Metro Transit Network Redesign

Choices Report

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metro transit | Network Redesign

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1 Introduction

The Metro Transit Network

Madison's Public Transportation System

In Madison, public transportation is provided by Metro Transit, a division of the City of Madison's Department of Transportation. Metro Transit provides two kinds of service:

- **Transit.** This is the service offered by most buses, operating on fixed routes and following published schedules. Anyone in Madison can use transit by boarding a bus at a bus stop and paying the appropriate fare.
- **Paratransit.** This is a specialized door-to-door service for people with disabilities that make it difficult to use transit. Paratransit is part of how Metro Transit fulfills its obligations under the Americans with Disabilities Act (ADA).

When we talk about the "transit network", we mean the network of regular bus routes. This redesign does not envision changes to paratransit. As of early 2021, the transit network includes:

- 23 routes that operate all day, seven days a week. Service typically starts between 5 and 7 AM, and ends around 11 PM.
- 18 routes that operate on weekdays only, including ten routes which operate only during the morning and afternoon peaks (more or less 6 to 9 AM and 3 to 6 PM).
- 4 weekend-only routes. These routes combine one or more weekday routes to expand the area coverable by a single bus on weekends.

The map in Figure 1 shows the routes currently operated by Metro Transit.

Although Metro Transit service is centered around City of Madison, some of its service is funded by neighboring municipalities, and by organizations such as the University of Wisconsin and the Madison Metropolitan School District.

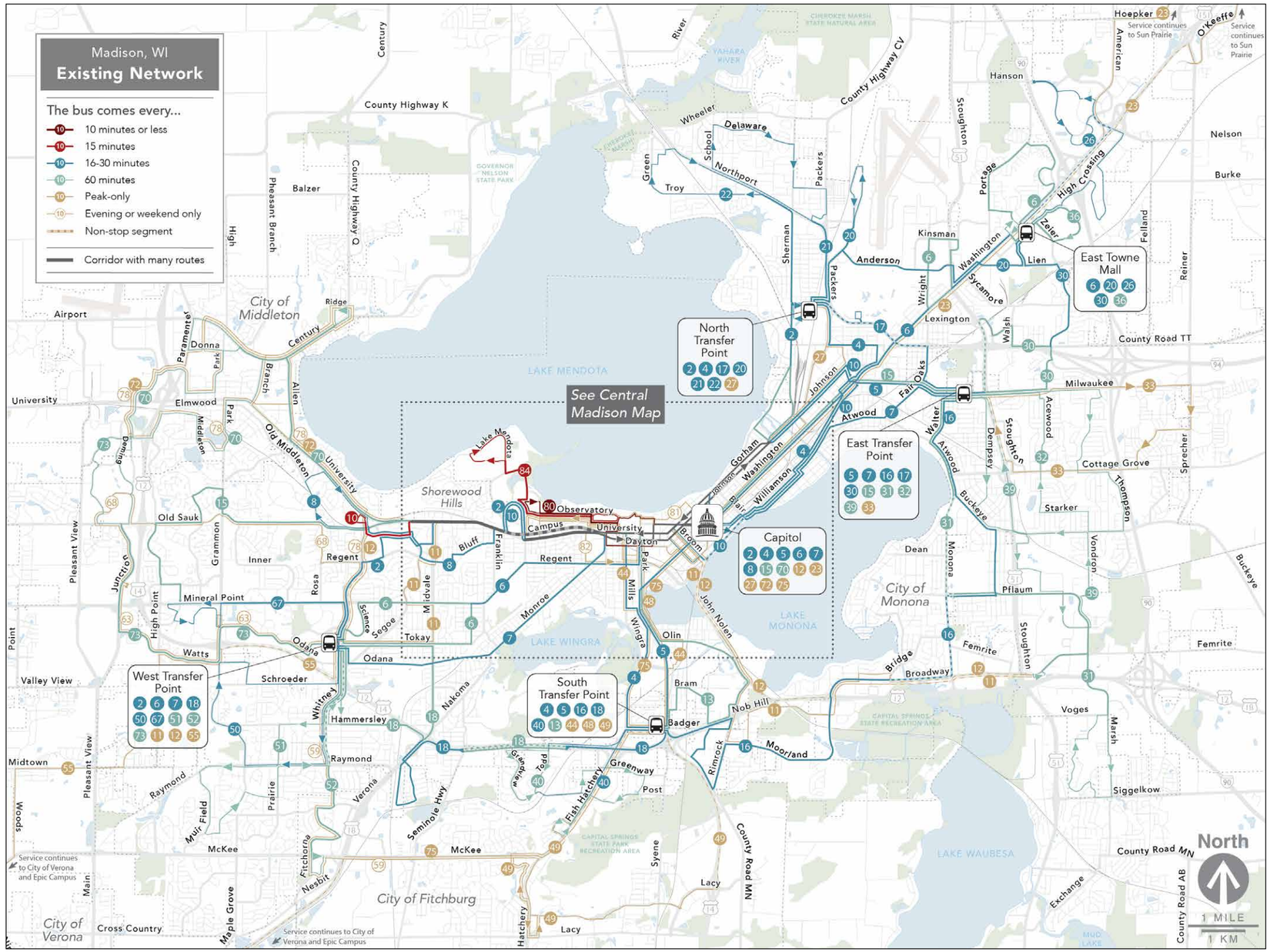


Figure 1: Metro Transit network of bus routes, as of early 2021. The network is centered around Downtown Madison, where many routes converge. Most outlying areas are served by routes that connect to a local transfer point, where passengers can transfer to routes going Downtown or across town.

What makes a transit network useful?

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.

Think of this blob as a "wall around your life." Beyond this area are things you can't do because it simply takes too long to get there. The extent of this area affects your options in life: for employment, school, shopping, or whatever places you want to reach.

The technical term for this is access, but it's also fair to call it freedom, in the physical sense. If you can go to more places, you have more choices, so in an important sense you are more free.

How Transit Expands Access

The basic point of transit is to increase the number of useful places people can access in a reasonable amount of time without driving, beyond the area they could reach on their own.

On transit, the extent of your access is determined by:

- The **network,** including transit lines with their frequency, speed, and duration. These features determine how long it takes to get from any point on the network to any other point.
- The **layout of the city.** This determines how many useful destinations can be located near transit stops. For example, where there are more people or useful destinations near a given stop, good access from that point is of value to more people.
- Your **location.** This determines which routes are close and frequent enough to be useful to you.

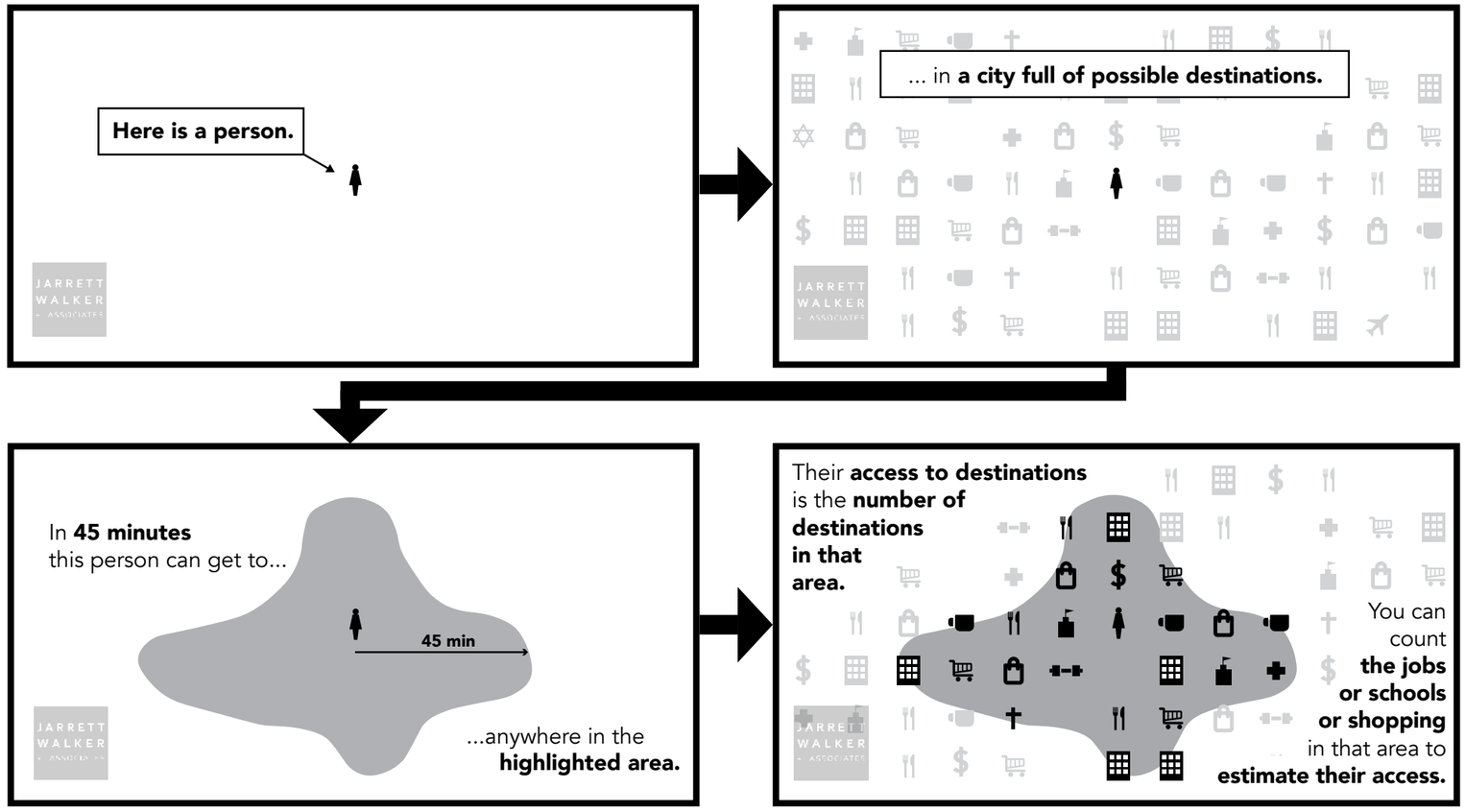


Figure 2: Access is the ability to get from your current location to places you need to go. The more places you can access in a reasonable amount of time, the more freedom you have to live your life in the way you need. Transit helps increase this freedom by providing access to more places, without needing to drive.

Transit helps expand the area reachable in a given amount of time, without needing to drive. The more the transit network makes this possible, the more useful it is.

Why does the transit network need a redesign?

A twenty-year old system...

The basic shape of Madison's current transit network was established in 1998. The system revolves around five hubs:

- The **Capitol** in Downtown Madison, where many routes converge on their way to and from different sides of town. Most Downtown routes are in fact connecting two of the:
- **Four Transfer Points** (North; East, South and West). Most outlying parts of Madison are served by bus routes that connect to a Transfer Point. From there, passengers connect to a second route to go Downtown or across town.

...that leaves some people and places behind...

The Transfer Point system has some advantages. By combining people from many routes onto the same bus going into downtown, it uses resources efficiently, which enables Metro Transit to provide more extensive service. Timed connections also make it easier for people to travel within their side of town, or between areas far from downtown.

The disadvantage is that transfers impose delay on the passenger. That time can be worth it in the context of a fairly long trips, but Metro Transit is unusual in requiring transfers for many short trips into downtown, increasing travel times from the affected areas. This problem is largest in the North and South parts of the city, which can have long travel times over short distances.

This is illustrated by Figure 3. This map shows that Metro Transit can connect people to many jobs in 45 minutes or less if they live close-in, but not if they live farther out than the Transfer Points.

This contrast is further illustrated by the examples provided in Figure 5 on page 8.

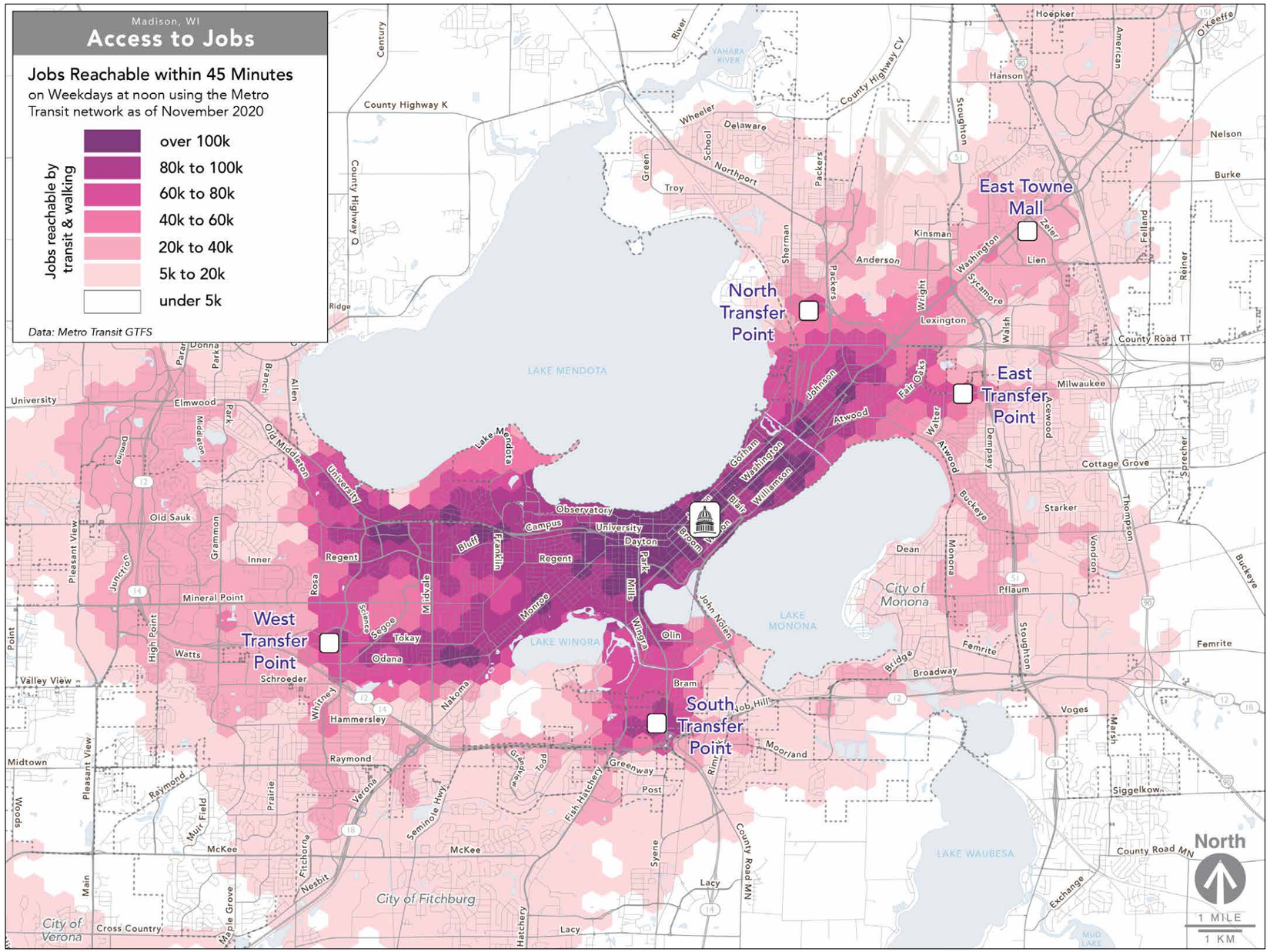


Figure 3: Map showing the number of jobs accessible in 45 minutes or less by transit and walking, on a weekday at noon. Transit provides relatively high levels of access to jobs and opportunity in central Madison, and very low levels of access in areas farther out than the Transfer Points.

...and can be confusing even where it works best.

The hourglass shape of central Madison means transit service naturally converges on a small number of streets as buses approach Downtown. This is both necessary and useful, providing the most service in the areas where the most people are nearby to use it.

But **even though bus volumes are high Downtown, the actual frequency of service tends to be fairly low**. This is the result of decisions that favor service in many directions over service that comes often. For example, on Gorham and Johnson streets:

- Routes 2, 5 and 10 each operate every 30 minutes on weekdays, all day. That's six buses per hour per direction.
- Six buses per hour is enough to provide a frequency of every 10 minutes along this segment, which would be useful for local travel, but the routes are not scheduled to do that. Instead, there's a bus every 12 to 18 minutes eastbound, and every 4 to 15 minutes westbound.

There are similar situations on every major east-west street Downtown: East Washington, Jenifer, and University Avenue. And on each of these streets and many others, service is further complicated by routes that change or don't operate on weekends and evenings.

The result is that **there are many buses on many streets, but there are relatively few trips anyone could take where the fastest bus comes more often than every 30 minutes.**

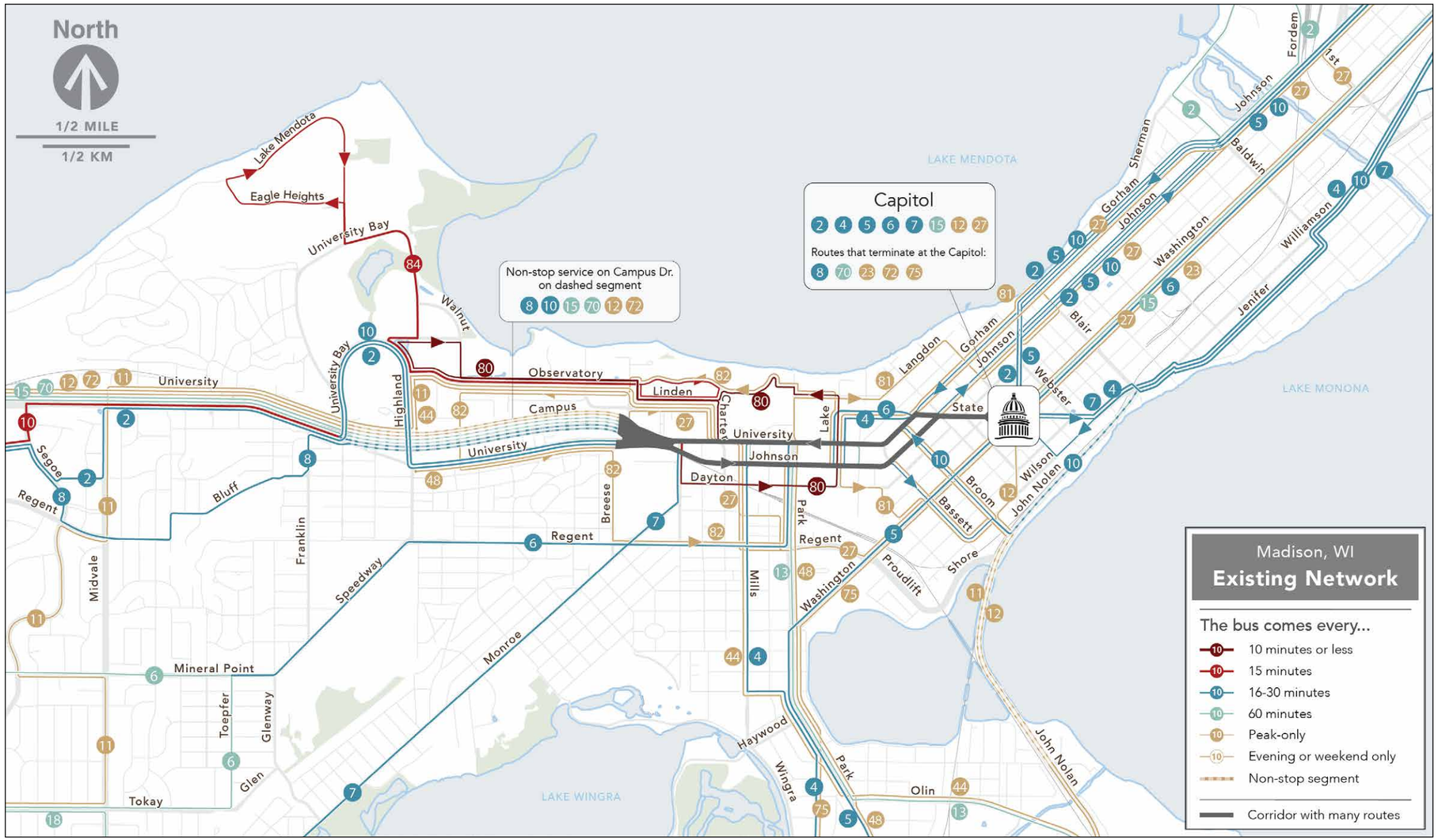


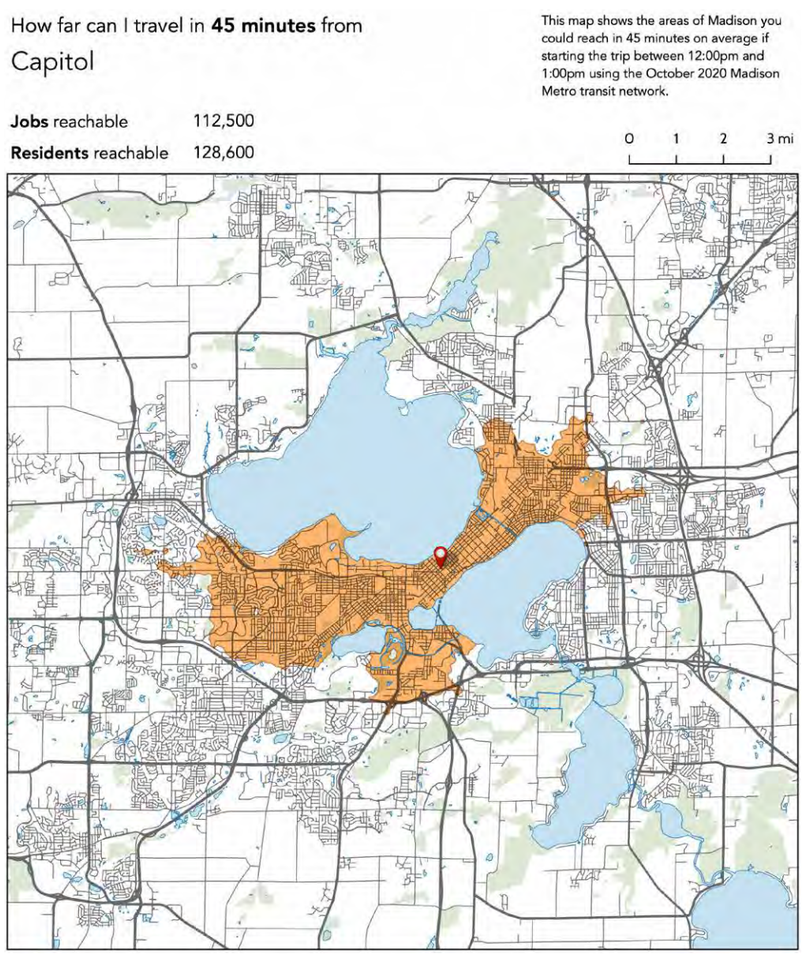
Figure 4: Metro Transit network in Central Madison, from Midvale Boulevard to First Street. This area includes Downtown Madison and the University of Wisconsin main campus. Many routes converge coming from many directions.

Example: How the Usefulness of Transit Varies by Location

Figure 5: An example of travel-time maps from two locations in Madison: the Capitol, and Northside Town Center.

