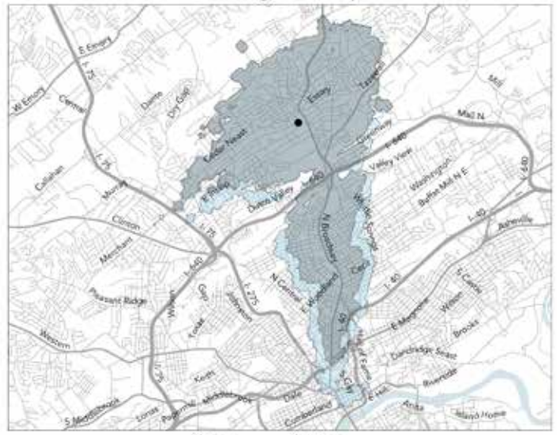
Figure 64: Isochrone maps comparing the access to and from Fountain City (Knox Road), Western Heights, Fulton High School, and the Millerton Pike Walmart.

How far can I travel in **45 minutes** from

Knox Road Transfer Point

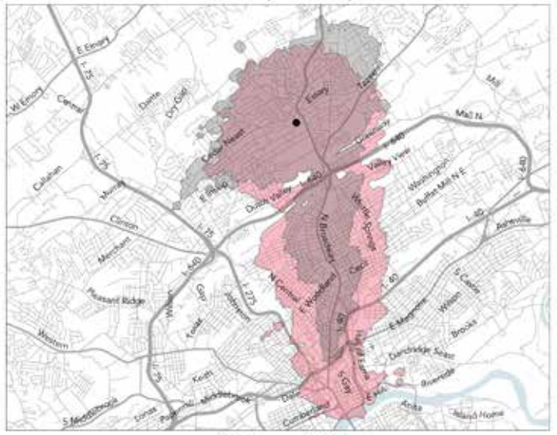
on Weekdays at noon using the:

Coverage Concept



	Change	% Change
Jobs	+17,100	+206.0%
Residents	+6,000	+25.5%

Ridership Concept



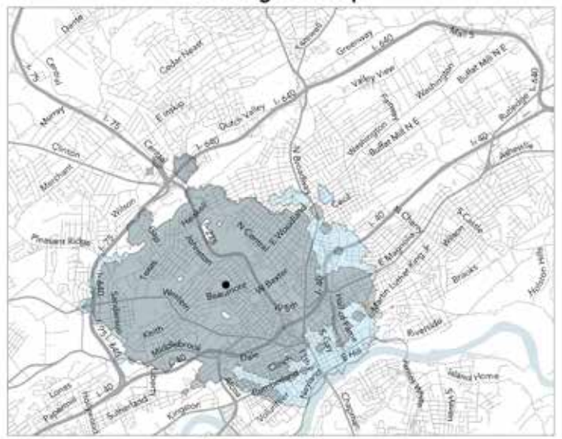
	Change	% Change
Jobs	+31,700	+380.5%
Residents	+10,700	+46.0%

How far can I travel in **45 minutes** from

Western Heights

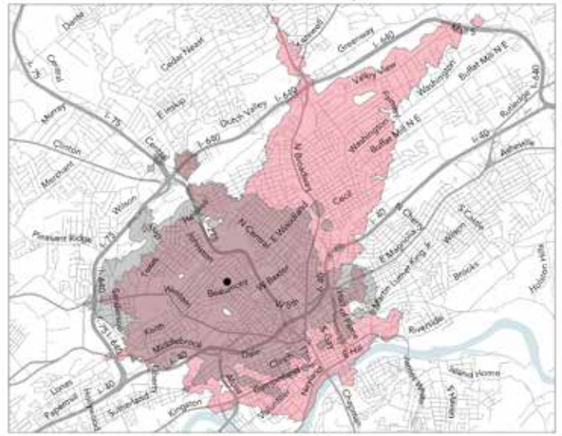
on Weekdays at noon using the:

Coverage Concept



	Change	% Change
Jobs	+18,900	+63.5%
Residents	+7,000	+26.5%

Ridership Concept



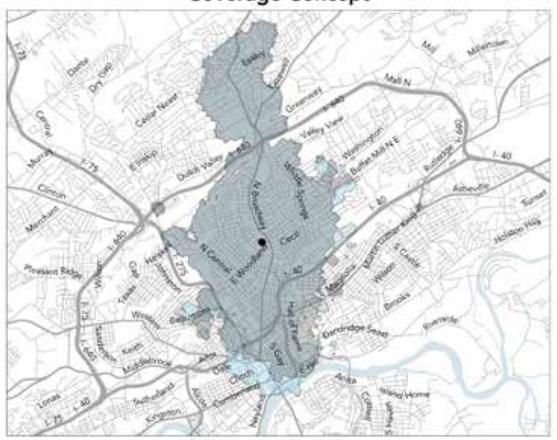
	Change	% Change
Jobs	+26,100	+88.0%
Residents	+19,800	+75.0%

How far can I travel in **45 minutes** from

Fulton High School

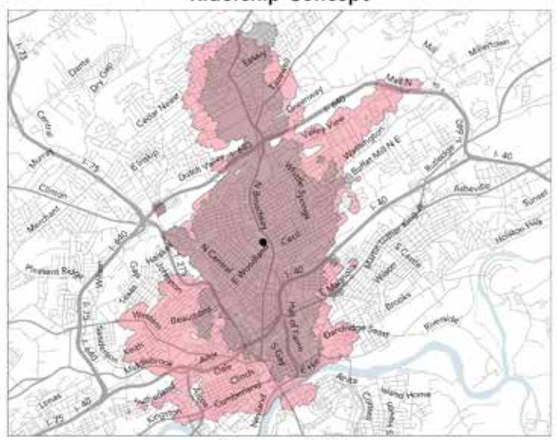
on Weekdays at noon using the:

Coverage Concept



	Change	% Change
Jobs	+3,900	+11.0%
Residents	+3,100	+11.0%

Ridership Concept



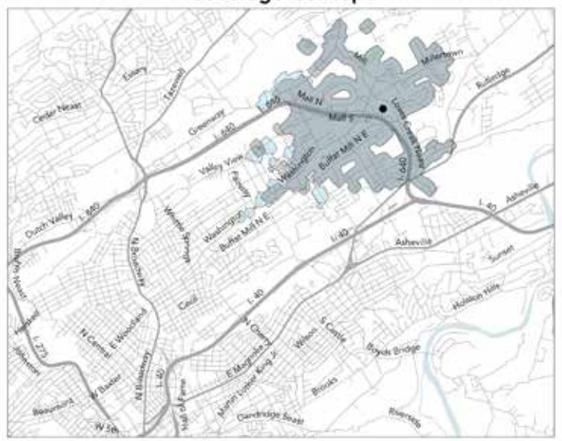
	Change	% Change
Jobs	+20,300	+56.0%
Residents	+24,600	+88.0%

How far can I travel in **45 minutes** from

Walmart Millerton Pike

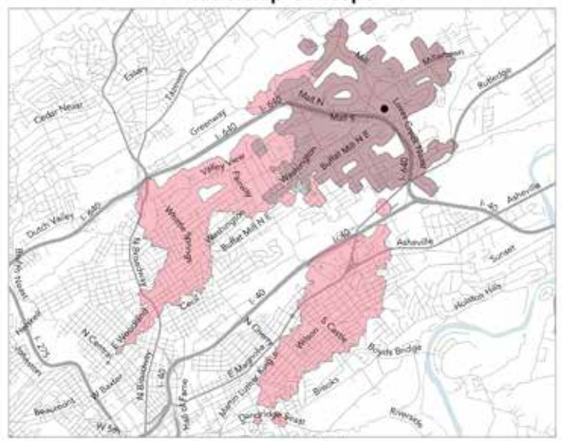
on Weekdays at noon using the:

Coverage Concept



	Change	% Change
Jobs	+100	+5.0%
Residents	+300	+11.0%

Ridership Concept



	Change	% Change
Jobs	+3,000	+134.5%
Residents	+12,100	+399.0%

Change in Access: Coverage

The previous maps show how the concepts expand where people could go in a given time, from certain places and the number of jobs and residents reachable. Again, access to other opportunities, like education on shopping would likely change in a similar way. We can run the same analysis on a grid of locations throughout the city to estimate how access to jobs changes for different parts of the city.

The map on this page and the next summarize the same thing for every part in the city. In this map, every dot represents 20 residents and the color of the dots represents the change in jobs reachable in 45 minutes as compared to the existing network. Blue dots represent more jobs accessible and orange or red dots represent fewer jobs available. The intensity of the color represents the intensity of the change.