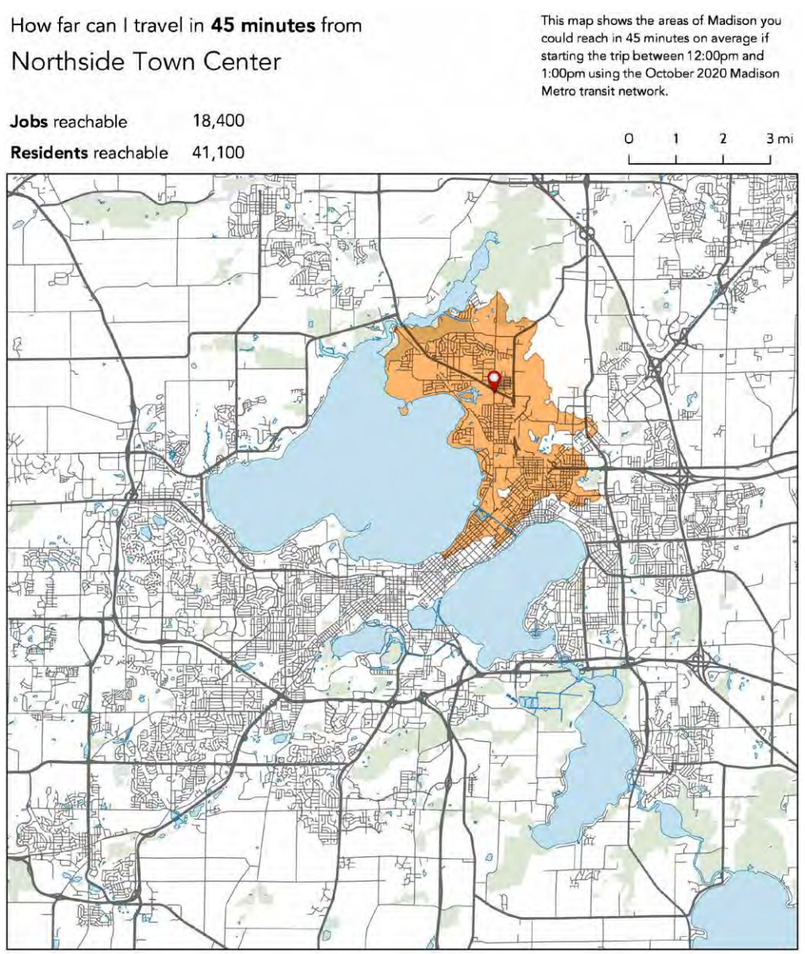
These maps show how far someone can reach by transit and walking in 45 minutes or less, starting from the location shown. Travel times include: walking to the nearest bus stop, the average wait for the next bus, time on the bus, and any transfers.

High Access – Downtown Madison



This Downtown location features direct service to all of Madison's inner neighborhoods. Even though most routes are not very frequent, the direct services and central location make it possible to **reach about half of city residents and 60% of jobs in Madison in 45 minutes or less.**

Low Access – North Side



This is 4.5 miles from the Capitol. Routes 21 and 22 go to the North Transfer Point, where passengers can make a timed connection with buses that go to other areas. The combined effects of being a few miles away from downtown, having to wait for buses that come every thirty minutes, and waiting an additional 5 minues at the Transfer Point, mean that it's only possible to **reach about 10% of jobs in Madison and 15% of residents in 45 minutes or less.**

The Challenge of Transit in Madison

Downtown is the largest destination by far

As a state capital with a major university, and being geographically constrained by bodies of water on two sides, Madison has a higher concentration of housing, jobs near Downtown than many cities of similar size. Figure 6 below, shows the number of jobs within 1.5 miles of locations throughout the city. It illustrates the dramatic concentration of destinations in central Madison.

The high density of Central Madison allows buses to serve more trips, at a lower cost per passenger. Radial routes that extend outward also brings an abundance of destinations within reach of people throughout the city.

Nevertheless, most people aren't travelling Downtown

Metro Transit has limited resources and has logically deployed much of those resources towards Central Madison because many people's daily trips start or end there.

That means there isn't much direct service between peripheral areas, even though demand for trips to and from these areas exists, and has been growing. Approximately two-thirds of Madison's jobs are located beyond the isthmus and the university.

Metro has to answer to the travel needs of people traveling throughout the city, but **within a fixed budget, it has to make conscious trade-offs between where to focus the most service.**

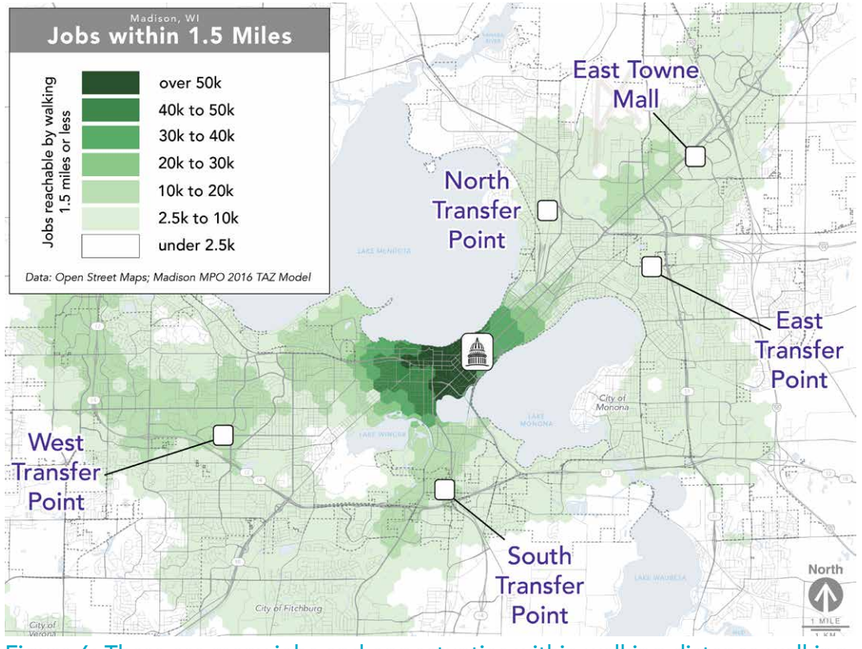


Figure 6: There are many jobs and opportunties within walking distance walking distance from locations along the UW campus, and across the isthmus. Radial transit routes allow people throughout the city to access the dense cluster of opportunities in central Madison with relative ease.

Most outlying areas aren't built for transit

Transit service between peripheral areas is further complicated by a range of transit hostile land-use patterns.

Transit is most effective when it can operate along linear, continuous corridors of high density, where many people are within a short walk of bus stops.

The meandering streets and dead-ends of some outlying areas mean that fewer people can walk to bus stops on main roads, or that buses have to make time-consuming deviations to get close to destinations. Barriers like freeways and railroads prevent people from reaching bus stops on the other side, even if they are close enough to see.

Figure 8 (at right) illustrates this by comparing the development pattern of Central Madison with that of an area around the Beltline freeway and High Point Road.

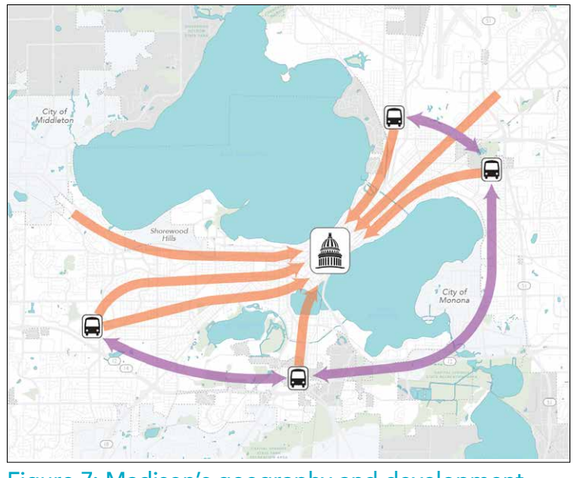


Figure 7: Madison's geography and development pattern drivers a radial (orange arrows) network design. A ring of orbital routes (purple arrows) connect with the radial services.

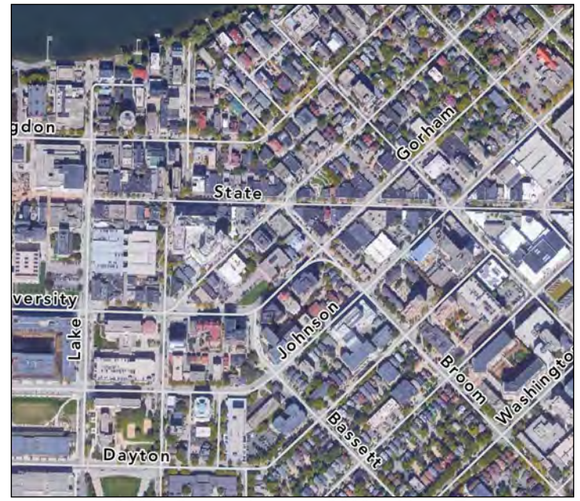


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Figure 8: In central parts of Madison like the upper example from Capitol Square, the connective street grid maximizes the area within short walk of each bus stop. In some peripheral areas like lower example from Watts Road and HIgh Point Road, a combination of landscaping, fences and dead-end roads makes it impractical or impossible to walk in a straight path, except to the main road.

How does the network redesign relate to Bus Rapid Transit?

Making the Most of BRT

As part of the Metro Forward plan, the City of Madison has been planning the construction and operation of a Bus Rapid Transit (BRT) system.

The Transit Network Redesign offers an opportunity to think about how BRT will work in the context of the whole network, and to extend its benefits beyond the East-West route to the whole city.

BRT will serve Mineral Point Road, University Avenue, Downtown Madison, and East Washington Avenue.". **It will run every 15 minutes or better, all day up to 7 days a week**, reaching many of Madison's busiest destinations.

Maximizing the value of this frequent cross-town service requires re-thinking all of Metro Transit's other routes, considering issues like:

- Should outlying routes still use the Transfer Points, or should they connect to BRT at other locations?
- Once BRT is implemented, what other routes should continue to run all the way Downtown?

The City intends for the East-West BRT to begin operating by 2025. The network redesign could be implemented beforehand, with a "pre-BRT" route that would serve the same areas.

At this time, plans for these two routes (shown as BRT B and BRT C on the map in Figure 9) remain conceptual. Many details remain to be worked out, and will be refined as part of the Transit Network Redesign.

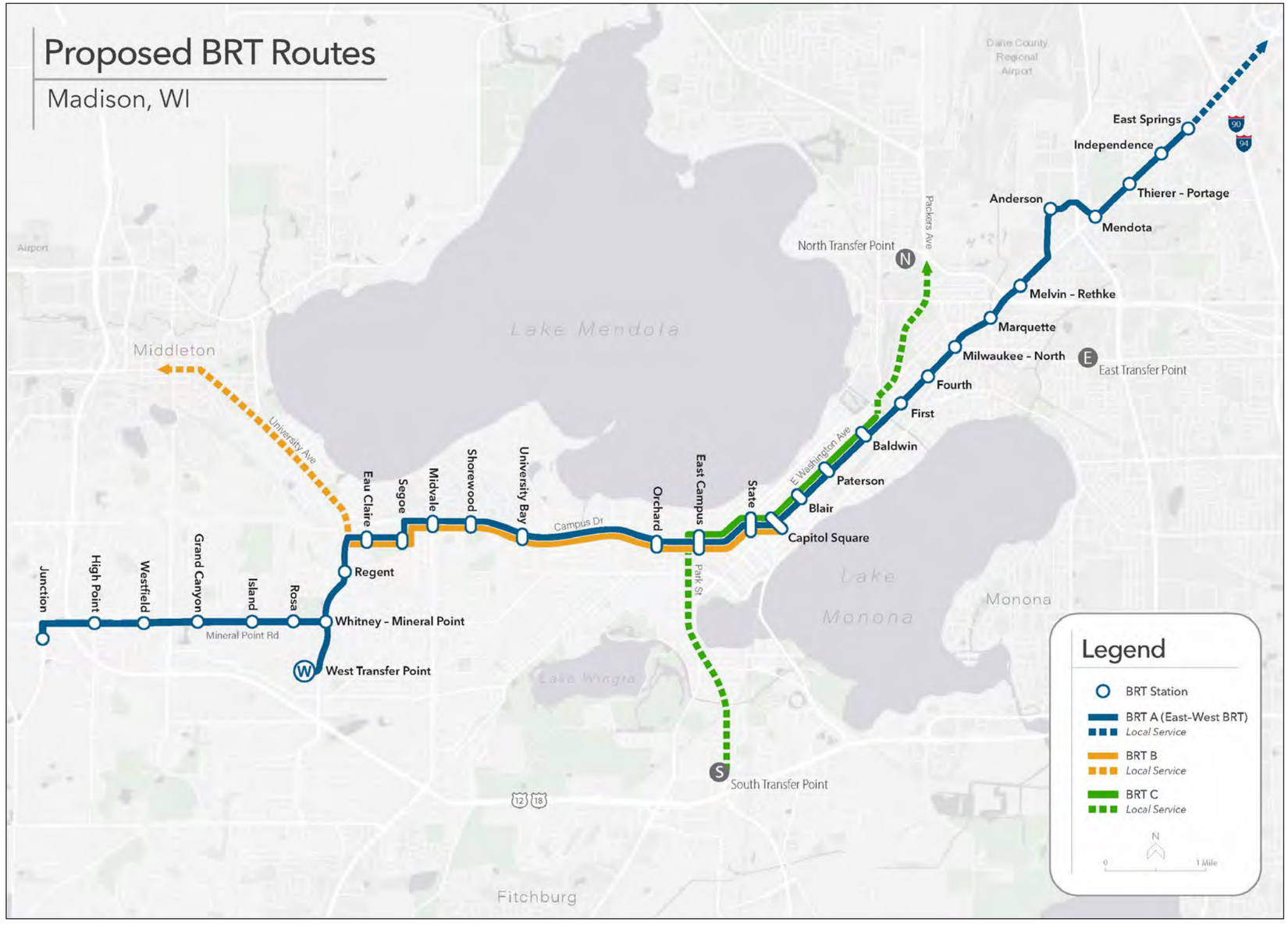


Figure 9: Bus Rapid Transit lines envisioned by the City of Madison, as of early 2021. BRT A is the main East-West Corridor; the City has undertaken significant detailed planning work on this route. BRT B and BRT C remain conceptual routes to serve other areas. BRT B would serve Middleton, while BRT C would be a North-South route. (Source: City of Madison)

How has the pandemic impacted Metro Transit use?

The COVID-19 pandemic has presented Metro Transit with significant short-term challenges. In response to low ridership and public health concerns, **Metro Transit has reduced service by over 20%**. Rush hour service has taken the biggest cut, wth some buses reallocated to peripheral routes to reduce crowding.

The conditions experienced during the pandemic won't last forever. But they do lay bare certain assumptions inherent in pre-pandemic service planning, and the unequal level of need experienced by different types of riders.

Ridership is way down.

As shown in Figure 10, comparing Fall 2019 to Fall 2020:

- **Weekday ridership is over 80% lower**, from 51,000 to less than 10,000 boardings per day.
- **Weekend ridership is about 60% lower**. Saturday boardings went from nearly 16,000 to just over 6,000 per day. Sunday boardings went from nearly 12,000 to less than 5,000 per day.
- Data from spring 2021 shows that **ridership is slowly recovering**, but is still far from pre-pandemic levels.

Rush hour is almost gone.

Figure 11 shows that weekday ridership in pre-pandemic times was heavily concentrated in the morning and afternoon rush. Ridership peaked in the 4 PM hour was about twice as high as in the middle of the day.

Although Metro Transit continues to see more boardings in the mid-afternoon, there is no longer a clear 8-to-5 pattern dominating ridership.

This change relates not just to how many people were riding, but who was riding.

Ridership change has been unequal

The charts in Figure 10 and Figure 11 show how ridership has changed by area and by time of day. The maps in Figure 12 and Figure 13 (see next page) give us further context for what we observe. Specifically:

- Pre-pandemic service and ridership were heavily focused on two groups: the University of Wisconsin and downtown office jobs. This is clear from where bus routes go, where boardings took place, and the dominant 8-to-5 pattern in 2019 weekday ridership.
- During the pandemic, **University-related ridership has dropped the most.** This is explained by the prevalence of remote learning, and perhaps also in part by a greater willingness on the part of students and staff to commute by bicycle or car.
- **Ridership has dropped the least in peripheral low-income areas and communities of color.** This reflects the areas that are most likely to house many essential workers, and where people are likely to lack alternatives to transit for their mobility needs.
- The Fall 2020 patterns of weekday and weekend ridership by hour suggests that **most pandemic-era transit users are likely essential workers with daytime hours, and people on non-work trips.**

Current ridership is not a picture of the future. As the pandemic recedes, transit ridership will likely increase and may return to pre-pandemic levels. We share this snapshot because of what it reveals about the people who rely most on transit, and whose travel purposes are so essential to society that they continue even in a public health emergency.

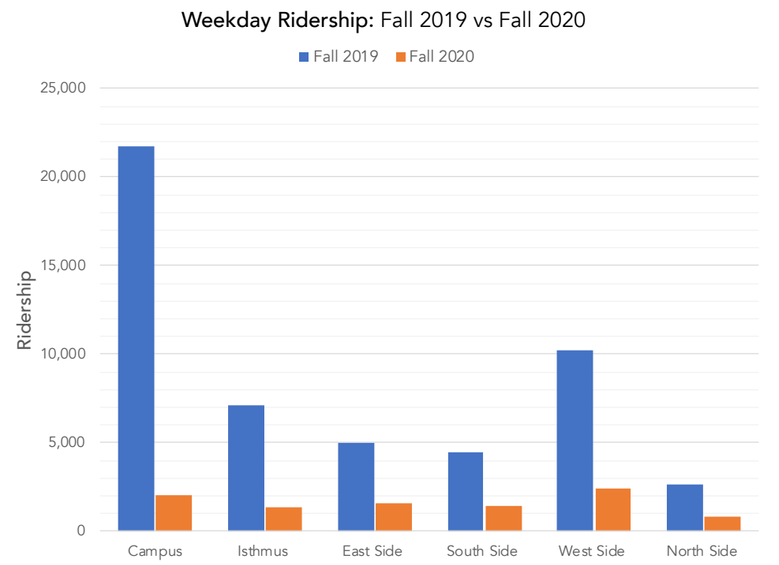


Figure 10: How weekday ridership has changed from Fall 2019 to Fall 2020 in different parts of Madison.

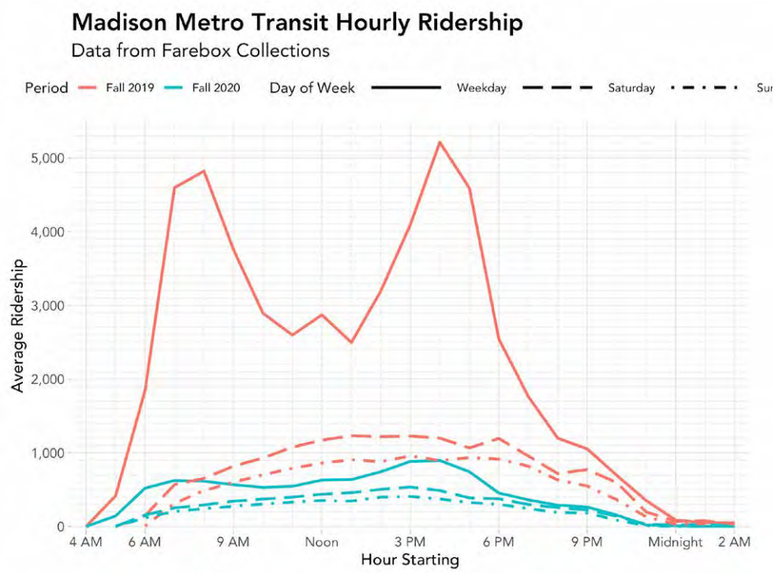
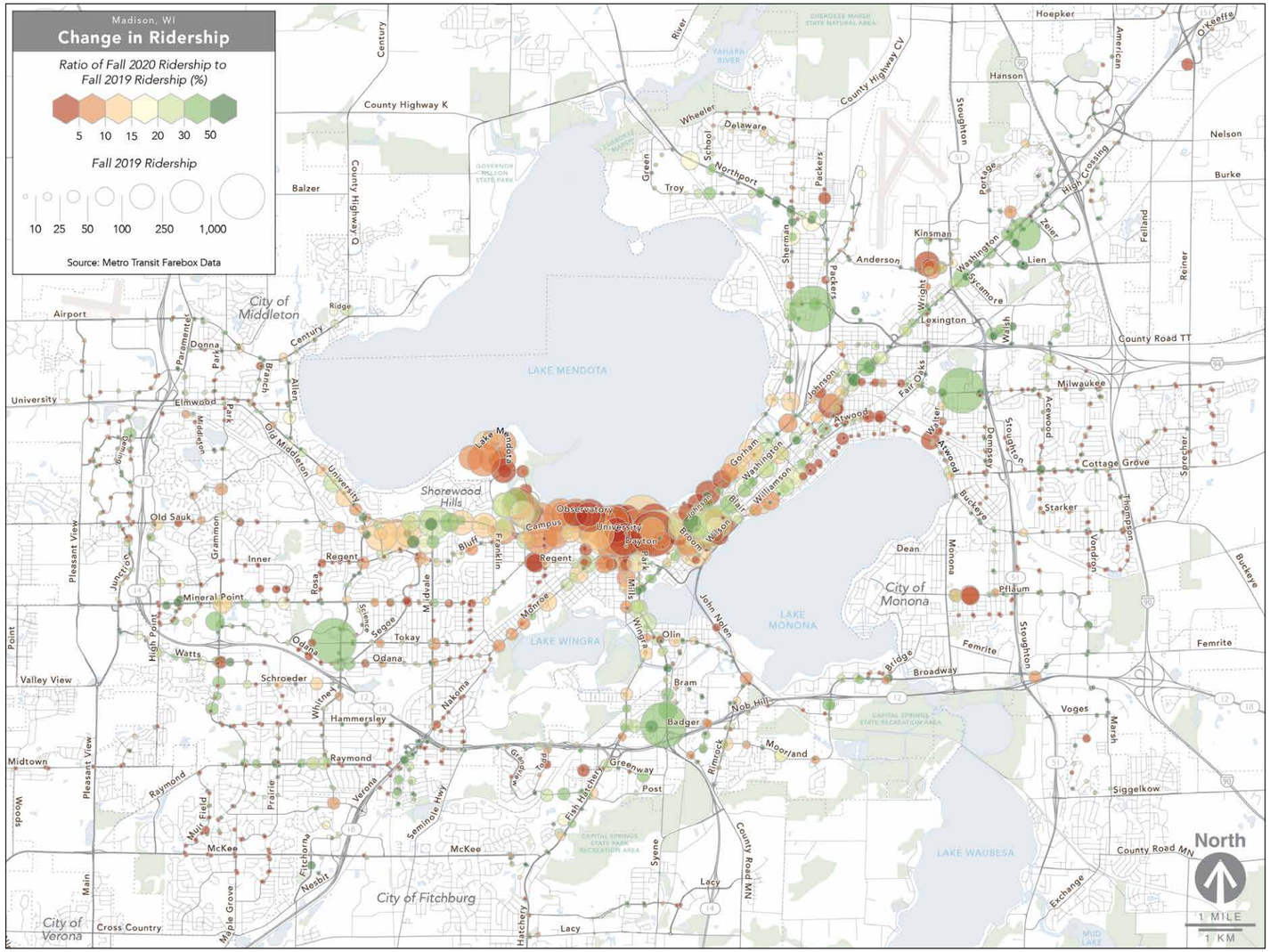
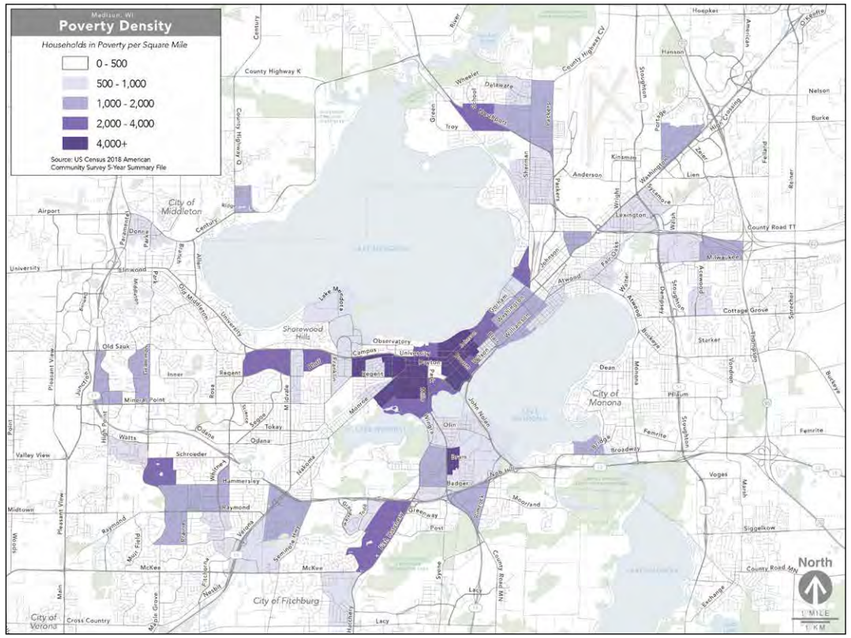


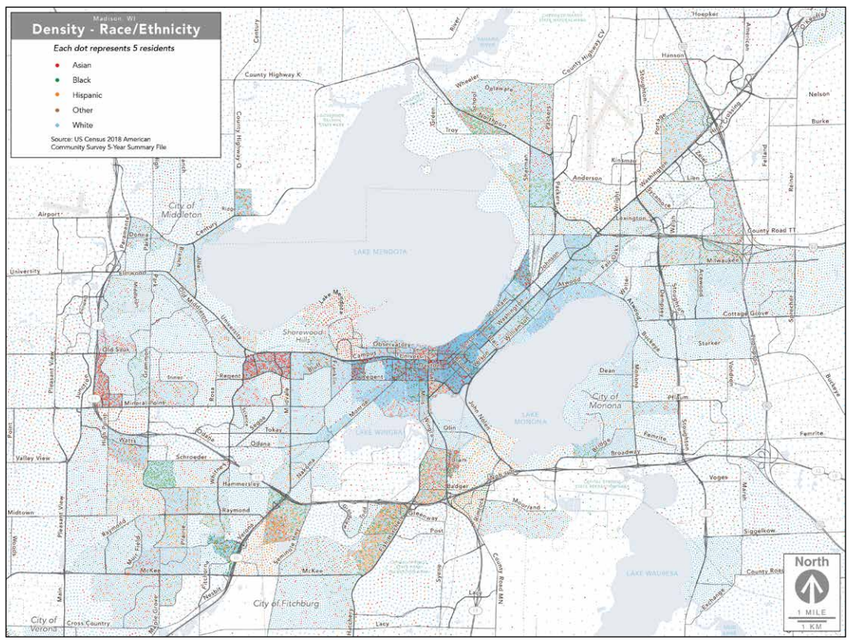
Figure 11: How ridership varied by hour and by day of the week in Fall 2019 and Fall 2020.

Figure 12: The map on the left of this page shows ridership changed from Fall 2019 to Fall 2020. Each dot represents one bus stop. The larger the dot, the more people used this bus stop in Fall 2019. Red and orange dots are stops where ridership fell the most from 2019 to 2020. Green dots are stops where ridership fell the least.

Figure 13: The maps on the right show where people in poverty and people of different racial and ethnic groups live in Madison. It is clear from this map that (a) the strongest ridership drops were in the vicinity of the University of Wisconsin, and (b) there was the least change peripheral low-income areas, where people of color disproportionately live.







Key Choice: Ridership vs. Coverage

The Metro Transit Network Redesign is a unique opportunity to rethink the purpose of Madison's transit system, and how it relates to other ways of getting around such as cycling and driving.

The most basic choice is the degree to which the transit system should be pursuing ridership or coverage.

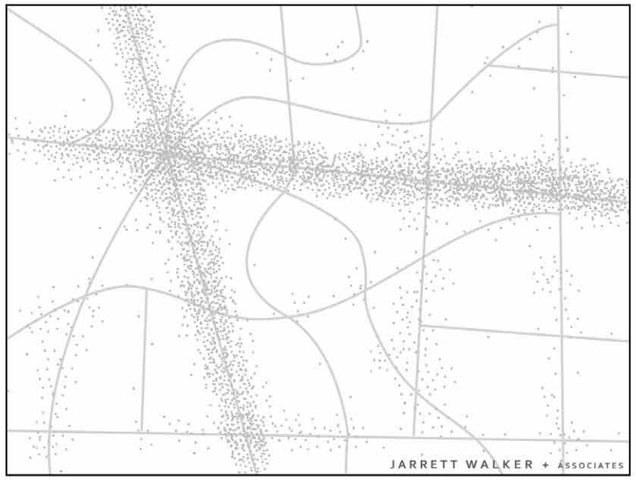
Designing a transit system for **high ridership** serves several popular goals, including:

- Competing more effectively with cars, so that the city can grow without increasing traffic congestion.
- Reducing the public subsidy needed for each ride by carrying more passengers and by collecting more fare revenue.
- Minimizing climate impact by replacing single-occupancy vehicle trips with transit trips, reducing greenhouse gas emissions.
- Supporting dense and walkable development.

On the other hand, many other popular goals for transit don't require high ridership. Designing a transit system for **high coverage** serves these goals:

- Ensuring that everyone in the service area has access to some transit service, no matter where they live.
- Providing access for people without access to personal vehicles.

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 high frequency along a dense corridor is a dollar that cannot be spent bringing transit closer to each person's home or reaching areas at the edge of the city, and vice versa.



Imagine you are the transit planner working in this fictional neighborhood.

The dots scattered around the map are people and jobs.

The 18 buses 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?

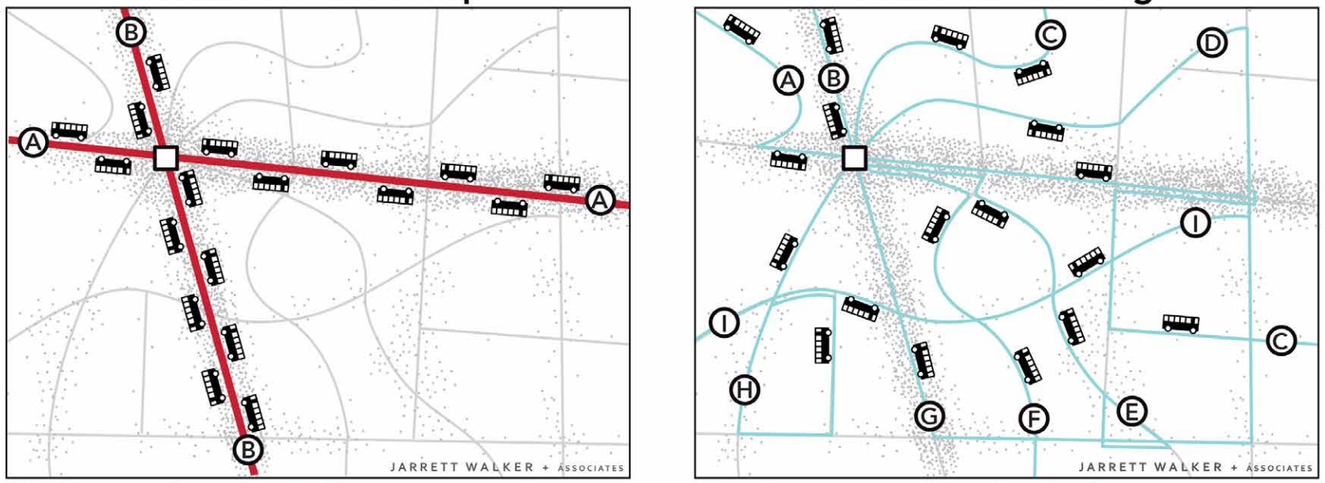


Figure 14: Comparing an imaginary town where transit is run with the goal of maximizing frequency and ridership (left) vs. the same town where transit is run with the goal of providing a little service near everyone (right). The maximum ridership (left) network has very frequent service, but only on the roads where the most people live and work. The maximum coverage network has service on every road, but it doesn't come very often. Madison's existing network looks more like the one on the right. Should a redesigned network focus more on frequency, even if some people will have to walk farther to reach service?

How the Pandemic Changes This

Many people who used transit before are not during the pandemic. It's unclear when many people will once again consider transit as an option.

So a more frequent network might not result in higher ridership immediately. Those effects take time. For example, some people will choose where to live based on bus service, and only then begin to ride.

But regardless of ridership, a more frequent network would increase the amount of access provided between different parts of Madison, and make transit useful for more trips.

The key challenge remains whether it is acceptable for some people to walk further to reach their bus stop, or for some areas not to receive service.

Key Choice: Walking vs. Waiting

Is it more important for bus service to be very frequent, or for service to be available very nearby?

Most people in Madison live and work close to bus service, but very little of that service is coming soon.

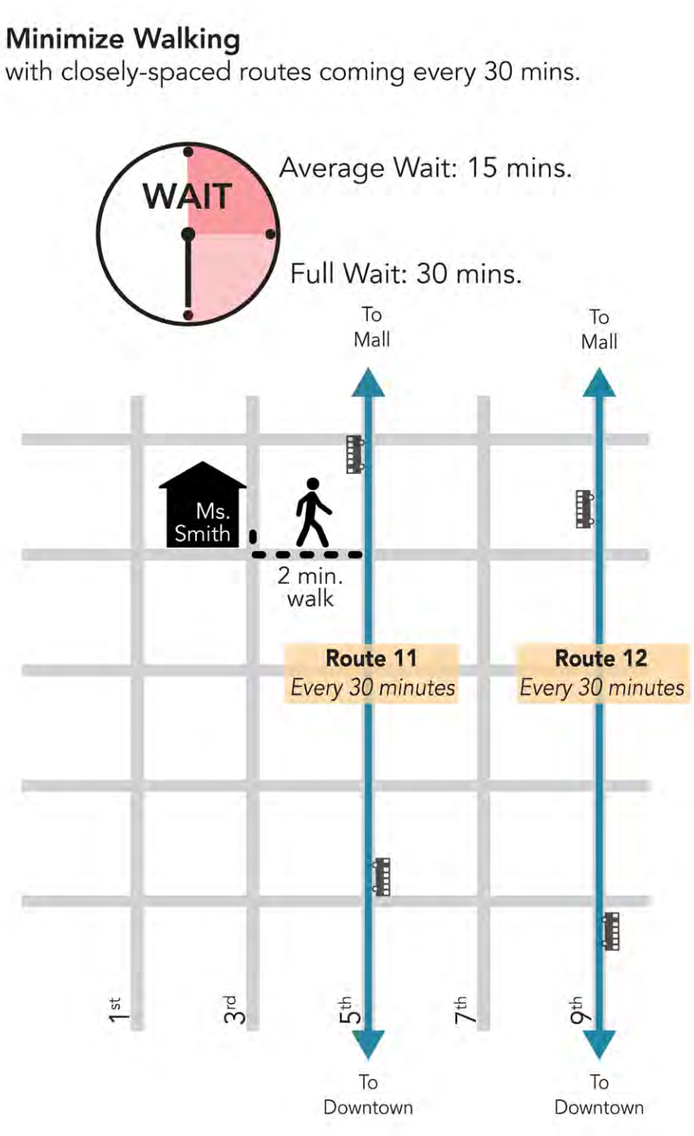
- 82% of residents and 89% of jobs in the city of Madison are located within 1/4-mile of a bus stop.
- Only 11% of residents and 17% of jobs are near a route where the bus comes every 15 minutes or better throughout the day.

These two facts are connected. Metro Transit's network is designed to reach every neighborhood in the city, and to provide a bus stop within a 5 minute walk of most front doors. As a result, the network is stretched thin. Most routes run every 30 to 60 minutes, and many streets only have bus service in one direction.

If Metro Transit planned a network around longer walks to service, more bus routes could operate frequently, every 15 minutes or better. In turn, many riders would wait less and would get to their destination sooner.

But longer walks can be challenging for many people, including some who really need transit. This includes some people who experience physical disabilities, but also people traveling with young children, older adults, or anyone carrying a large enough bag.

Frequent service that gets people where they are going sooner tends to generate higher ridership, even when it requires longer walks**.** This is one of the core principles underlying BRT. Should it be extended to more routes, or generalized?



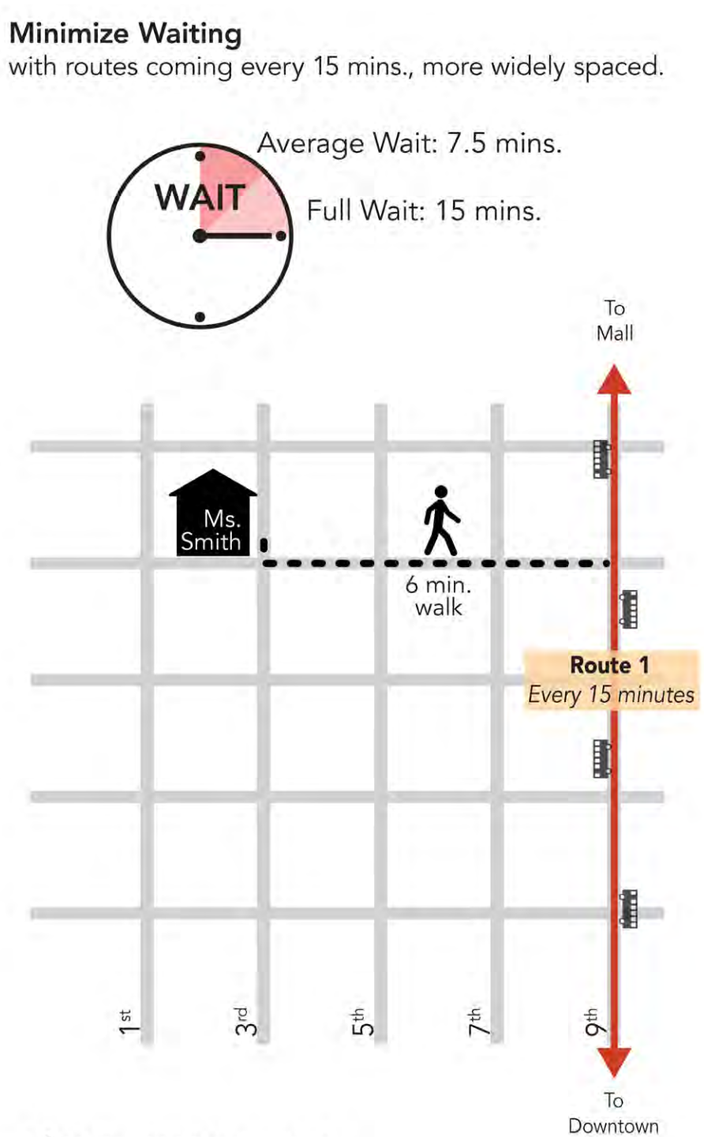


Figure 15: In some situations, consolidating parallel routes onto fewer streets can make the average person's trip faster. There are many areas where Metro Transit could consider doing this, but only if people value shorter waits and longer spans of service more than they value shorter walks.

One-Seat Rides vs. Transfers

Is it more important to focus on one-seat trips to Downtown, or to plan a network that relies on people changing buses along the way?

Metro Transit's existing network is built around the idea that people can use transit to travel in many directions if they are willing to change buses along the way. This is undermined by low frequency. **Who wants to take a short trip with a wait of up to 30 minutes, only to be delayed another 5 to 10 minutes by a transfer?**

The impacts of such long waits are disproportionately felt by low-income riders in outlying areas who have few if any alternatives.

Published schedules help, but aren't a cure-all: sometimes a bus is late, and people can't always control when they need to leave somewhere or arrive somewhere else.

But if Metro instead shifts to more one-seat rides[1], this would further increase the focus on Downtown and the University of Wisconsin. These two areas remain by far the largest hub of jobs and other destinations. Even though most trips in the city are going somewhere else, there are very few places in Madison where you would serve more trips by orienting service to go somewhere other than Downtown.

So a "one-seat ride" network would likely feature many more buses travelling through the Isthmus, and few if any improvements in direct service between outlying areas.

1 A "One-Seat Ride" refers to a trip on public transit which does not require transfers and can be completed on a single vehicle.

Peak vs. All-Day Needs

Is it more important to provide high levels of service at rush hour, or to provide consistent levels of service all day and all week?

Prior to March 2020, in Madison:

- Twice as many Metro Transit buses operated at rush hours than in the middle of the day.
- Saturday and Sunday service levels were around 60% lower than on weekdays.

This matches the travel patterns of State government employees and UW students and staff. Both institutions generate huge numbers of 9-to-5 commutes and (prior to the pandemic) lots of transit riders.

However, running a bus only during the peak hour is expensive, because of three inefficiencies:

- Short shifts are less efficient for drivers.
- The agency must own many vehicles that it doesn't use very much.
- Peak demand tends to be in one direction, but the buses must all return empty in the other direction, because driver shifts must end where they began.

In addition, transit service that is much more convenient at peak times does not match the needs of many lower income people, whose jobs are more likely to have nontraditional work schedules, or to include work on weekends.

As the pandemic has proceeded, **the combined impact of remote learning and white-collar work-from-home has greatly reduced peak-hour transit ridership,** and reduced the difference between weekday and weekend travel patterns.

But the pandemic won't last forever. It's likely that a substantial fraction of University and white-collar ridership will return as schools and offices reopen. But no one knows exactly when this will happen, or what percentage of pre-pandemic ridership will come back.

So, in a post-pandemic environment:

- Should transit service once again focus most on weekday peak hours, so the capacity for high ridership is there if peak demand comes back?
- Or should Metro transit focus instead on providing the best possible service throughout the day and on weekends, even if that might result in some overcrowded buses at rush hour if peak demand comes back?

Let us know what you think!

Project Timeline

The Metro Transit Network Redesign will combine technical analysis and broad-based community input to develop a public transit network for the future. This will include the following steps:

- **March 2021: Choices Report.** This report provides facts and analysis about the existing network, and describes the key choices for future service.
- **March – April 2021: Public Input on Key Choices**. This will include a combination of online resources, targeted focus groups, and a remote public meeting. Key information is available online at www.networkredesign.com
- **April – July 2021: Develop Alternatives.** The project team will develop up to four different network alternatives, illustrating real-world consequences of different key choices.
- **August-September 2021: Public Review of Alternatives.** The project team will reach out to the public for feedback on the alternatives. Members of the public can use these to make more informed judgements on the type of service they'd prefer.
- **Fall 2021: Draft Plan**. Based on community input and direction from the City's Transportation Policy and Planning Board (TPPB), the project team will develop a full draft of a redesigned network.
- **Winter 2022: Public Review of Draft Plan.** Taking into account public feedback, the TPPB will direct the project team on any changes to make to develop the Final Plan.
- **Spring-Summer 2022: Final Plan.** Depending on the amount of change, it could take more or less time to finalize and implement the network redesign.
- **Fall 2022: Partial implementation.** If the redesign process reveals clear consensus on the benefits of some transit network changes that can be isolated for early implementation, these changes may be put into place in Fall 2022.
- The City is targeting **full implementation for Fall 2023.**

Figure 16: Timeline for the first three phases of the Transit Network Redesign. The Final Plan will be developed in the first half of 2022. Depending on the degree and complexity of change involved, the redesigned network may be implemented in either 2022 or 2023.

Let us know what you think!

Take the online survey at:
mymetrobus.com/redesign

2 What makes transit useful?

What goals should transit serve?

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

Possible Goals for Transit

Transit can serve many different goals. Different people and communities value these goals differently. Understanding which goals matter most in the Madison is a key step in redesigning the transit network.

Possible goals for transit include:

- **Economic Development**. Transit can give businesses access to more workers; workers access to more jobs; and students more access to education and training.
- **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.
- **Social Safety Net.** Transit can help meet the needs of people in situations of disadvantage, with access to essential services and jobs.
- **Congestion Mitigation.** Because buses carry more people than cars, transit use can mitigate traffic congestion by reducing Vehicle Miles Travelled (VMT).
- **Environmental**. By reducing VMT, transit use can reduce air pollution and greenhouse gas emissions. Frequent transit can also support compact development and help conserve land.
- **Health**. Transit can support physical activity. 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.

Some of these goals are only served if many people use transit. For example, transit can only mitigate congestion and pollution if many people ride the bus rather than drive. We call such goals "ridership goals" because they are achieved through high ridership.

Other goals are served by the simple presence of transit. A bus route through a neighborhood provides residents insurance against isolation. A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every municipality. We call these types of goals "coverage goals" because they are achieved in large part by covering geographic areas with service, rather than by high ridership.

High ridership is not transit's only goal

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal. But in many cases, transit agencies are intentionally operating coverage services in areas that are not expected to generate high ridership. Coverage services are sometimes visible to the public as mostly-empty buses.

If Metro Transit wanted to maximize transit ridership, it would focus service where and when it could be useful to the most potential riders. Metro would then be thinking like a business, focusing on places where its service is competitive for a large number of people.

Businesses are under no obligation to operate where they would spend a lot of money to reach few customers. For example, a retail chain is under no obligation to provide a store within a mile of everyone in Madison. If it were, then the company would have to add many additional locations, and most of them would operate at a loss.

People understand that less populated areas will naturally have fewer stores. We don't describe this as the retail chain being *unfair* to those areas; they are just acting like a business. The retail chain has no obligation to cover all areas with its stores.

Transit agencies are not private businesses. Most transit agencies decide they do have some obligation to cover most or all of their service area. The officials who 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". So they decide that some coverage, even in low-ridership places, is an important transit outcome.

Figure 17: Is an empty bus failing? It depends why you are running it.

Ridership and coverage goals conflict.

All transit agencies must balance the competing goals of high ridership and extensive coverage. Within a limited budget, if an agency wants to do more of one, it must do less of the other.

Consider the fictional town illustrated at right. The little dots are homes and job locations. The lines are 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, since many people are nearby, and buses can run direct routes. Service would be very frequent and convenient, but only for certain areas. This would result in a network like the one at bottom left.

If the same agency were pursuing only coverage, it would spread its routes out so every street had some service, as in the network shown at bottom right. Service would be available but infrequent everywhere, even on the main streets.

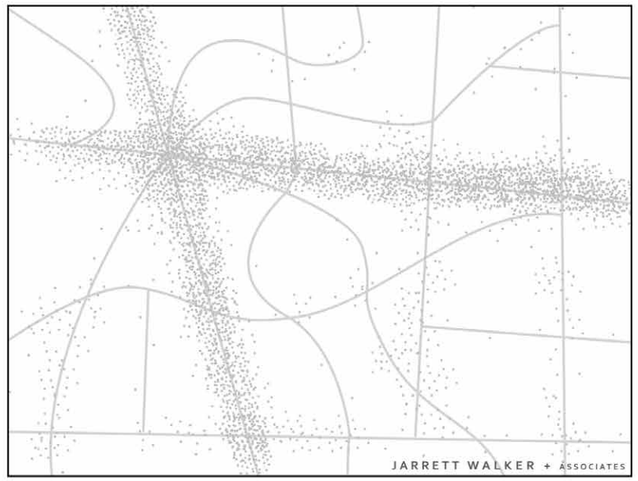
These two scenarios require the same number of buses and cost the same amount to operate, but deliver very different outcomes.

The choice between pursuing ridership and coverage is not binary. All transit agencies spend some portion of their budget on each type of goal.

A particularly clear way for cities and transit agencies to set a policy balancing ridership and coverage 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.

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.



Imagine you are the transit planner working in this fictional neighborhood.

The dots scattered around the map are people and jobs.

The 18 buses 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?

Maximum Ridership

All 18 buses are focused on the busiest area. 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.

Maximum Coverage

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 18: Comparing an imaginary town where transit is run with the goal of maximizing frequency and ridership vs. the same town where transit is run with the goal of providing a little service near everyone.

Transit is useful because it expands where people can go.

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, as in Figure 19.

You can think of the edges of this blob as a "wall around your life." Beyond this area are things you can't do on most days because it simply takes too long to get there. The extent of this area affects your options in life: for employment, school, shopping, or any other places you might want to reach.

The technical term for this is access, but it's also fair to call it freedom, in the physical sense. If you can go to more places, you have more choices, so in an important sense you are more free.

How Transit Expands Access

Transit provides value when it increases people's freedom. That happens by increasing the number of useful places people can access in a reasonable amount of time without driving.

On transit, the extent of your access is determined by:

- The **network,** including transit lines with their frequency, speed, and duration. These features determine how long it takes to get from any point on the network to any other point.
- The **layout of the city.** This determines how many useful destinations can be located near transit stops. For example, where there are more people or useful destinations near a given stop, good access from that point is of value to more people.
- Your **location.** This determines which routes are close and frequent enough to be useful to you.