The Coverage Concept shows an increase in job access for many parts of the region, particularly outer parts where route simplification or adjustments in frequency mean shorter waits and faster trips. The greatest increase in jobs reachable is along the Middlebrook Pike corridor due to the improved frequency of service which means shorter waits.

There is a decrease in access along certain corridors, in part due to the lower frequencies. For example, along Kingston Pike between Neyland Drive and Sutherland Avenue, the frequency of service is every 60 minutes in the Coverage Concept, compared to every 30 minutes today. So along that section, job access has declined significantly. Along Clinton Highway, the frequency of service has been reduced to 60 minutes so that another branch of Route 20 can be sent to North Knoxville Medical Center. Therefore, outer portions of Clinton Highway have lower job access in the Coverage Concept.

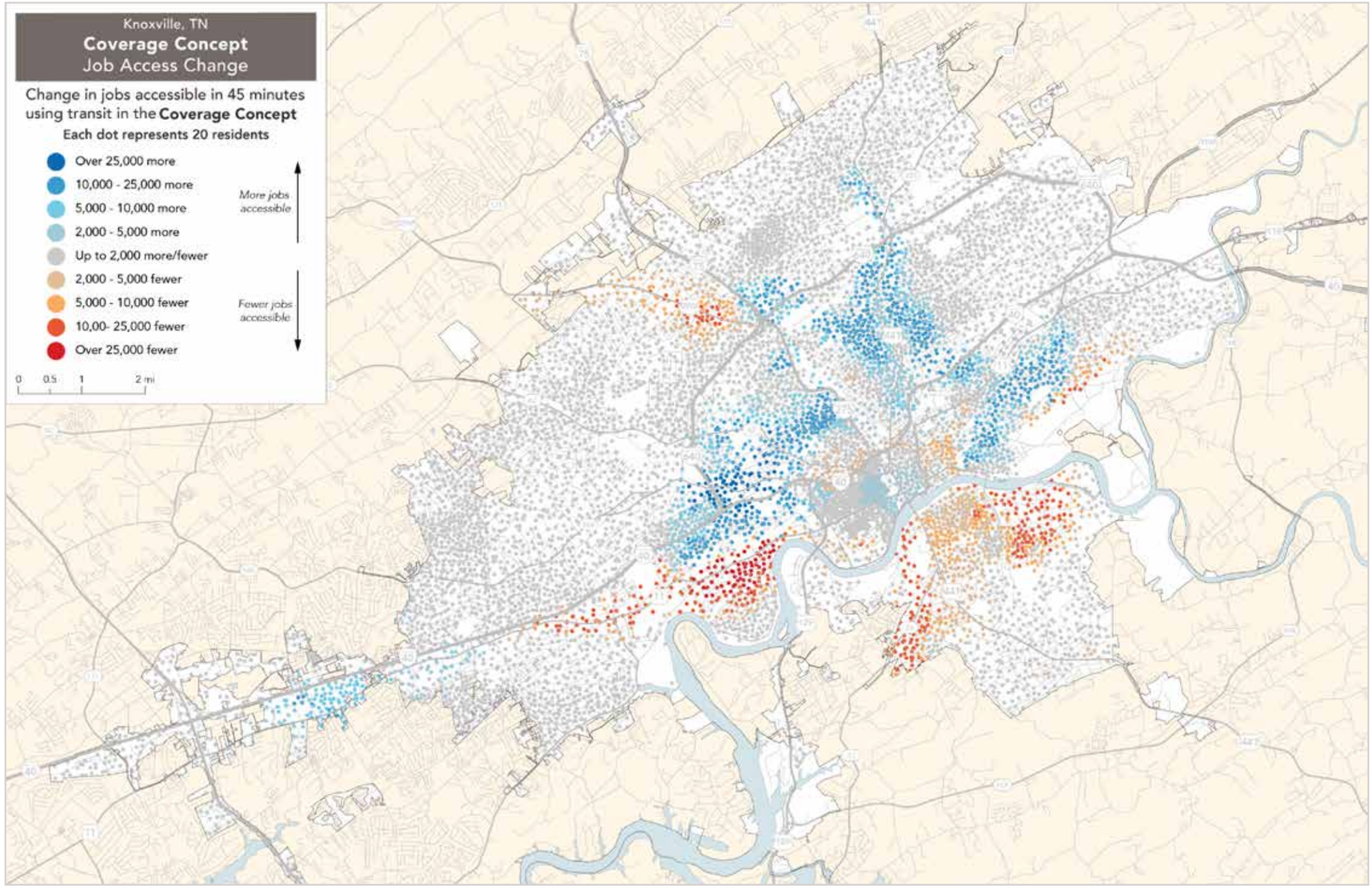


Figure 65: Change in jobs reachable in 45 minutes for all parts of Knoxville under the Coverage Concept.