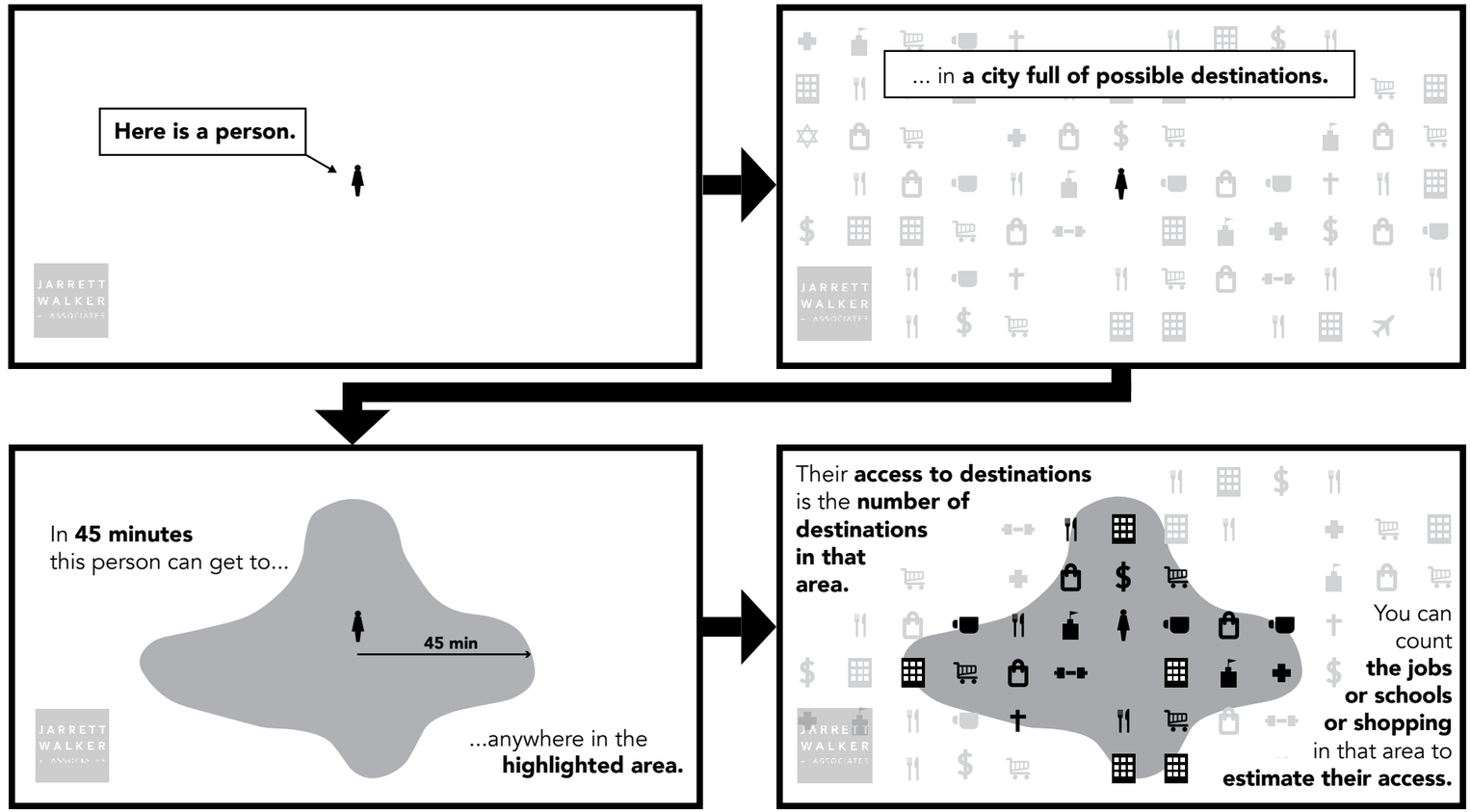


Figure 19: Access is the ability to get from your current location to places you need to go. The more places you can access in a reasonable amount of time, the more freedom you have to live your life in the way you need.

Access and Ridership

On an individual level, access represents convenience and the ability to do the things you need. As such, **the level of access transit provides is part of what determines ridership, but it is also something that many people will see as a worthy goal in itself.** For example:

- Access to jobs is a key concern for keeping people employed.
- Access to manby amenities from a particular location gives that location value. Real estate firms routinely outline where you can get to by car from a particular development parcel, and this is the same analysis for transit. In cities, transit access can be an important factor in overall value.

If you are deciding where to live based on whether you'll be able to get to your job, school, or relatives, you are asking a question about access. Access by transit may be a factor in that decision.

How the Pandemic Changes This

Many people who used transit before are not during the pandemic. It's unclear when many people will come back to transit in the future. So the link between high levels of access and high ridership is weaker at this time than it has been in the past.

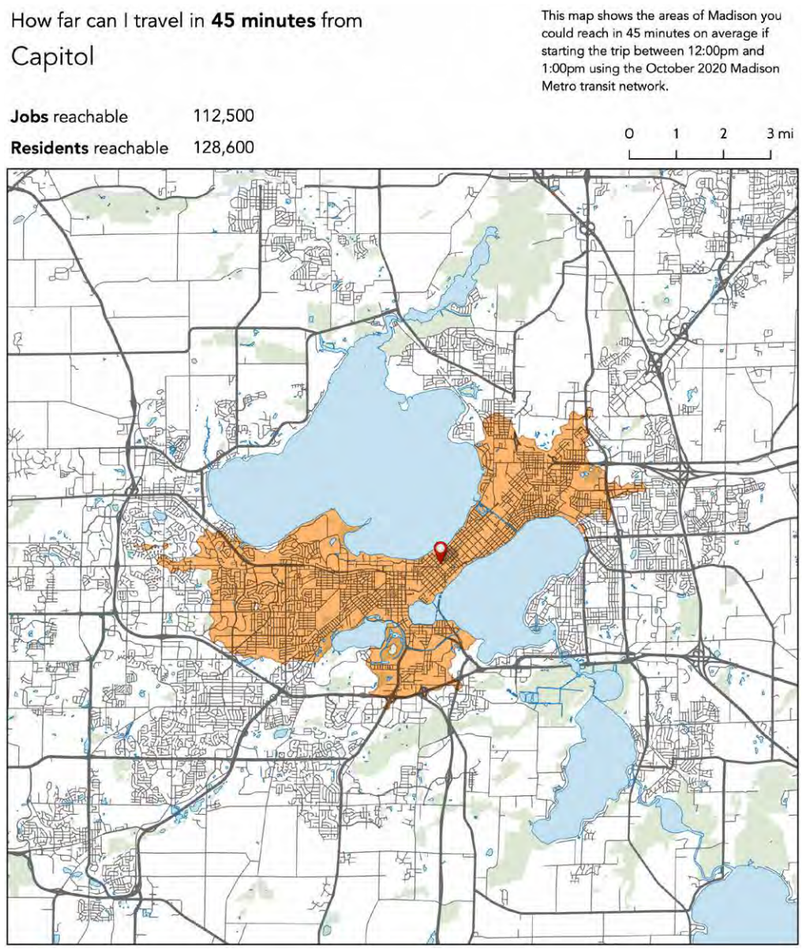
But regardless of when more people choose to ride again, no network can achieve high ridership without providing high access.

How far can I go in a reasonable amount of time?

Figure 20: An example of travel-time maps from two locations in Madison- the Capitol, and Northside Town Center.

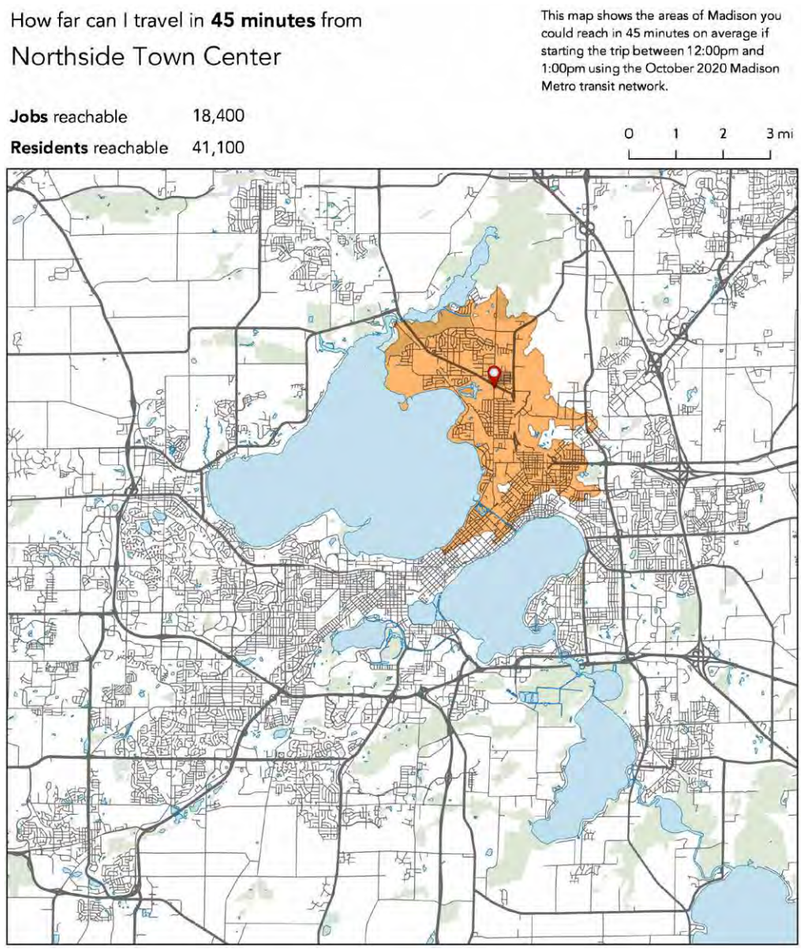
These maps show how far someone can reach by transit and walking in 45 minutes or less, starting from the location shown. Travel times include: walking to the nearest bus stop, the average wait for the next bus, time on the bus, and any transfers.

High Access – Downtown Madison



This Downtown location features direct service to all of Madison's inner neighborhoods. Even though most routes are not very frequent, the direct services and central location make it possible to **reach about half of city residents and 60% of jobs in Madison in 45 minutes or less.**

Low Access – North Side



This is 4.5 miles from the Capitol. Routes 21 and 22 go to the North Transfer Point, where passengers can make a timed connection with buses that go to other areas. The combined effects of being a few miles away from downtown, having to wait for buses that come every thirty minutes, and waiting an additional 5 minues at the Transfer Point, mean that it's only possible to **reach about 10% of jobs in Madison and 15% of residents in 45 minutes or less.**

Frequent transit is useful to more people and for more trips.

A transit network is a pattern of routes and services, where each line:

- follows a **path**,
- at certain days and times (its **span**),
- at a given average **speed**, and
- buses come every certain number of minutes. This is known as the headway or **frequency**.

Frequency is invisible and easy to forget, and yet on transit it is often the most important factor determining where you can get to in a given amount of time.

Frequency Is Freedom

More frequent service dramatically improves access. High frequency reduces travel time by providing several linked benefits:

- **Shorter Waits.** Unless you plan your life around a bus schedule, the average wait for transit is half the frequency. If a bus comes every 30 minutes, your average wait will be 15 minutes. But if it comes every 15 minutes, your average wait will be 7.5 minutes.
- **Faster Transfers.** To go further than the places on the bus route you happen to be on, you'll need to connect to another route. Frequency makes this kind of connection easy, because the next bus is always coming soon.
- **Easier Recovery from Disruption.** Frequent service is more reliable, because if a bus breaks down you don't have to wait as long until the next one shows up.
- **Spontaneity and Freedom.** When transit comes every few minutes, there's no need to build your day around a bus schedule. You can turn up at the stop and go, whenever you want.

Frequency and Ridership

The plot in Figure 21 shows all the routes operated by 33 different U.S. transit agencies, at various points in the 2010s.

Each route is located on the plot based on its frequency and its productivity (boardings per service hour). More frequent service is to the left, and more productive service is higher up. The shade of each hexagon indicates the number of routes in that place on the graph.

The plot shows that higher productivity is correlated with higher frequency, even though higher frequencies require more service hours. In other words, **ridership appears to rise exponentially as frequency increases.**

This is a two-way street: transit agencies rarely run high frequency service in places where they expect low ridership. But conversely, if frequency isn't very high, the amount of ridership transit can attract is fundamentally limited.

What is frequent enough?

Frequency is expensive, so it's important to think about just how frequent service needs to be.

A frequency of 15 minutes or better has a good chance of being useful to someone whenever they need to travel, especially if that frequency extends over many hours of the day, every day.

Adequate frequency depends on trip length, because it doesn't make sense to wait long to go a short distance. For many people, it wouldn't make sense to wait 15 minutes to go half a mile, because you could probably walk to your destination in that time. But it might make sense to wait that long to go several miles across town.

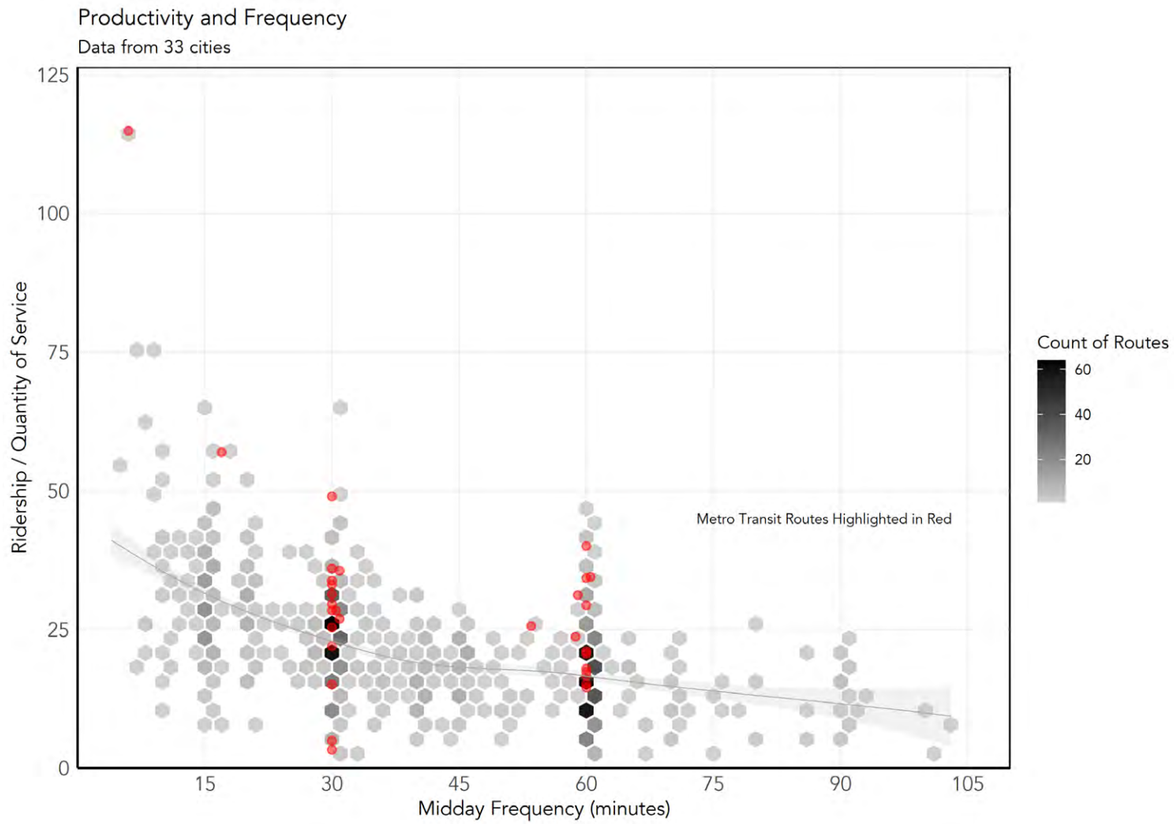


Figure 21: Transit Productivity and Frequency in 33 cities across the USA. Routes that operate more frequently tend to attract a higher number of riders per hour of service. This is because frequency makes transit trips shorter and more reliable.

Frequency is invisible and easy to forget, but on transit it is often the most important factor determining where you can get to in a given amount of time.

Access isn't just about service. It also depends on the built environment.

Creating a high-access transit network isn't just about faster or more frequent service. Many factors outside the control of Metro Transit – such as land use, development, urban design, street networks – affect transit's usefulness. This is why **land use and infrastructure decisions made by the City and other agencies are an essential part of transit's success.**

The built environment factors shown in Figure 22 are critical to facilitating a broadly useful transit network:

- **Density.** Where there are many residents, jobs and activities in an area, there are many places people might want to go.
- **Walkability.** An area only becomes accessible by transit if most people can safely and comfortably walk to and from the nearest transit stops.
- **Linearity.** Direct paths between many destinations are faster and cheaper for Metro Transit to operate relative to the number of places served. Linear routes are also easier to understand and more appealing to most potential riders.
- **Proximity.** The longer the distance between two places Metro Transit wants to serve, the more expensive it is to connect them. Areas with continuous development are more cost-effective to serve than areas with big gaps.
- **Mix of Uses.** When there is a mix of land-uses along a direct path, transit can provide direct access to a broad range of destinations. Mixed-use transit corridors also tend to be very productive, because people ride in both directions at many times of the day.

Even within the context of Madison's unique geography, these five elements determine where transit can be useful for many people, at a relatively low cost. In fact, Madison's lakes have likely encouraged higher density and linearity along the Isthmus over the course of the city's development.

These geometric facts pose a difficult political challenge. A transit system focused on cost-effectively providing the most useful service possible tends to serve its city unevenly, concentrating service in well-connected areas where demand is high.

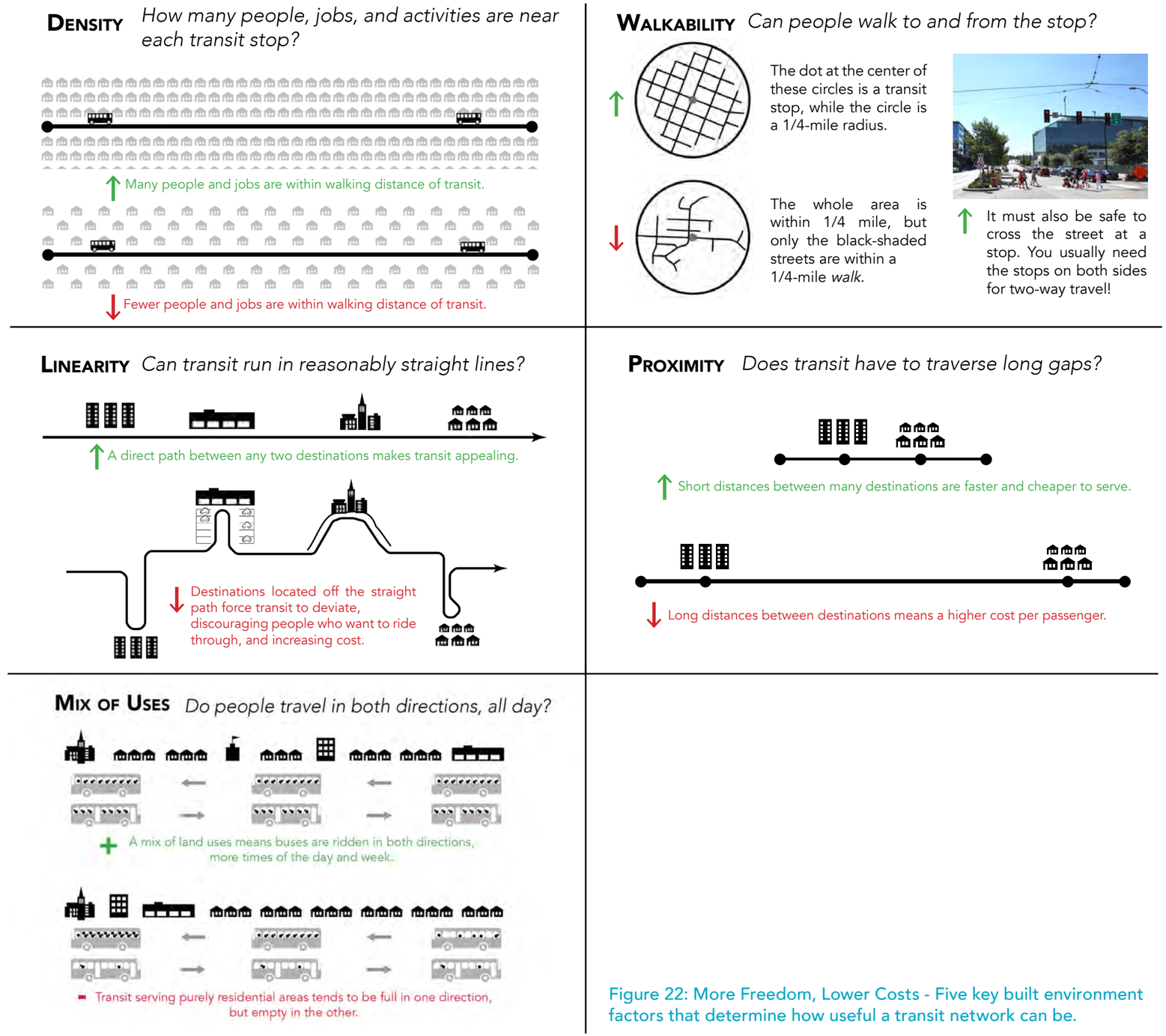


Figure 22: More Freedom, Lower Costs - Five key built environment factors that determine how useful a transit network can be.

Examples from Madison - Density and Walkability

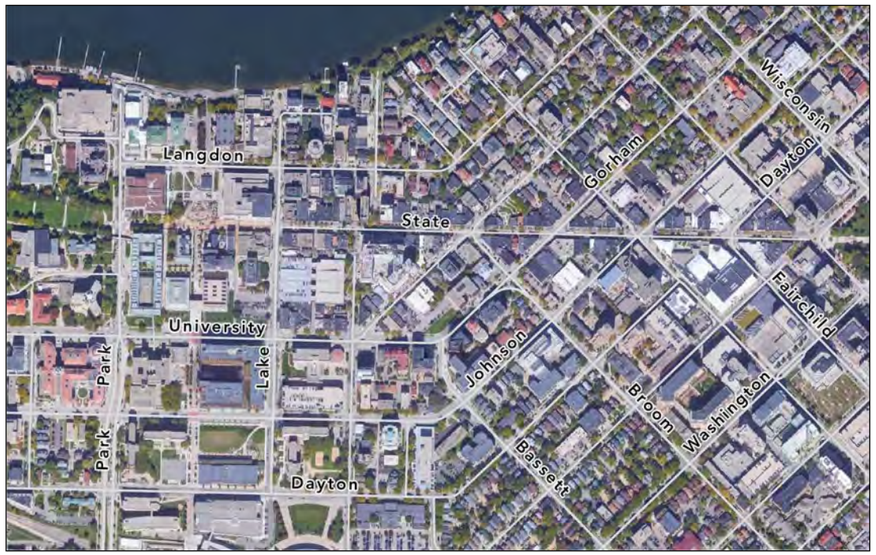
Dense areas often support multiple land uses in close proximity, density and walkability often go hand in hand. Nonetheless, there's nothing inherently walkable about a high-density neighborhood. There's also no specific reason why a low-density neighborhood can't feature good pedestrian connections.

The examples in Figure 23 show four ends of the density/walkability spectrum in Madison:

- **High density/high walkability:** Downtown, west of Capitol Square. This area is among the densest neighborhoods in the region, with around 150 residents per acre in its residential portions. It features a traditional street grid, with legal crossings every 400 feet, and sidewalks on both sides of every street.
- **High density/low walkability:** Watts Road. This area in West Madison has fairly high density, with many apartment buildings, but is much less walkable. A combination of landscaping, fences and dead-end roads makes it impractical or impossible to walk in a straight path, except to the main road.
- **Low density/high walkability:** Lake Edge. This area just east of Lake Monona is mostly filled with detached houses with generously sized yards. Despite the lack of sidewalks, the abundance of crossing opportunities, low traffic speeds, and proximity to many services and retail make this area quite walkable.
- **Low density/low walkability:** Sherman at Delaware. This area of North Madison includes detached houses on a street network with numerous dead ends. There are no services or shopping destinations to walk to in this area.

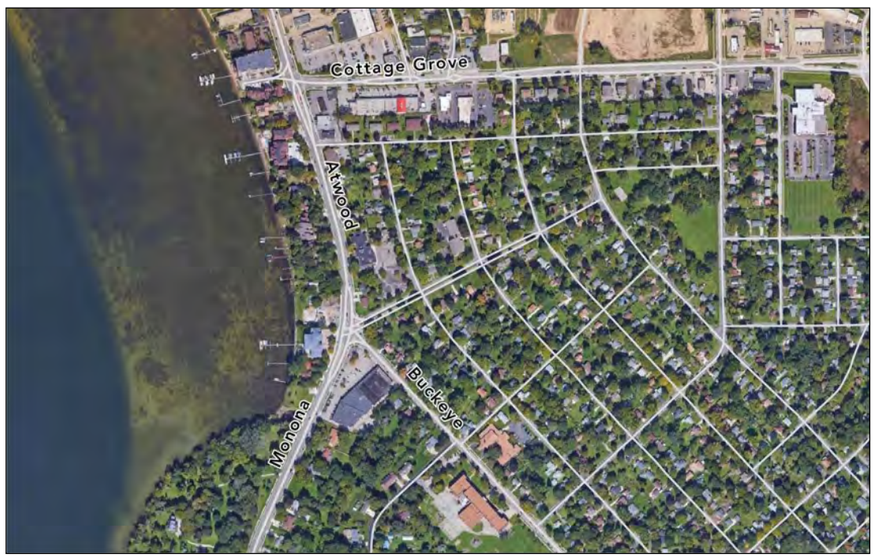
Because these four neighborhoods are built very differently, providing the exact same amount of transit service in each area will result in very difficult access and ridership outcomes.

Downtown Madison, West of Capitol Square
High Density; High Walkability



Watts Road at High Point Road, West Madison
High Density; Low Walkability

Pinney/Lake Edge, East Madison
Low Density; High Walkability



Whitetail Ridge/Sherman Village, North Madison
Low Density; Low Walkability

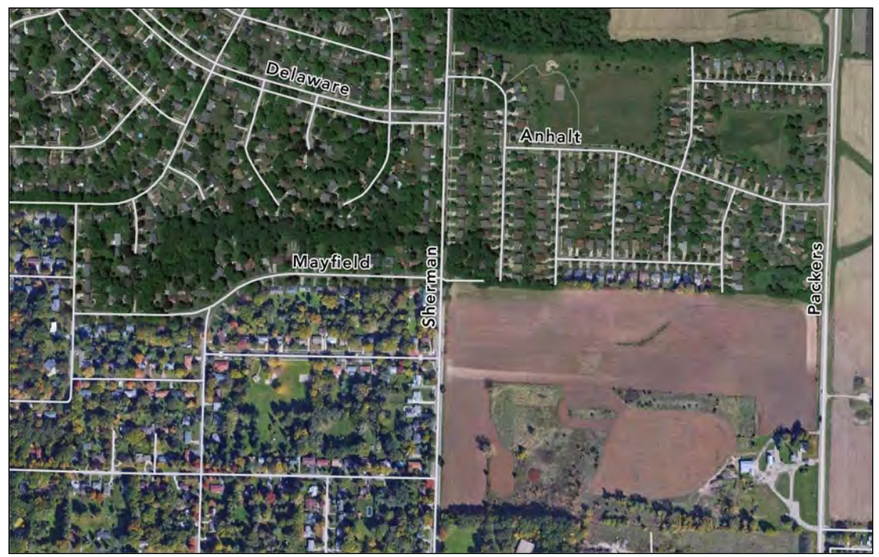


Figure 23: Examples of Density and Walkability in Madison.

Examples from Madison - Linearity

Because of geographic constraints and the way Madison has developed, some major destinations can be served very directly by transit, while others require the bus to twist and turn off its path.

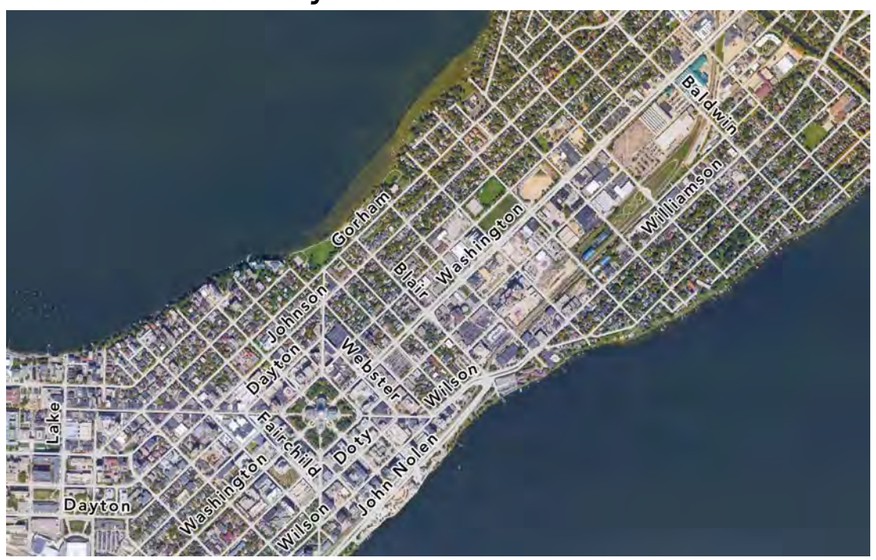
The examples in Figure 24 contrast two situations where connecting to a major destination requires more or less deviation from a straight path:

- **Very Linear: The Isthmus.** Gorham and Johnson; Washington; and Williamson, all offer straight, efficient paths into downtown. Along the way, multiple bus routes serve many destinations within walking distance.
- **Not Linear: American Center.** Hospital buildings, offices, and retail businesses in this area are situated along a set of meandering roads, and set back behind parking lots. As a result Routes 26 has to drive in a circuitous path in order to get reasonably close to most destinations.

Passengers on a bus traveling through American Center need to sit through a series of complicated loops, so it takes longer to get to and from other places on the way. In contrast, passengers on a bus going the Isthmus can essentially ride straight through.

A linear street pattern is an important component of linear transit routes, but beyond that, a linear pattern of density is also important. See page 30 for more on this.

Madison Isthmus - Very Linear



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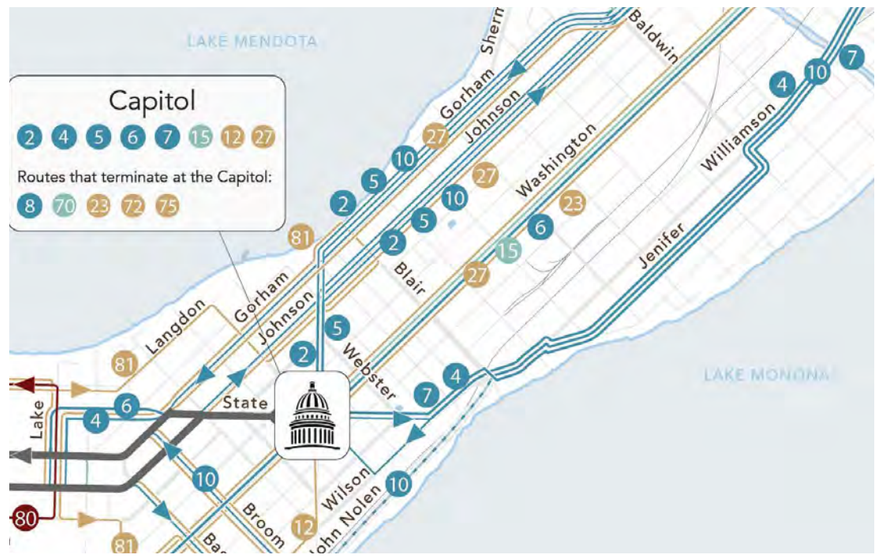

American Center - Not Linear

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Figure 24: Examples of Linearity in Madison.

3 The Geography of Madison's Transit Challenge

The Market and Need for Transit

A "strong transit market" is mostly defined by where people are, and how many of them are there, rather than by who people are.

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, with potential for high ridership and low operating costs?**
- **Where are there moderate or severe needs for transit, where coverage services may be important even if they do not attract high ridership?**

A "strong transit market" is mostly defined by where people are, and how many of them are there, rather than by who people are. We learn about transit needs mostly by examining *who* people are and what life situation they are in.

Measuring Demand and Need

On the following pages, these maps and diagrams help us visualize potential transit markets and needs[1]:

- **Residential density**
- **Job density**
- Activity density (combined residential and jobs)
- Maps of **walkability**
- **Zero-Vehicle households**
- **Poverty** density map
- Density of **Residents under age 18** (Youth)
- Density of **senior residents**

1 The maps in this chapter are based on data from the U.S. Census Bureau (2010 Census and 2018 American Community Survey), and from the Greater Madison MPO's 2016 Travel Demand Model.

How to Use These Measures

No one measure tell us that a place has high ridership potential or high needs. Rather, we must consider them in combination.

Designing for Ridership

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. A lower income person is often more likely to choose transit than someone with a higher income. This is especially true in outlying areas where driving and parking cars is so easy, so transit tends to be used mostly by people who don't have the option to drive.

Designing for Coverage

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

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

Civil Rights and Equity

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

Unequal treatment on the basis of race or ethnicity is prohibited by Civil Rights Act of 1964. (Unequal treatment on the basis of other characteristics, including income and age, is also prohibited by law.)

A person's race or ethnicity does not tell us if they need transit, or if they have a propensity to use transit. However, we know that race and ethnicity are correlated with income.

Providing equitable and supportive levels of service to minority people, even in areas that are costly to serve or that do not generate much transit ridership, can be an important element of a coverage goal.

Where there are moderate or severe needs for transit, coverage may be important even if it does not serve a large total number of people.

Indicators of Demand: Residential Density

Residential density is a key metric in assessing the strength of transit markets, since most people's daily travel behavior begins and ends at home.

Figure 25 is a map of residential density in Madison, based on the Greater Madison Metropolitan Planning Organization's 2016 household data and US Census household size data.

This map shows that the largest area of continuous residential density stretches from just west of the University of Wisconsin, through Downtown and east across the Isthmus, ending at approximately Washington and Aberg.

Outside this area, there are a few small pockets of high-intensity residential development, and larger areas developed at moderate densities still capable of generating substantial transit demand.

In particular, there are a few clusters of density around Mineral Point Road; High Point Road; Verona Road; Fish Hatchery Road; Northport Drive; and Park Street near the South Transfer Point.

Higher density areas outside central Madison tend to be areas with significant concentrations of poverty, as can be seen by comparing the map on this page to Figure 31 on page 33.

This map only represents one side of the overall travel market. The other half is where people go once they leave their home, such as offices, schools, universities, retail, industries, recreational areas, houses of worship and other places.

Madison's largest area of high residential density stretches from the UW, through Downtown and across the Isthmus. Elsewhere, density exists in isolated pockets within a largely single-family landscape.

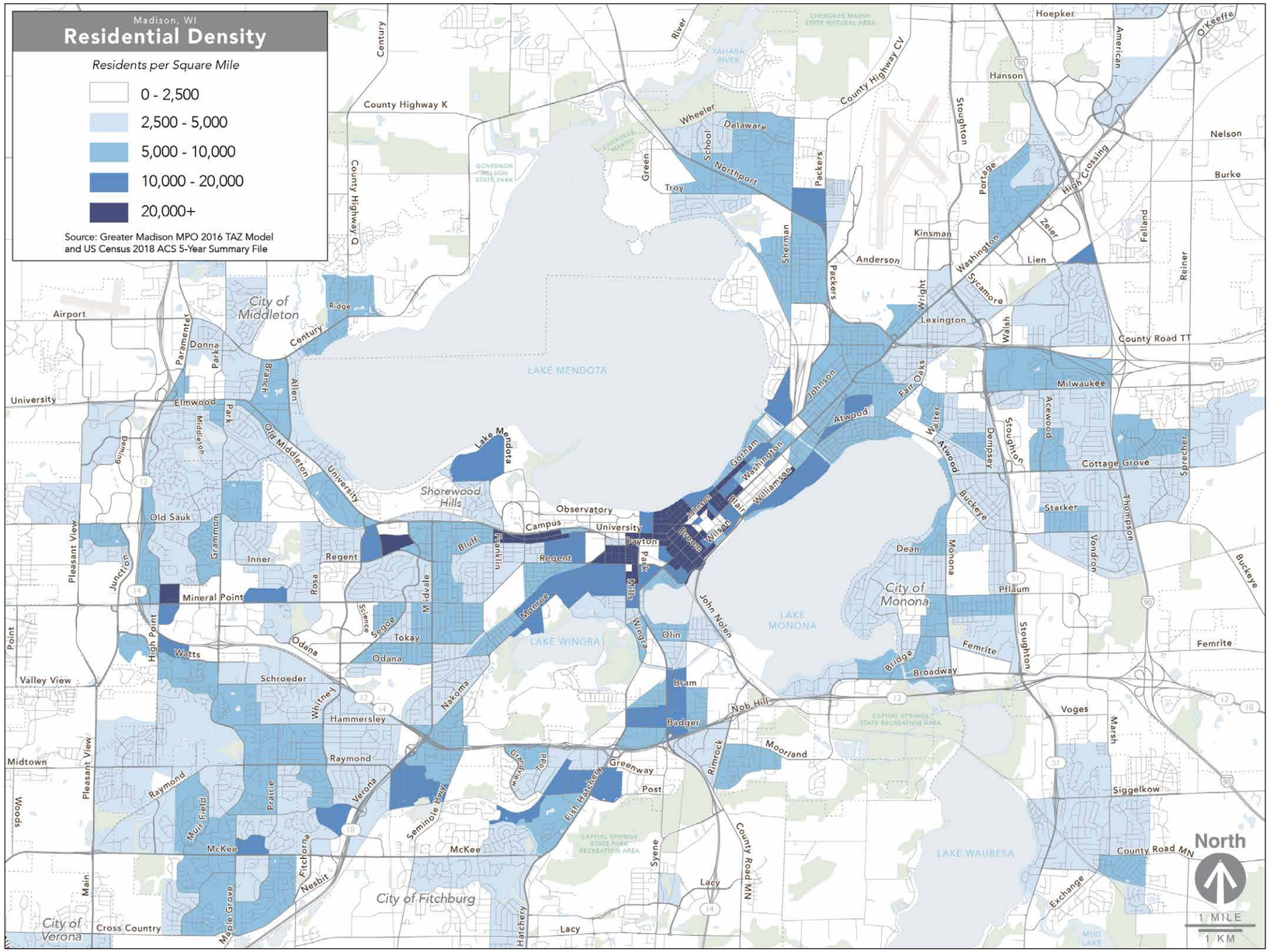

Figure 25: Residential Density in Madison

Indicators of Demand: Job Density

Employment density can tell us not just about where people might be going to work, but also about important destinations people travel to. Particularly in the retail and service sectors, high employment density also indicates places that are likely to have a high density of customers.

Similarly to residential population, the largest concentration of job density is around Downtown and UW. Hospitals and post-secondary institutions also appear as significant employment locations throughout the city and there are also significant peripheral employment areas spread around Beltline.

Some employment areas around the Beltline have job densities nearing those in central Madison, but they are more difficult to serve by transit due to freeway-oriented street networks and large parking lots that separate buildings from streets.

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Figure 27: There are many jobs in suburban centers, like around Highway 12 and Old Sauk Road, but they are located along meandering streets that don't offer an efficient, linear path for transit.

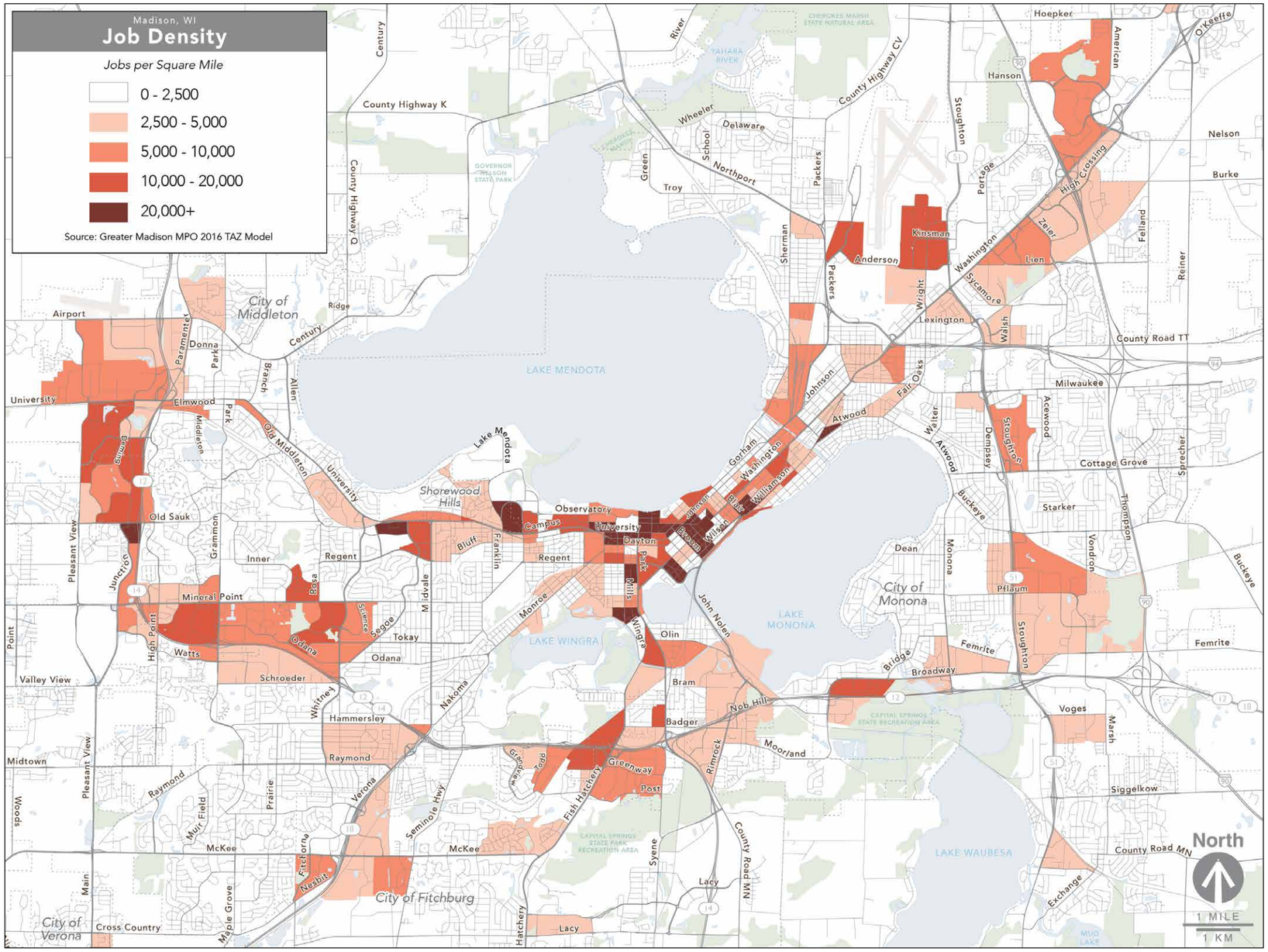


Figure 26: Employment Density in Madison

Indicators of Demand: Activity Density

The map at right shows many different types of activity: homes, workplaces, shopping, industry, entertainment and more.

It uses a three-color scale: residential density is shown in shades of blue, job density is shown in shades of yellow, and places where residents and jobs are both present are shown in shades of red. The darker the color, the greater the number of jobs or residents in the area.

This map allows us to see not only high density, but also the mix of activities in an area, which contributes to ridership potential. Transit routes serving purely residential neighborhoods tend to be used mostly in only one direction each morning and evening rush hour.

In contrast, where residential, commercial and other uses are mixed, people are traveling in both directions so buses can be full in both directions. Corridors which straddle a purely residential and purely employment area see some of the benefits of mixed land-uses.

This Activity Density map allows us to see three ingredients in the Ridership Recipe: high **density**, arranged in **linear** patterns, and **proximate** to other dense places.

However, there is a catch! Some of the seemingly-linear and dense corridors on this map are actually arranged around *freeways.* The transit consequences of freeway-oriented development are described on page 39.

With job density in both the city center and the periphery, and residential areas in between, two-way demand may allow some buses to be full in both directions.

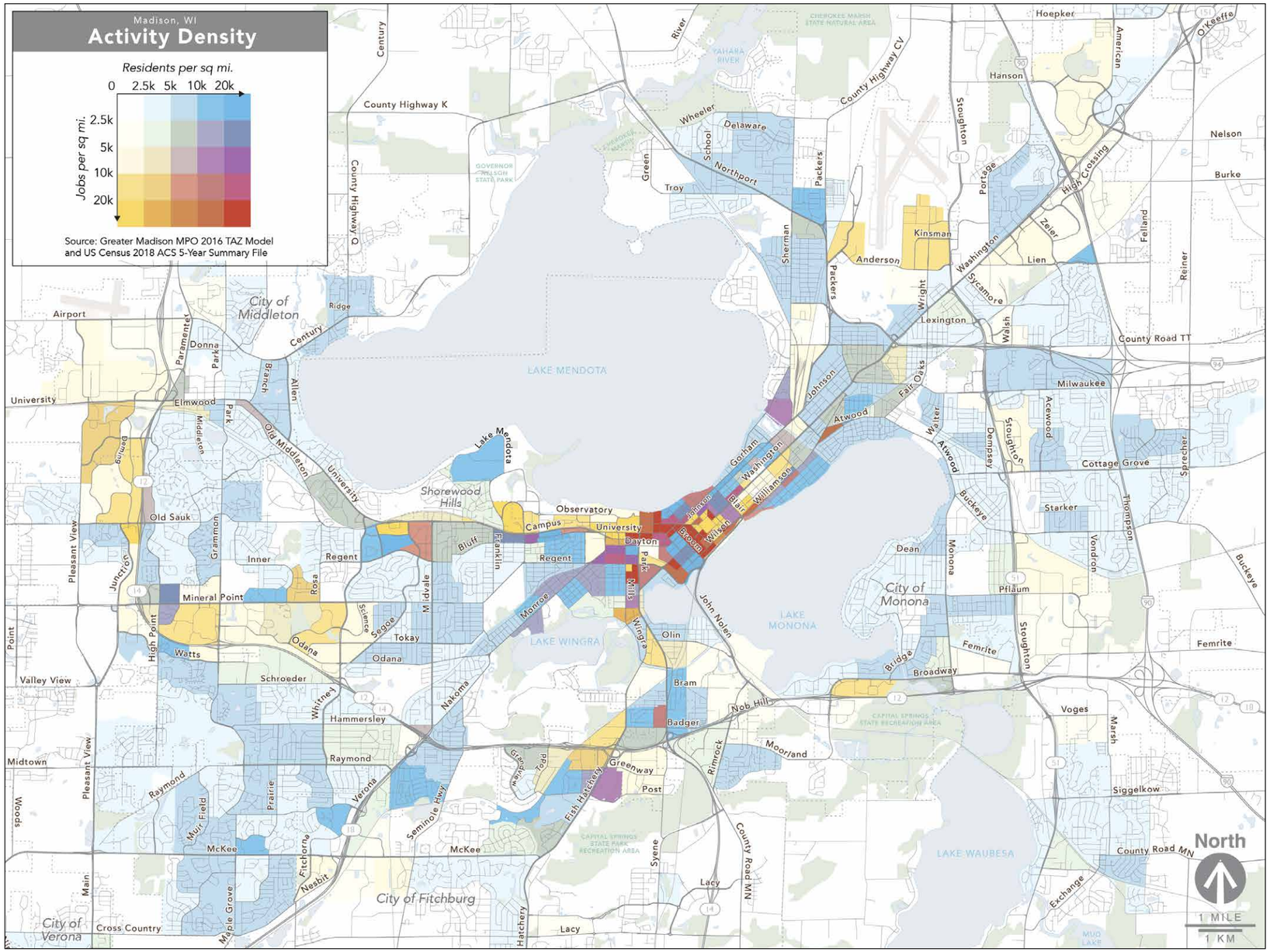


Figure 28: Activity Density in Madison

Indicators of Demand: Walkability

The map at right shows an estimate of how walkable different parts of the metro area are, based on the percentage of the land area within a half-mile of any given point that can actually be reached by walking a half-mile, using available streets and pedestrian paths.

This map clearly outlines the more walkable pre-war neighborhoods of Madison, where a dense grid of streets with many intersections makes it easier to walk to bus stops.

Newer developments can have high street connectivity, even without a traditional grid of streets. However, many newer developments are designed to minimize car traffic past the most valuable real estate.

This is done in part with intentionally poor street connectivity. If streets don't go through, only residents will drive down them. Anyone who wants to go anywhere will have to use the nearest arterial road. In most cul-de-sac developments, walking routes are long and circuitous, making it hard for people to reach transit if the bus routes stick to the major, linear roads.

Undeveloped land and waterways, having no streets or sidewalks, tend to appear in light shades. Areas near freeways and freight rail appear in light shades because those barriers reduce the area someone can reach with a short walk.

Areas around freeways, rivers and railroads tend to have few streets or paths that allow people to cross them, limiting peoples' access to transit stops just on the other side.