Change in Access: Ridership

With more frequent routes across the busiest and most dense parts of the city, the Ridership Concept increases access to jobs and opportunity across much of Knoxville, and particularly closer to the core. Traveling across large parts of the city, particularly in the most dense areas, would be much faster, because waiting times would be much shorter, both for the initial wait for a bus and for a connection. The Ridership Concept would require people to walk longer distances, but it will get most people farther and faster to their destinations, primarily due to shorter waits.

There are large increases in access to jobs throughout the region. Areas along Cumberland, Sutherland, Broadway, Magnolia, Western, and many more corridors see significant gains in job access due to more frequent service. Some neighborhoods where frequency has not improved also see an increase in job access due to the frequency improvements across the rest of the network reducing travel times across the city. For example, in South Knoxville more dense neighborhoods like Old Sevier, Lindbergh Forest, and portions of Vestal see an increase in job access, even though frequency of service has not increased along Routes 40 or 41. With so many more frequent routes to connect to within downtown, these neighborhoods can now reach the many jobs in Fort Saunders and other job centers beyond downtown in less time.

Some areas see declines in access. For examples, areas like Sequoyah Hills see a decline in access because there is no longer service nearby. Island Home and South Haven in South Knoxville see a decline due to the removal of segments of Routes 40 and 45. Areas along Brooks Avenue in East Knoxville see a decline in job access due to the reductions in service on that corridor in the Ridership Concept.