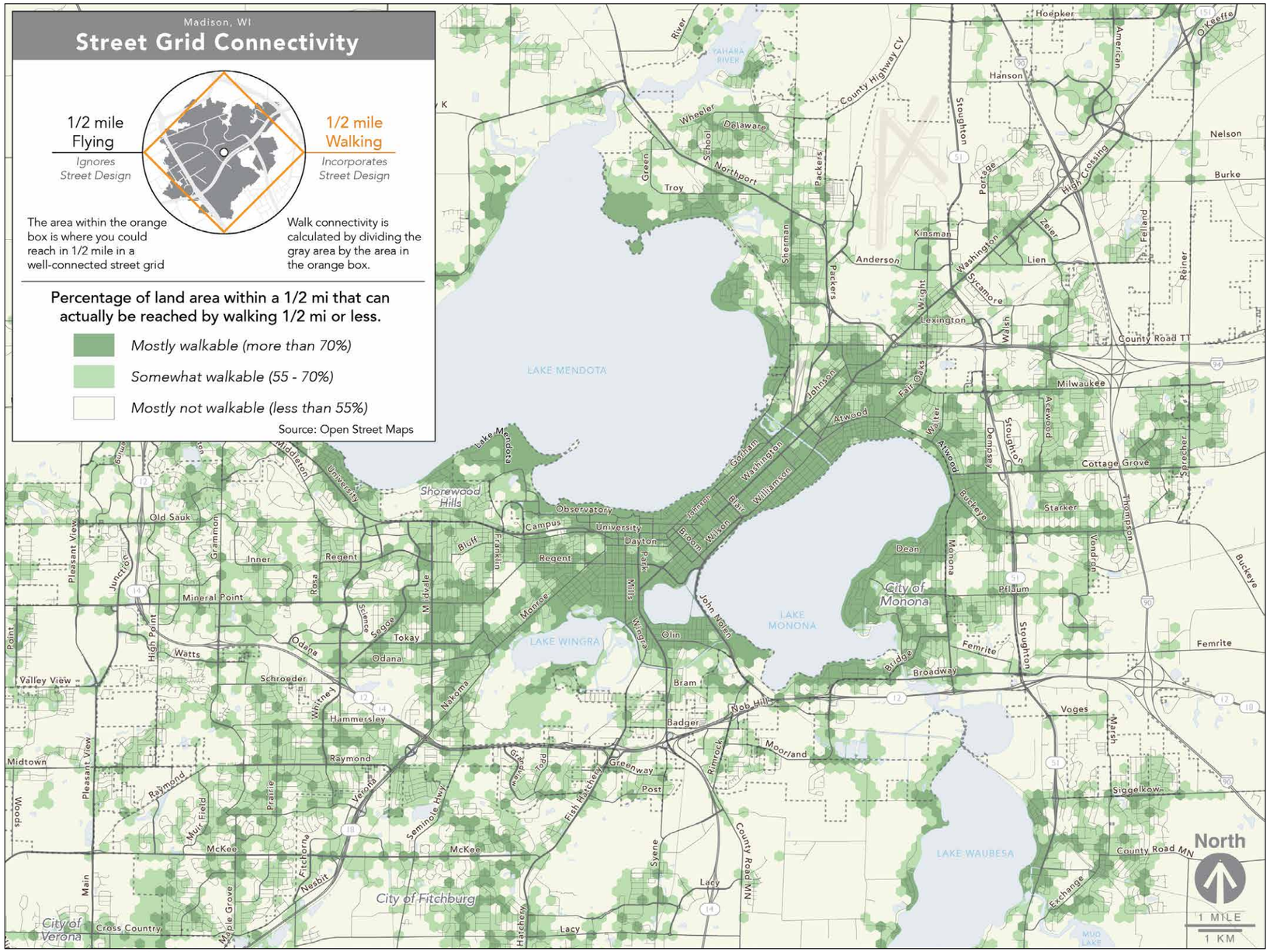


Figure 29: Map of Street Grid Connectivity in Madison

Indicators of Demand: Zero-Vehicle Households

Another factor affecting transit's competitiveness in an area is the availability of personal cars. The map at right shows the density of households with zero vehicles.

While people who don't own cars don't use transit by default, they have fewer options than those people who do have access to personal automobiles. As a result, if transit is a useful method (fast, reliable, available when they need to travel) of reaching 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 of reaching the places they need to go, by getting rides from friends or family members, cycling, walking, or using taxis or ridesharing services.

In Madison, the absolute highest density of zero-vehicle households is found downtown, and around the university. This is a common pattern in cities with major universities, since students, particularly those living in on-campus residences, are much less likely to own cars than the general population.

Outside of Central Madison, the density of zero-Vehicle Holseholds largely corresponds to the density of low-income households.

However, there are some exceptions. The areas near Schroeder and Gammon in the Southwest, as well as along Northport in North Madison, both have high rates of car ownership despite having a densit of people in poverty. This suggests that transit does not meet the travel needs of many people there, despite high levels of need. The opposite is true on the Isthmus, east of 1st, where it appears that some people forgo car ownership despite being able to afford it.

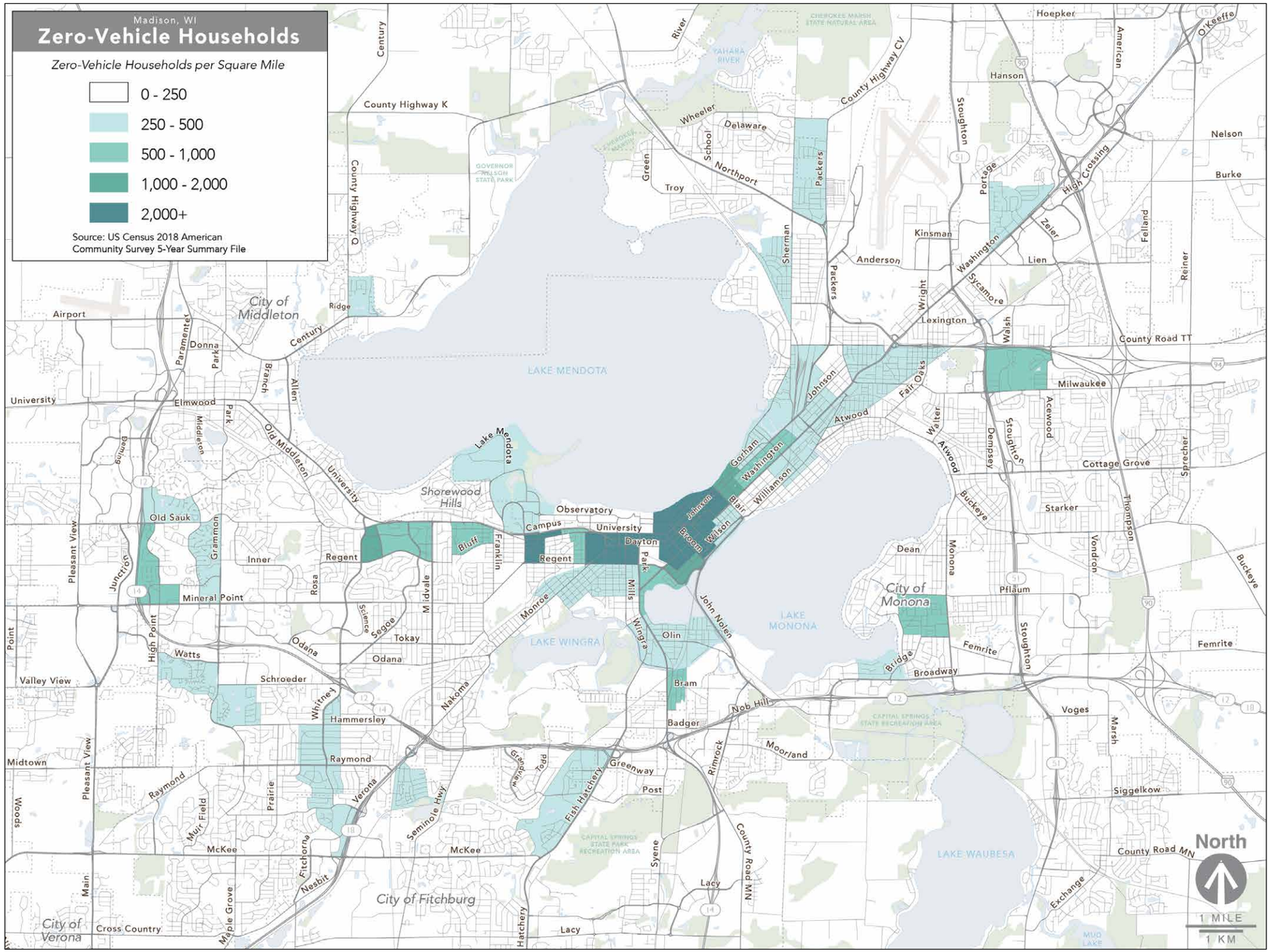


Figure 30: Density of Zero Vehicle Households in Madison

Indicators of Demand and Need: Low Income Households

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.

Comparing the maps in Figure 30 (previous page) and Figure 31 (at right), there is in fact some correlation between areas of higher poverty and lower vehicle ownership.

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 causes financial or social stress.

In Downtown and areas south of the UW campus, the high-density of households in poverty corresponds largely to the student population.

Outside of downtown, the density of households in poverty correlates with areas of higher non-White population. As a result there are clear equity implications of planning that focuses on needs of central city versus the needs of outlying areas of moderate to high density.

Concentrated poverty in central Madison is likely related to the UW student population. For many, this is a temporary problem.

Concentrated poverty in outlying areas may be more generational, and correlates with concentrations of Black, Latino and some Asian minorities.

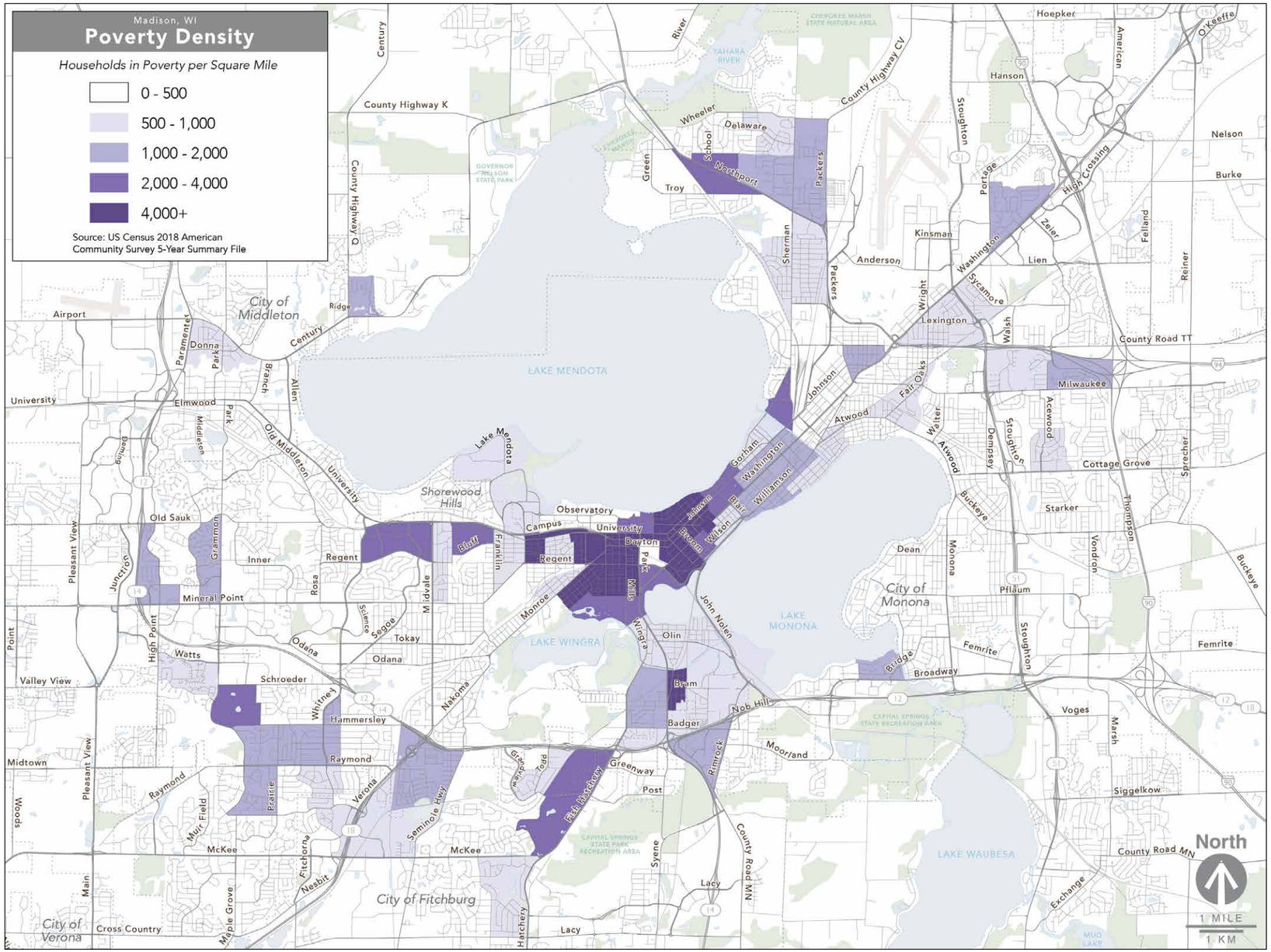


Figure 31: Density of Residents in Poverty in Madison. Poverty is defined as 100% of the Federal poverty level.

Civil Rights: Race and Ethnicity

The map at right shows where people of different races and ethnicities live in Madison and surrounding areas. Each dot represents 5 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.

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. However, avoiding placing disproportionate burdens on minority people, through transportation decisions, is essential to the transit planning process.

About 26% of Madison residents are people of color, with 7% identifying as Black and 7% as Hispanic or Latino. However, in outlying pockets of high density, there is a much higher share of residents who are people of color than in the city average. For example, in the area immediately west of Fish Hatchery Road and south of the Beltine (partly in Madison and partly in Fitchburg), about 65% of residents are people of color.

This means that when Metro Transit makes decisions about where to provide service, down which streets and in which neighborhoods, those choices have a racial dimension. Metro cannot assume that any bus route going down any road serves people of all different races, just because Madison as a whole is a diverse city.

High density areas in outlying neighborhoods tend to have a disproportionate share of residents who are people of color.

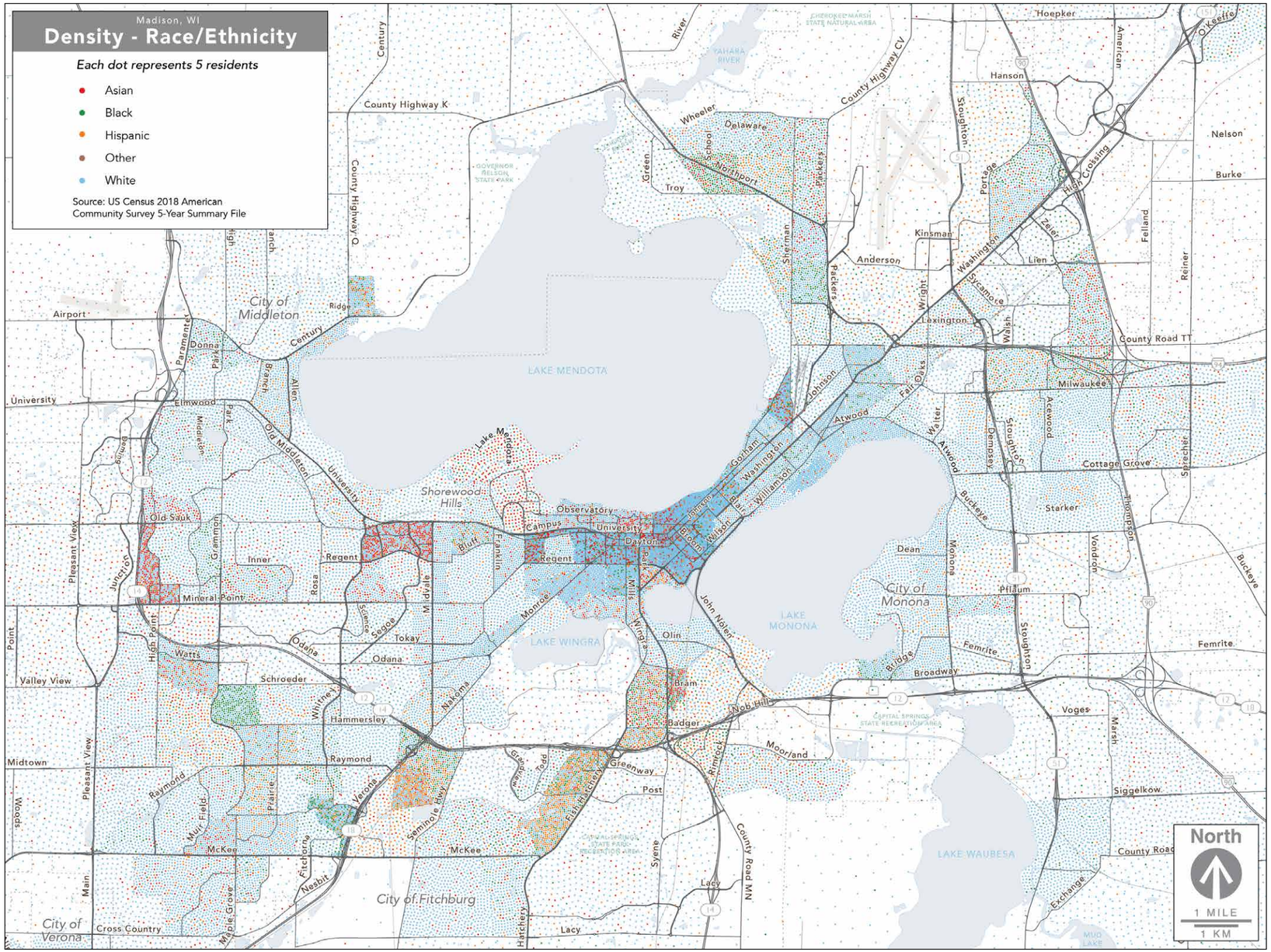


Figure 32: Race / Ethnicity map of Madison. Each colored dot represents five residents.

Civil Rights: Racial and Ethnic Minorities

Transit agency policies that protect minority people from negative impacts are one type of coverage goal, because they pursue an outcome that is valuable regardless of ridership. Such policies might state, for example, that service to high-density and high-minority neighborhoods should be prioritized even if such service would not maximize ridership.

It is also important to understand where large numbers of non-white people live, so that public outreach during this project can be sensitive to language and cultural barriers, and so that service changes can be evaluated in light of impacts to protected people.

In order to highlight contrast, Figure 33, at right, only shows the density of people of color.

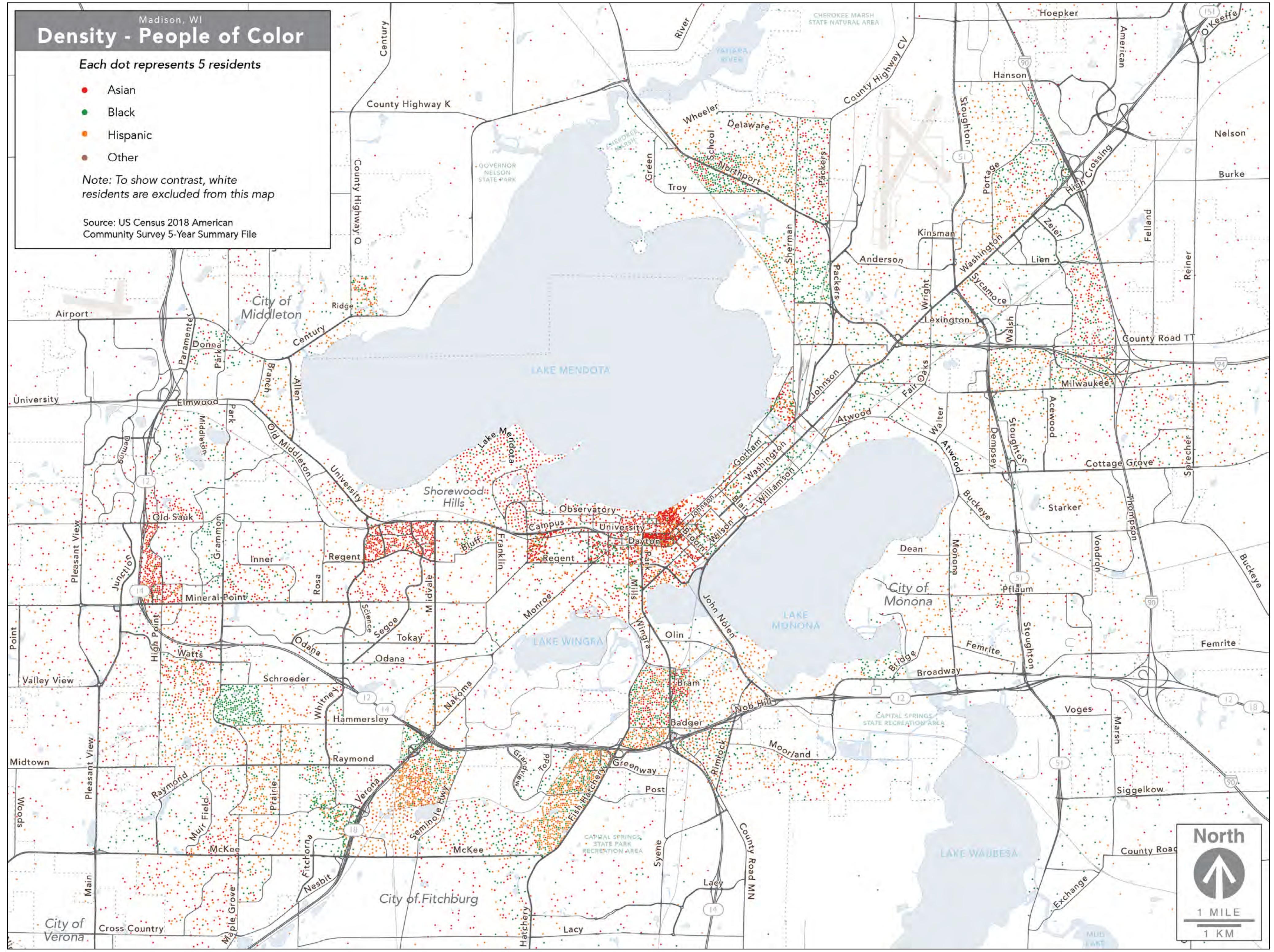


Figure 33: Race / Ethnicity map of Madison with only dots representing non-white residents. Each dot represents five residents.

Indicators of Need: Senior Residents

Senior residents live in areas throughout the city. The map at right shows the density of senior residents in Madison. Seniors are distributed throughout the city more evenly than the general population. To a certain extent, this map of senior residents appears to be the inverse of the map of low-income households.

Some seniors cannot drive and may be more likely to use transit. As a group, senior-headed households are less likely to own cars than the general population, an advantage for transit in places where other characteristics for high ridership (such as density, walkability) are present.

Seniors tend to have different preferences for transit. Seniors' needs and preferences are, on average, different from those of younger people. Seniors tend to be more sensitive to walking distance, because of limits on their physical ability. On average, seniors also tend to be less sensitive to long waits for transit, because many are retired and have a relatively flexible schedule. For the same reason, seniors are, on average, less likely to be discouraged by slow or indirect routes that take them out of their way.

Because of these factors, **transit service designed primarily to meet the needs of seniors rarely attracts high overall ridership.** Most riders who are employed, in school or caring for kids in school will find service with long waits to be intolerable. 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 community.

Seniors are spread out throughout Madison at relatively low density.

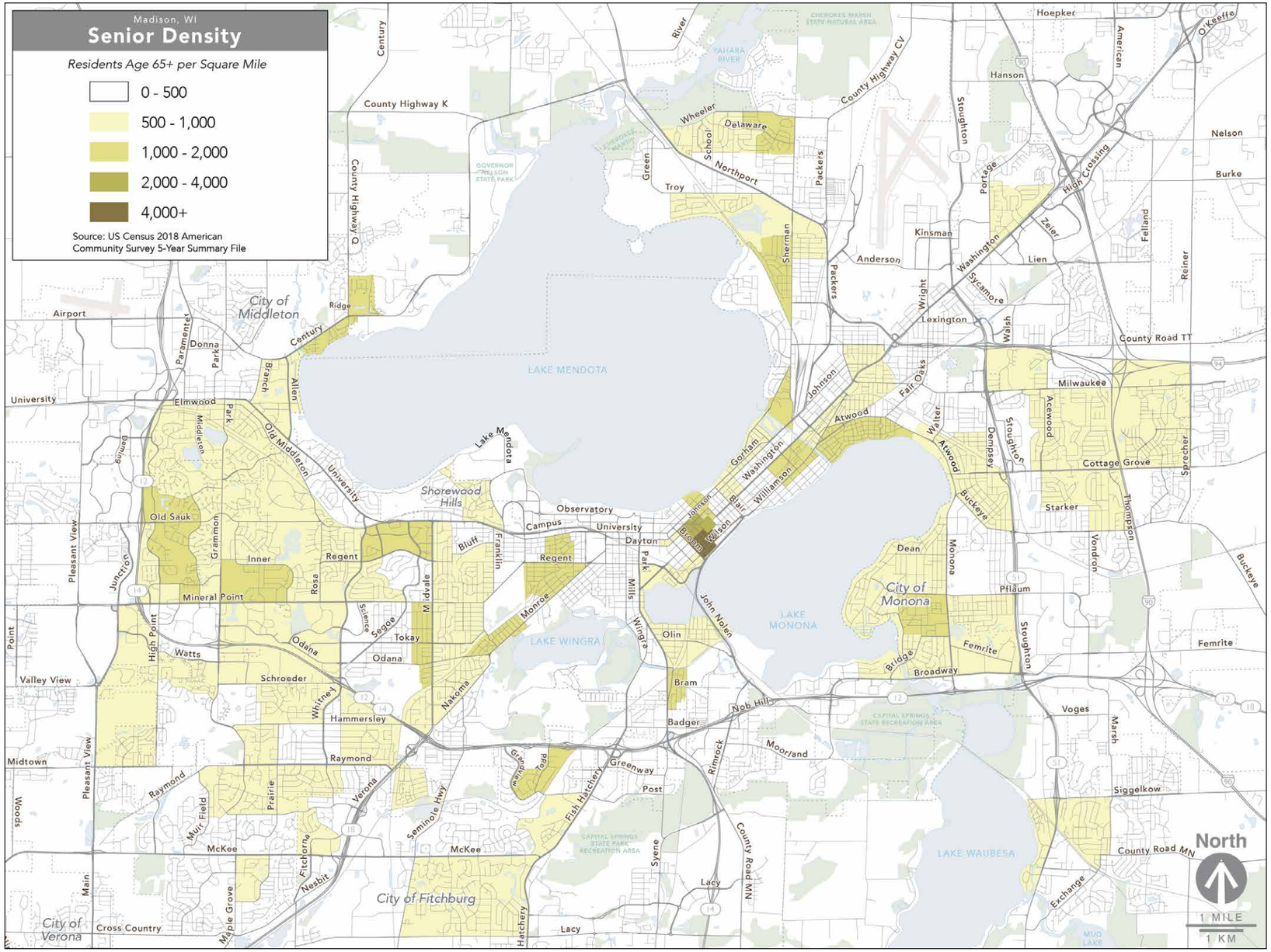


Figure 34: Density of Residents at or over age 65.

Indicators of Need: Residents under 18

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 at right shows the density of residents under the age of 18 in each Census block group in Madison.

The pattern of youth density is similar to the pattern of overall residential density in the city, with a few exceptions.

- Downtown and the adjacent neighborhoods show up in the lowest category, because they are so dominated by young professionals and college students.
- Unlike the map of the density of senior residents, areas with a high density of low-income households also tend to also have many residents under age 18.

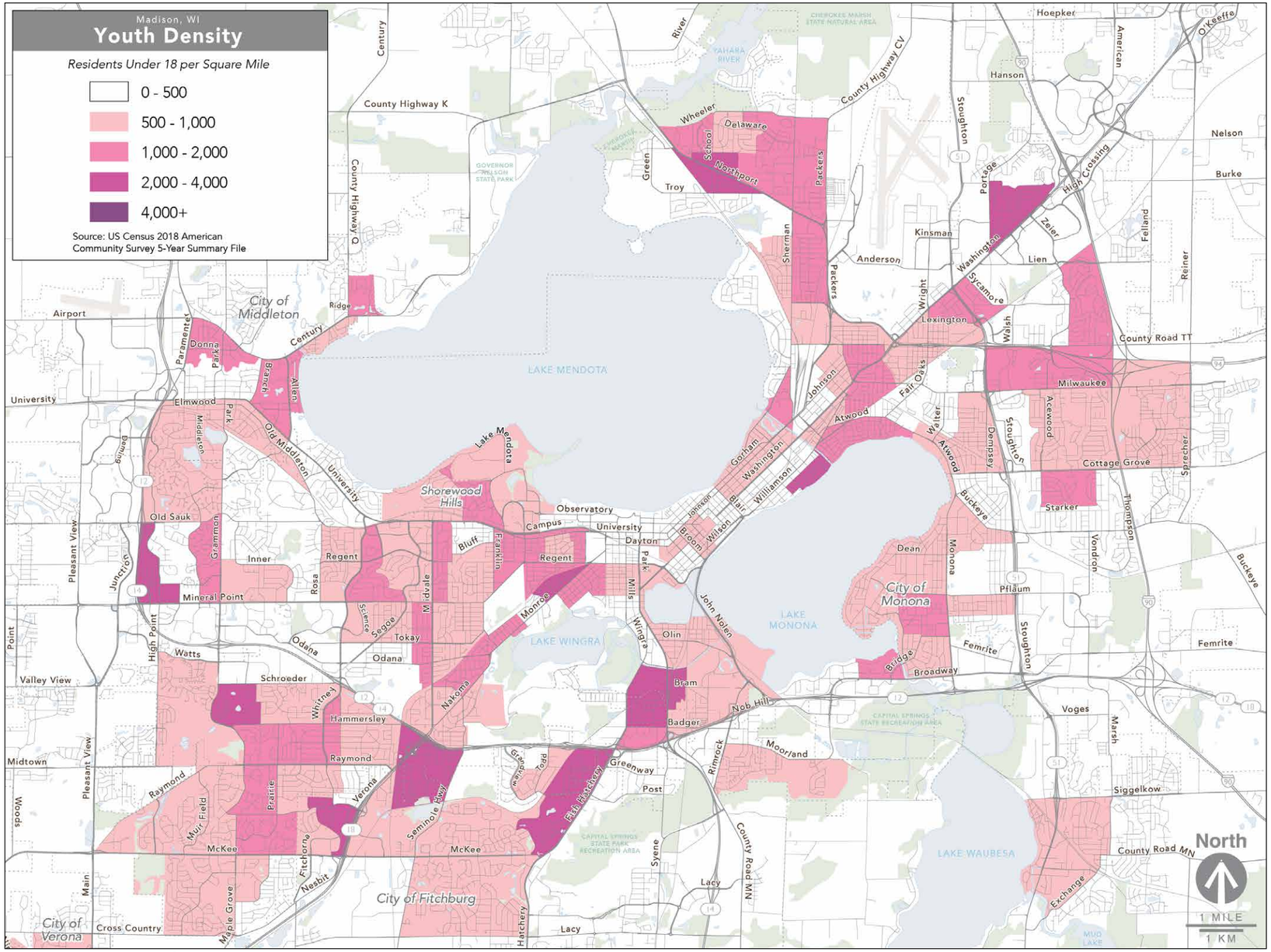


Figure 35: Density of Residents under age 18.

How Madison's Development Pattern Constrains What Transit Can Do

Radial vs. Grid Network

There are two basic network shapes that can be found in most transit systems, illustrated at right.

"Radial" networks have a central point, and nearly all routes go to that point. A radial network design ensures that anyone looking to travel downtown can make their trip without the need to transfer. Anyone going to another outlying place can get there with a single transfer at the center. Radial networks arose naturally in pre-car cities because so much commerce and culture was centralized.

"Grid" networks also offer people a way to travel from anywhere to anywhere with a single transfer. But unlike in a radial network, the transfers in a grid network happen wherever two routes intersect.

In large cities with many centers (such as LA, Chicago or Houston) a large frequent grid requires much less out-of-direction travel than a radial network would. A frequent grid offers the simplicity and reliability of a street network. It's easy to keep the map in your head.

In Madison, the concentration of destinations downtown and the geographic shape of the Isthmus, drive a radial orientation.

As a state capital with a major university, Madison has a strong concentration of destinations near downtown. The shape of Lake Mendota and Lake Monona also make it so that many transit routes must converge and connect along the isthmus. These two factors make a largely radial network the most effective option for Metro Transit.

Madison's radial-oriented network is complemented by a few orbital routes that provide direct connections between the transfer points. These offer shorter travel times for some trips that begin and end outside of central Madison.

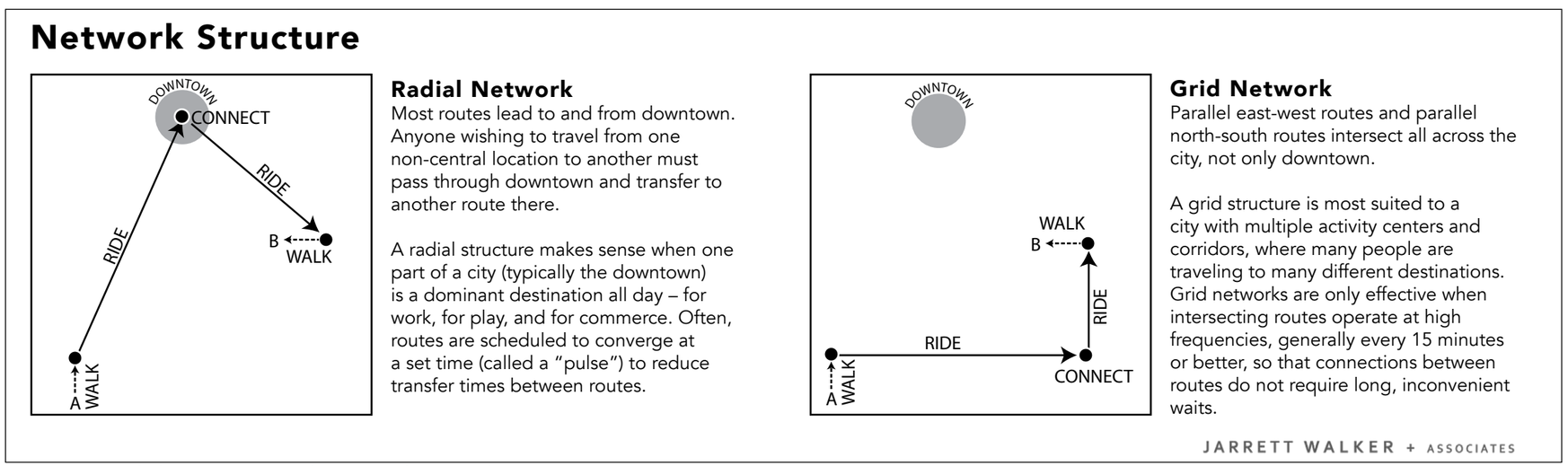


Figure 36: Radial Transit Networks vs. Grid Networks

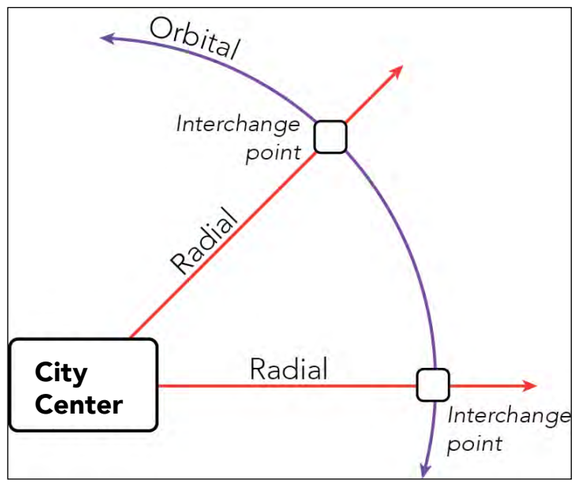


Figure 37: How orbital routes connect with radial routes. When orbital routes operate at high enough frequency to enable easy transfers, the network can become like a "radial grid".

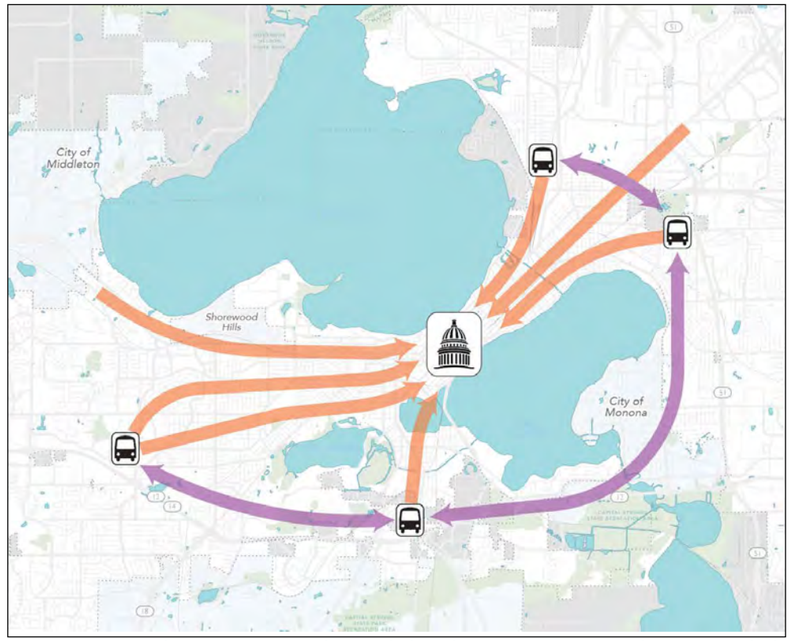


Figure 38: Madison's geography and development pattern drives a radial network design (orange arrows). A ring of orbital routes connect with the radial services.

Freeway-oriented development

Large areas of new development at moderately high density are located near freeways. This freeway-oriented development pattern reduces Metro's ability to provide transit service that is both useful and cost-effective. This pattern is visible in the map of activity density on page 30.

In the west and south of the city, developed areas seem to be arranged in a linear pattern – but the one continuous line along which they are arranged is grade separated freeway.

But linearity only works for transit if the line being followed is one along which buses can serve stops, and people can access those bus stops. Neither is true of most freeways, which are walled off from potential riders, and where buses must exit the freeway and loop around to serve stops. For transit, freeways are barriers, not corridors.

Unsafe, Unpleasant Pedestrian Access

There are two major consequences of this freeway-oriented development pattern. The most obvious consequence is that development concentrated around freeway interchanges requires people to walk in unsafe and unpleasant conditions to access transit service. This will naturally suppress transit ridership at those bus stops below what it could otherwise be.

For transit, freeways are barriers, not corridors.

Needing two routes instead of one

Another consequence is that Metro must respond by making sure that neighborhoods on both sides of the barrier have access to transit. This means running two routes, instead of one.

For example, Routes 15 and 73 run parallel between Old Sauk and Mineral Point, at times less than 1/4 mile apart, only serve people on both sides of the highway who cannot easily get to the other side.

Dividing a limited quantity of service into more routes means that routes have worse frequencies (or shorter spans of service) than they otherwise could.

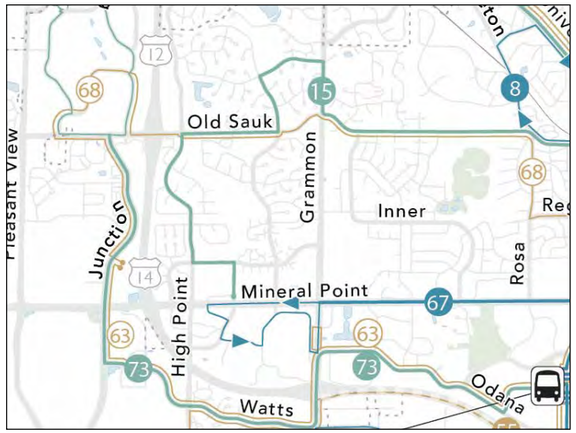


Figure 39: Two separate routes, 73, and 15, are necessary to serve people on both sides of the Beltline highway because they cannot easily walk to the other side.

Highway-running transit would require additional transfers to be able to serve many destinations along the way

Some transit agencies offer rush-hour express highway bus services into downtown but few are able to create a successful all-day highway-running bus services geared towards serving areas adjacent to the highway.

Without the ability to make stops at regular intervals and for passengers to access these stops on foot, people would have to transfer twice to get to their final destination, even if both their origin and destinations are physically close to the highway.

As a result, it is often more practical for transit networks to avoid using the highway altogether, despite lower speeds on city streets.

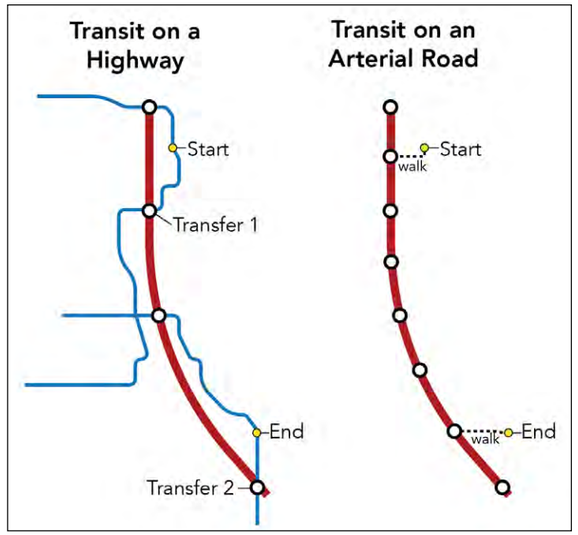


Figure 40: Highways can save time for cars travelling from adjacent destinations, but cannot do the same for transit riders. Transit networks cannot make use of the highways without requiring multiple time-consuming transfers, or time-consuming deviations at each major exit.

University of Wisconsin and Campus Drive

Multiple transit routes converge from the west as they approach the University and Downtown, both of which are major destinations. However, the layout of the university makes it impossible for service optimized for both the campus, and downtown.

The University Hospital is important to serve, but is a little far to walk to without a deviation.

The hospital is a major regional employer and generates a lot of transit ridership but its northernmost buildings are located nearly half a mile from University Avenue.

This is a long walk, particularly if you aren't travelling from far away. For convenient transit service to this hospital, east-west routes must be deviated along Highland Avenue in an inverted "U" shape. While this may be desirable for those working in the university, the added travel time is an annoyance for every person travelling through into downtown.

Observatory Drive is close to most university destinations, but slow, and unreachable for people living in the area south of campus.

In Figure 41 at right, Observatory Drive (path 1) appears to be just north of the centroid of UW academic buildings. It serves the university fairly well, but as a narrow, local street, it is slow. Using this path would increase travel time for anybody riding through to Downtown. And since there are few crossings available over Campus Drive, service along Observatory Drive would not be very useful for those living south of campus.

Campus Drive is fast, but buses cannot stop here.

Campus Drive (Path 2 in Figure 41) straddles the residential and employment area so service here would be in close proximity of both markets. It is also fast, and therefore desirable for passengers travelling through into Downtown.

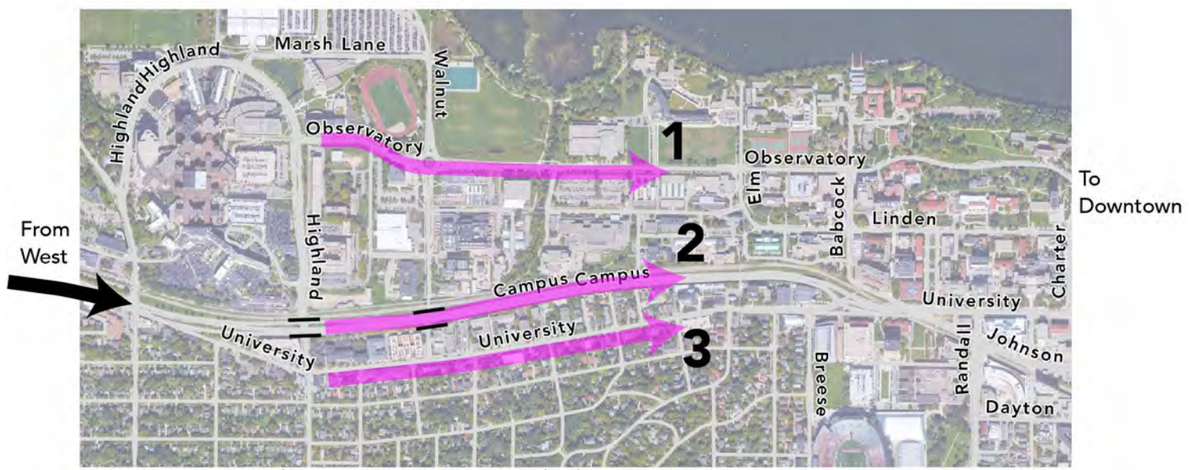
However, buses cannot stop in this segment due to grade separation and an active freight rail line just north of the street that hampers pedestrian access. If additional pedestrian crossings are added in the future, service along Campus Drive could be useful for many people.

University Ave serves the residential area to the south, and has moderate speeds, but doesn't provide access to campus.

University Avenue (Path 3 in Figure 41) is fully within the residential area south of campus, and on the wrong side of Campus Drive to be of much use to people travelling from outside this area to reach the main University campus.

Because Campus Drive is essentially a freeway, none of the available paths in this area is useful for service both to and through the University of Wisconsin.

This forces transit to operate on all three paths from the west to Downtown, for different purposes.



Imagery ©2021 Google, Imagery ©2021 , Maxar Technologies, USDA Farm Service Agency

Figure 41: There are three possible paths that transit could take through the UW campus into downtown. Each have advantages and disadvantages - it is not possible for the routing to be optimized for people accessing campus destinations and also be optimized for those accessing downtown.

4 The Metro Transit Network

Introduction to the Metro Transit Network

As of early 2021, Madison's transit network includes 45 bus routes[1].

- 23 routes that operate all day, seven days a week. Service typically starts between 5 and 7 AM, and ends around 11 PM.
- 18 weekday-only routes, including ten routes which run only in the morning and afternoon peaks (more or less 6 to 9 AM and 3 to 6 PM).
- 4 weekend-only routes. These routes combine one or more weekday routes to expand the area coverable by a single bus on weekends.

This reflects a network that has been significantly pared down due to the pandemic from a prior 58 routes. Overall, Metro Transit operated 20% less service in Fall 2020 than in Fall 2019.

Network Maps

These routes appear on the maps in Figure 42 and Figure 43. On this and other route maps in this report:

- **Red lines mean frequent service**, typically every 15 minutes or better in the middle of the day.
- **Dark Blue** means about every **30 minutes**.
- **Light Blue** means about every **60 minute**
- **Gold** means this route operates **peak-only** or otherwise **limited service** (e.g. evening-only, weekend-only).

Segments where many routes overlap are marked in dark gray. More detail for these segments appears in Figure 43 on page 43, a map of transit service in Central Madison.