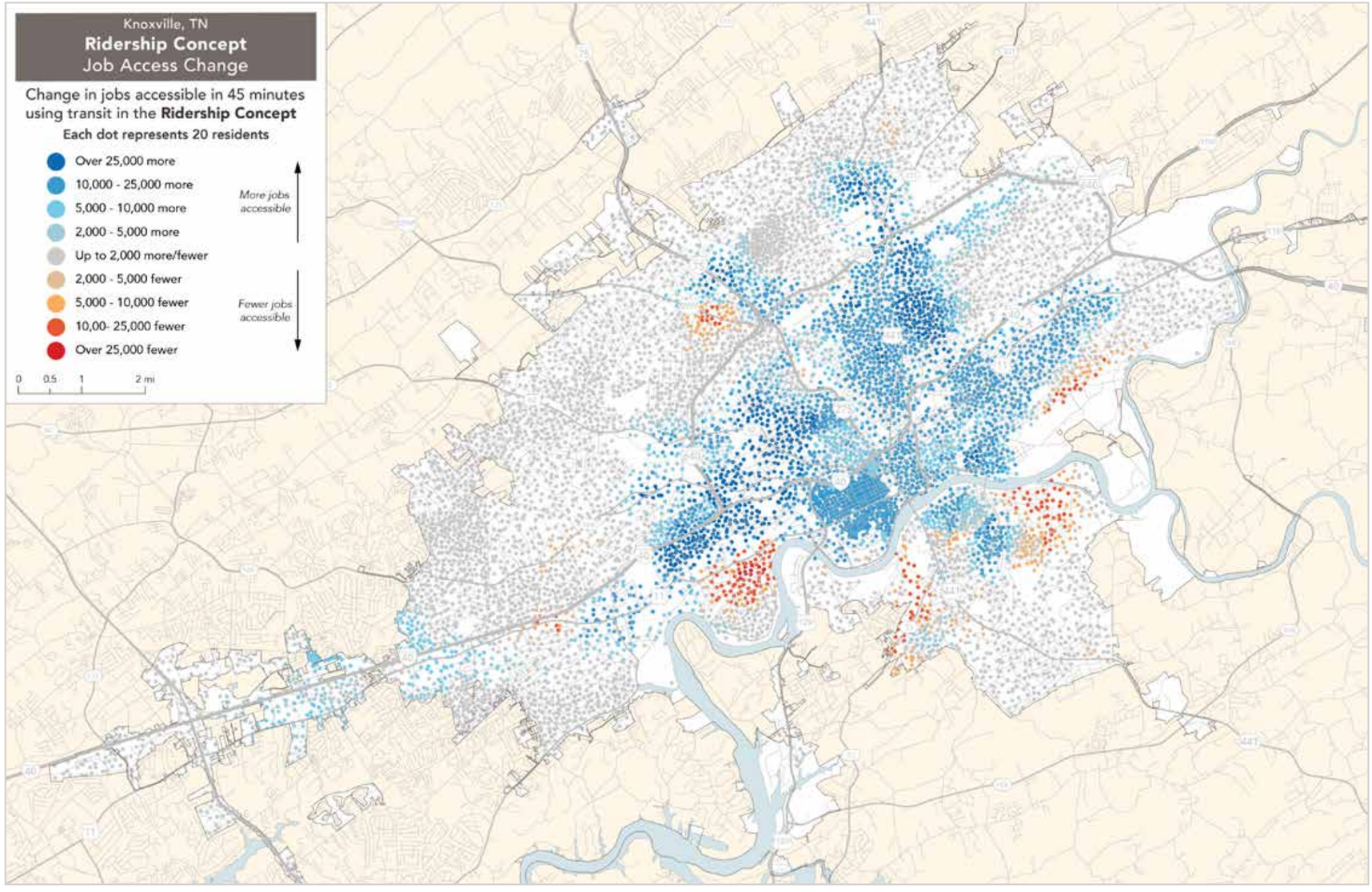


Figure 66: Change in jobs reachable in 45 minutes for all parts of Knoxville under the Ridership Concept.

Change in Access

The maps on the previous pages show the two concepts change access to jobs for different parts of Knoxville. By adding up all the increases and decreases across the city, we can estimate how each concept changes the access to jobs for the typical person in Knoxville.

The chart Figure 67 shows the change in how many jobs the median person could reach by walking and transit in 45 minutes. In the Coverage Concept this would decrease by 14%. When service is spread more thinly, more people have access to some service, but the average access goes down.

In the Ridership Concept, the improved frequency of service substantially increases the number of jobs the median person could reach by 33%. So while fewer people have access to some kind of service, those who have access, can reach many more opportunities.

It is also worth considering how these job access factors change for people in disadvantaged situations. The Coverage Concept would increase access to jobs for people of color by about 13% because it improves service in areas where these residents live more so than non-minority residents. For low-income residents, the Coverage Concept increases job access by about 5%. Since both groups see greater gains than the average resident, the benefits of the Coverage Network have been distributed in an equitable manner.

The Ridership Concept substantially increases the access to jobs for both disadvantaged population groups. For people of color, the Ridership Concept increases access to jobs by 86%. For low-income residents, the Ridership Concept increases the number of jobs accessible by 83%. The Ridership Concept improves job access for both disadvantaged population groups more than it does for the average resident, so again, since its job access benefits are more concentrated among these groups, it appears that the benefits of this network have been distributed equitably.

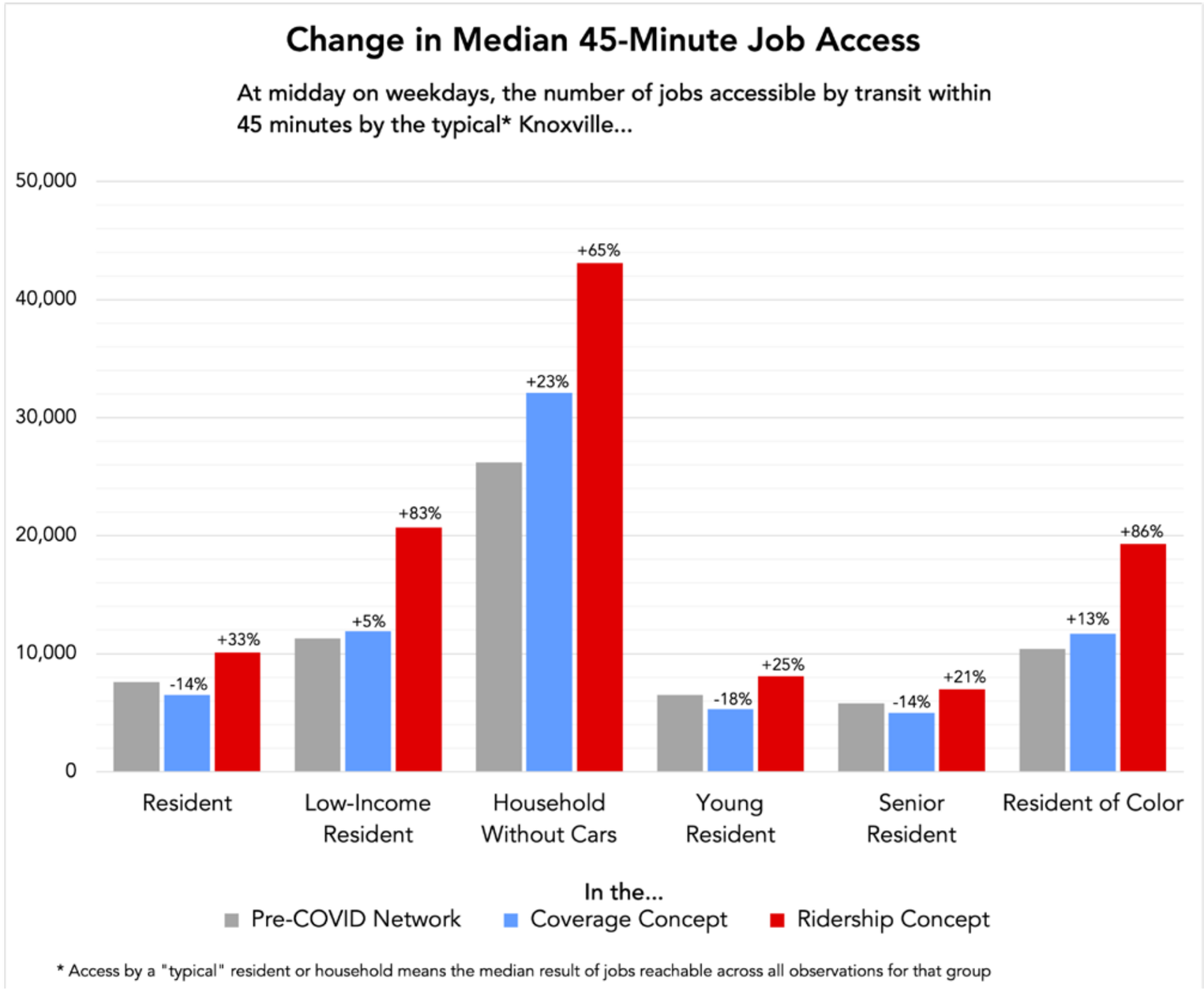


Figure 67: Chart comparing jobs reachable for the typical person in Knoxville by subgroup.

Next Steps

If you're interested enough to read this far, we'd love to have you more involved in this project!

This report is the first step in working with the public for KAT Reimagined. It kicks off a round of public engagement for KAT to help guide the Board's decision of whether to change how it balances the goals of high coverage and high ridership.

In March and April, members of the project team, KAT staff, and others will be engaging the public through media outreach, social media engagement, surveying at key transit centers, and public meetings. The project team will also engage with a select group of local representatives called the Stakeholder Advisory Group. Through this process, we need you to tell us what you think about these concepts and what priorities KAT should emphasize as it thinks about a new network.

Building on the input we get from you, the project team will develop a draft Network Plan beginning in May. The Draft Recommended Network will include maps of the new routes, and measures like job access change and proximity to service will be summarized in a report for the public and stakeholder to review by July. If KAT decides to move ahead with any of the recommendations of the Draft Recommended Network, then there will be additional community notification before any actual service changes are made.

For more information and to stay involved in the project, go to www.katreimagined.com to

- take the survey;
- email the team to ask questions;
- find out more about meetings and events where you can learn more about the KAT Reimagined process; and
- generally stay up to date on the latest happenings with the network redesign process!

Who will be consulted?

Many different people will be involved in guiding this plan:

- Transit riders
- People living on low incomes
- People of color and non-English speakers
- Civic and neighborhood leaders
- Employers and businesses
- Municipal staff
- Local elected officials

How to get involved

For more information and to stay involved in the project, go to www.katreimagined.com and:

Learn More

- Get more background on the project
- See scheduled events
- Sign up for project emails

Give Input

- Take the online survey
- Sign up for our online meeting
- Connect via social media

Share with Others

- Find videos, articles and reports to share
- Request a community presentation