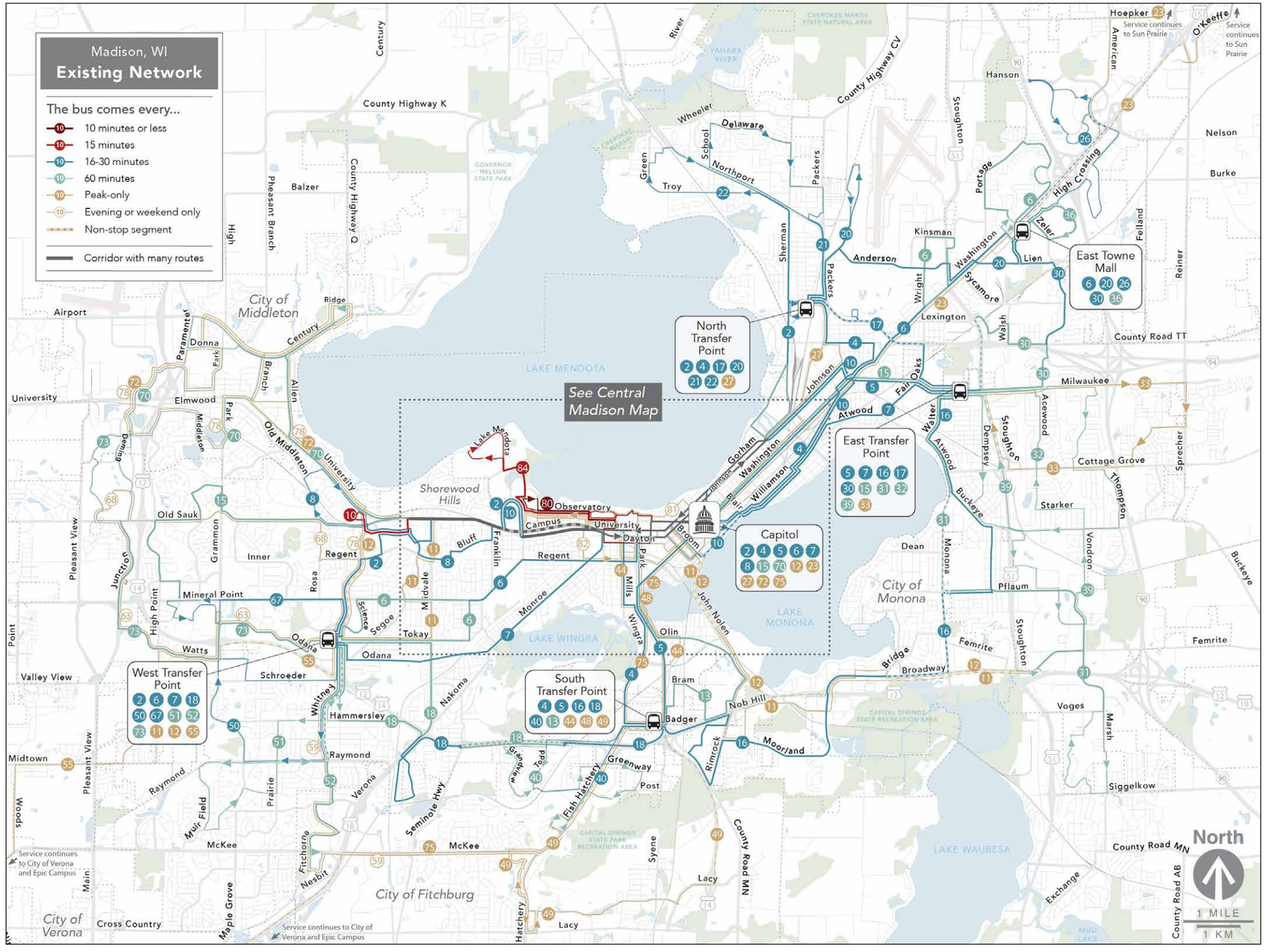


Figure 42: Metro Transit network of bus routes, as of early 2021.

1 Metro Transit also operates paratransit services for qualifying members of the public. As discussed on page 4, this outlying is about general public transit, and does not foresee any changes to paratransit.

Route Organization

The basic shape of Madison's current transit network was established in 1998. The system revolves around six hubs:

- The **Capitol** in Downtown Madison, where many routes converge on their way to and from different sides of town. Most Downtown routes are in fact connecting two of the:
- **Five outlying Transfer Points** (North; South; West; East; and East Towne Mall). Most outlying parts of Madison are served by bus routes that connect to a Transfer Point. From there, passengers connect to a second route to go Downtown or across town.

Most routes in the network are defined by their relationship to these hubs.

- **Radial routes** travel from all directions into Downtown Madison. Most radial routes connect two of the Transfer Points via Capitol Square
- **Feeder routes** operate in outlying areas of the city, connecting these areas to one of the Transfer Points.
- A ring of **orbital routes** connects outlying areas to each other, travelling between the Transfer Points.
- In addition, the network features a set of **University-oriented routes**. These routes serve the core of the University of Wisconsin campus.

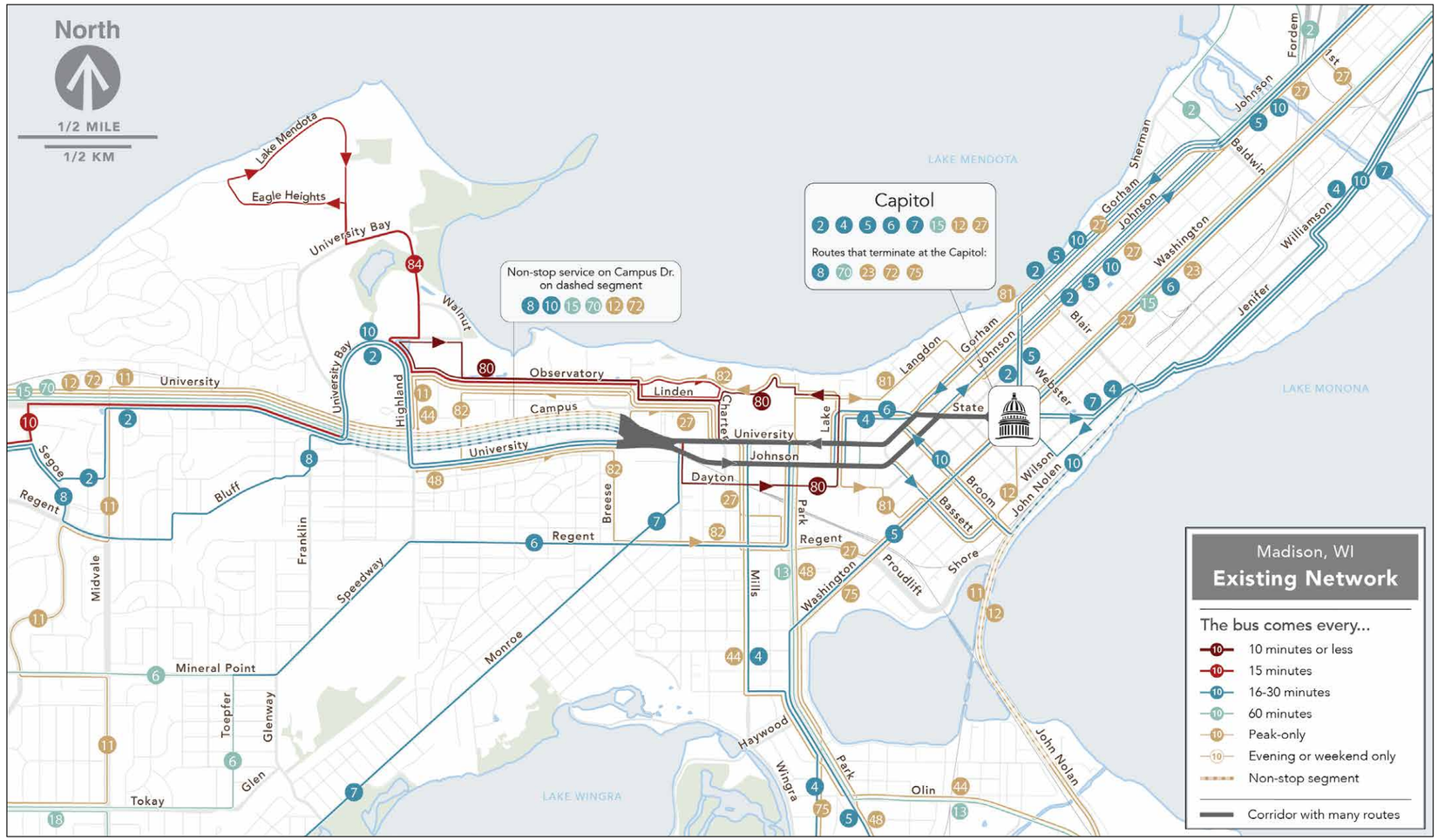


Figure 43: Metro Transit network in Central Madison, from Midvale Boulevard to First Street. This area includes Downtown Madison and the University of Wisconsin main campus. Many routes converge coming from many directions.

Radial routes connect inner areas to Downtown.

Radial Routes

The core of the network consists of Routes 2 through 10. These routes account for 20% of total service, but nearly 50% of boardings. This is explained by the high densities in central Madison, compared to other areas. The core routes connect more people and places than any other part of the network.

Each core pattern operates about every 30 minutes on weekdays, starting or ending at a Transfer Point.

- Route 2: West TP -> Capitol -> North TP
- Route 4: South TP -> Capitol -> North TP
- Route 5: South TP -> Capitol -> East TP
- Route 6: West TP -> Capitol -> East Towne
- Route 7: West TP -> Capitol -> East TP
- Route 8: Spring Harbor -> Capitol
- Route 10 has two patterns:
  - 10a: University Row -> Downtown -> North Street
  - 10b: University Row -> Downtown -> North Street

Each core route follows a unique path to Downtown, converging near Capitol Square, before terminating, or continuing in separate directions. This complex dance results in two key outcomes:

- **Many one-seat trips are possible through Downtown**, if your trip starts at or closer in than the Transfer Points.
- **Few trips are served more frequently than every 30 minutes**.

The network also includes secondary radial routes that operate at lower frequency or limited hours:

- Route 15 (Old Sauk Rd.) and Route 70 (Middleton) operate every 60 minutes in the middle of the day.
- Routes 11, 12 (Dutch Mill), 23 (Sun Prairie), 72 (Middleton) and 75 (Verona) are each peak-only routes that connect Downtown Madison to various outer outlying locations.

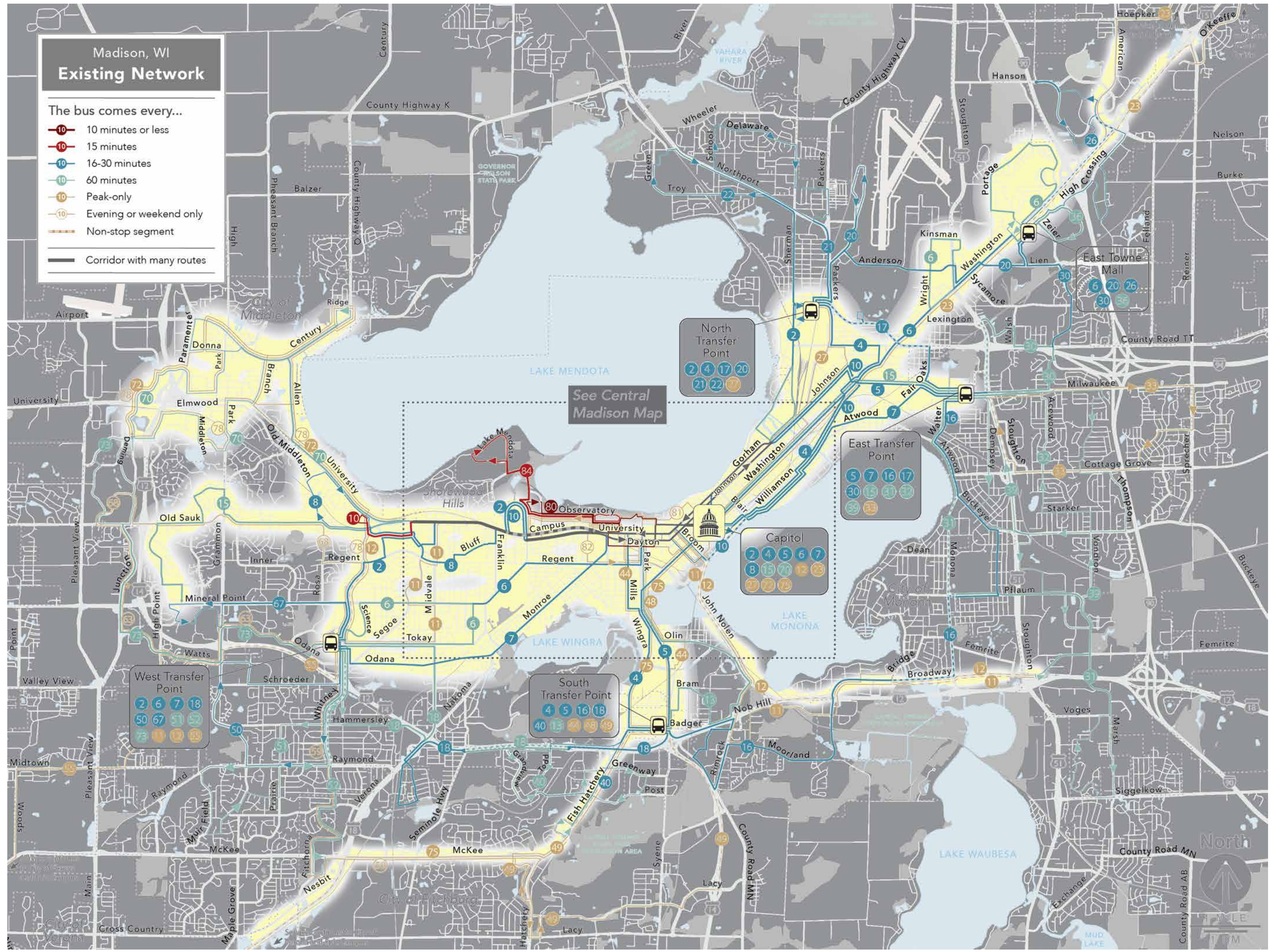


Figure 44: Metro Transit network of bus routes, as of early 2021, with radial routes and their surrounding areas highlighted.

Feeder routes connect outlying areas to Transfer Points

Feeder Routes

Each of the outlying Transfer Points serves as a hub for feeder routes coming from outlying areas of Madison and surrounding suburbs.

- **North TP:** Routes 21 (Lakeview) and 22 (Mendota)
- **East Towne Mall:** Route 26 (American Center)
- **East TP:** Routes 31 (Marsh Road), 32 (Thompson-Acewood), 33 (Sprecher) and 39 (World Dairy)
- **South TP:** Route 40 (Arbor Hills) and 49 (Lacy - Fish Hatchery)
- **West TP:** Routes 50 (Raymond), 51 (Muir Field), Route 52 (Orchard Pointe), 55 (Verona), 59 (Fitchburg), 63 (Prairie Town Center), 67 (West Towne Mall), 68 (Prairie Town Center) and 78 (Middleton)

Feeder routes provide coverage to these outlying areas, but **because they have infrequent and variable schedules, the feeders can be difficult to use** without consulting a schedule in advance.

Most buses operating on feeder routes continue as radial or orbital routes. This is called "through-routing", and it facilitates some one-seat rides. But **the pattern of through-routes (which bus becomes which other bus) changes by time and day of the week;** not all buses on a given route will continue as another route. If you leave your house at the wrong time, you might have to wait half an hour at the Transfer Point rather than at home.

The feeder routes also operate many different types of schedules, with different buses running at different days and times:

- Twelve routes operate seven days a week, but six are weekday-only, including Routes 33, 39, 49, 52, 55.
- On weekdays, three of the feeder routes operate only at peak hours: 33, 49 and 55.
- Four of the feeder routes operate only on weekends: 59, 63, 68 and 78.

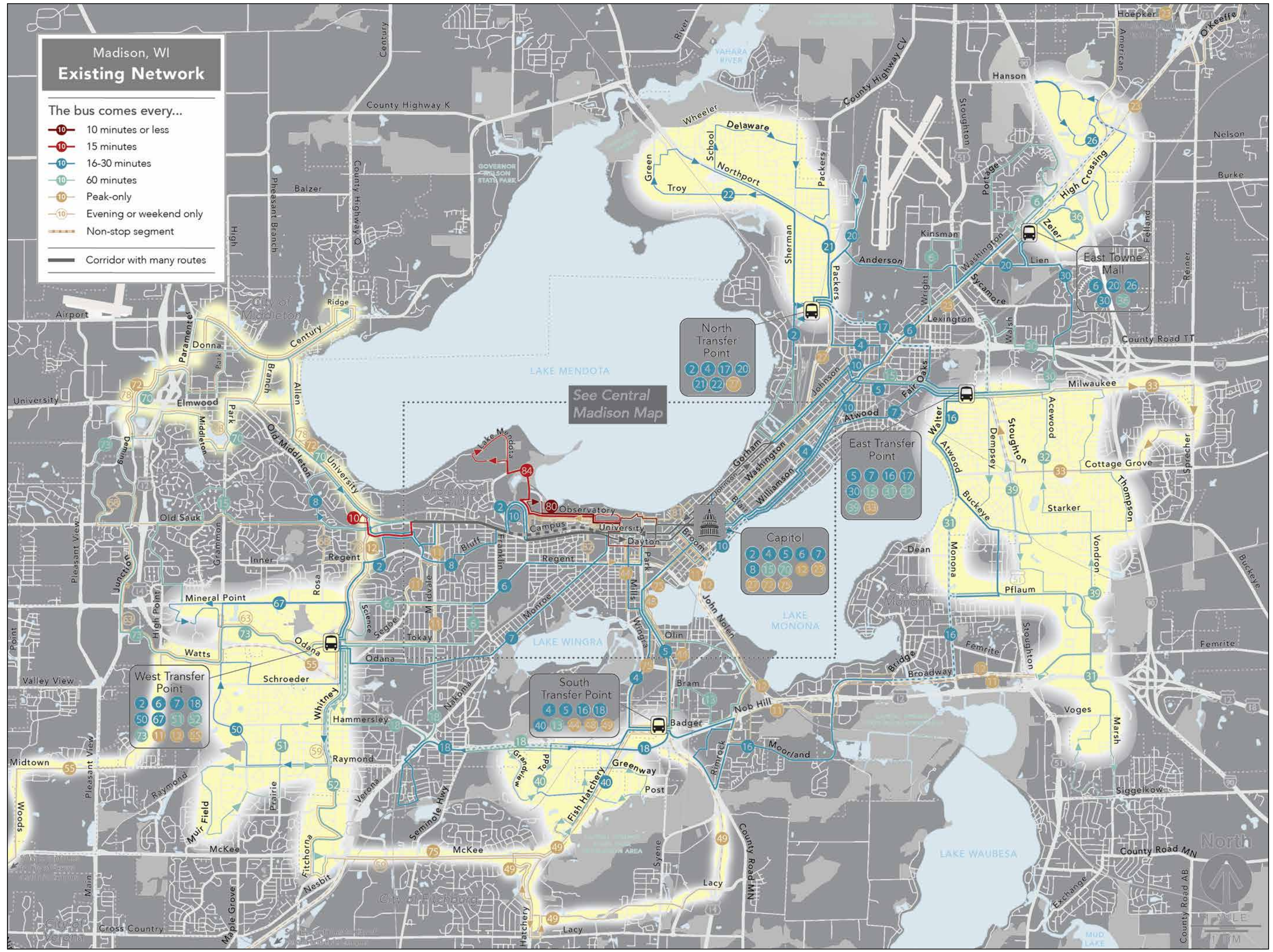


Figure 45: Metro Transit network of bus routes, as of early 2021, with feeder routes and their surrounding areas highlighted.

Orbital routes connect the Transfer Points to each other.

Long one-way loops are another factor that can make it difficult to use some feeder routes. These patterns exist so Metro Transit can cover more area at a lower cost, but present significant challenges to riders who usually need to travel in both directions.

Orbital Routes

Five orbital routes operate between the outlying Transfer Points. These include:

- Route 18: West TP -> South TP
- Route 16: South TP -> East TP
- Route 17: East TP -> North TP
- Route 20: North TP -> East Towne Mall
- Route 30: East Towne Mall -> East TP

All five of these routes operate about every 30 minutes on weekdays. Four of them continue to operate every 30 minutes on weekends, putting this group on par with the Core Radial routes for frequency.

A sixth route, Route 73 (West TP -> Middleton) also has an orbital arc to it, although it operates less frequently than the other orbitals: every 60 minutes, and only on weekdays.

Users of the orbital routes face some of the same difficulties as users of the feeder routes, and some unique ones as well.

- **Variable through-routes.**
- **Routes that split** so that only every other bus between two Transfer Points comes by a particular location.
- **Freeway-oriented development**, such that orbitals either have to run longer distances or miss certain destinations along the way (see page 39).

Also, although the map shows a ring of orbital routes that connect a broad range of outlying areas, **the orbitals actually tend to act as extensions of the radial/feeder system.** Only routes 16 and 17 are consistently through-routed to each other, and only on half of runs.

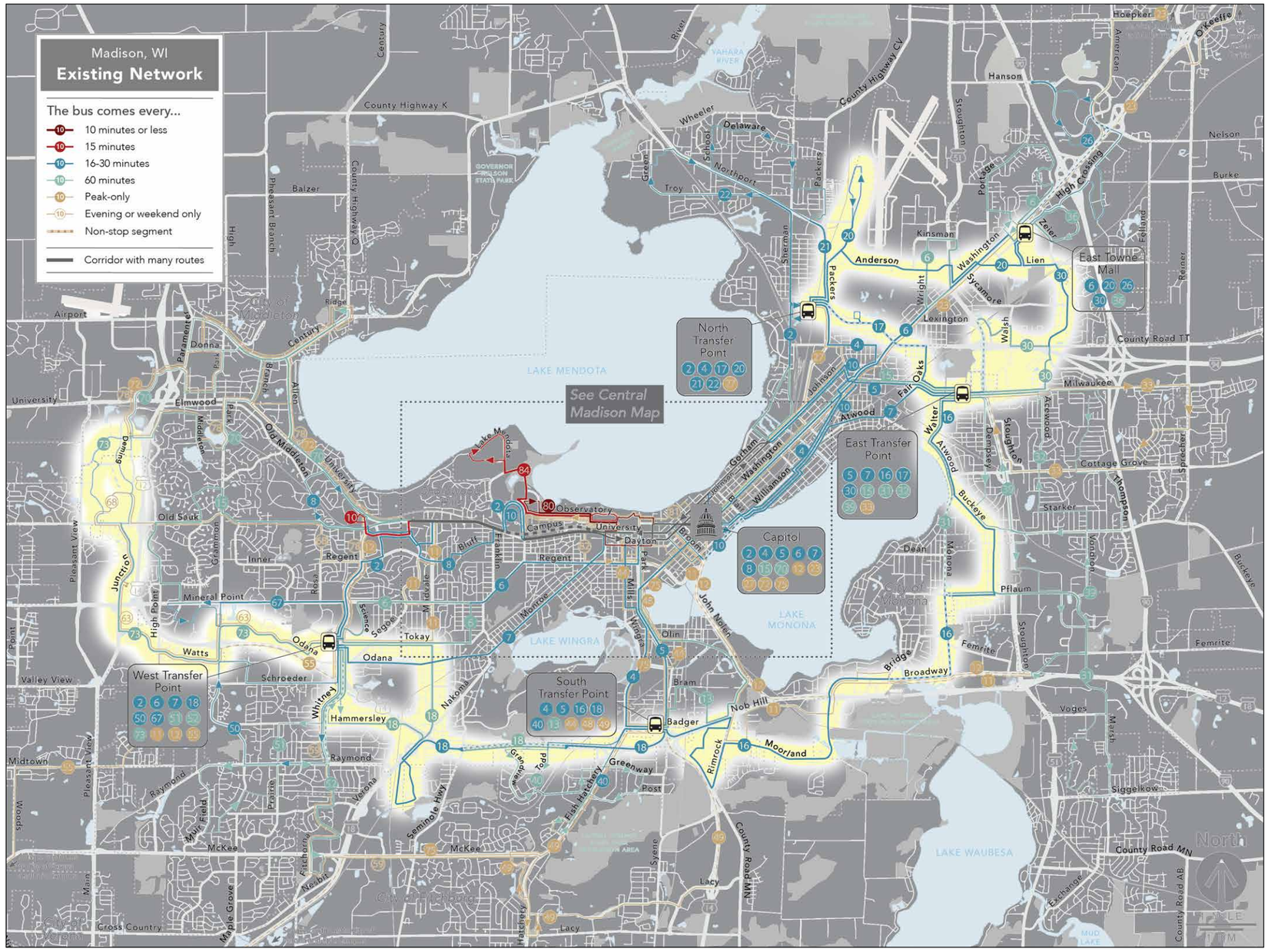


Figure 46: Metro Transit network of bus routes, as of early 2021, with orbital routes and their surrounding areas highlighted.

Some routes are provided for purposes specific to the University

University Routes

Many radial routes come near or to the edge of the University of Wisconsin campus on their way Downtown, like Routes 2, 8, 10 or 70. There are also routes that exist specifically for University-related purposes. These include:

- Routes directly contracted by the University, mostly for internal purposes, like:
  - Route 80, the main campus circulator, which runs every 10 minutes on weekdays and every 15 minutes on weekends. Pre-pandemic, Route 80 had the highest ridership of any Metro Transit route, by far, carrying over 10,000 passengers per weekday. That number is currently under 1,000.
  - Route 84, a weekday-only circulator connecting student housing in Eagle Heights to the center of campus every 15 minutes.
  - Routes 81 and 82, which connect campus to immediately adjacent residential and entertainment districts. These operate seven days a week, but only in the evenings after 7 PM.
- Peak-only or infrequent routes targeted at University students and staff coming from other parts of Madison. These include routes coming from the West (11/12), North (27) and South (13, 44, 48) transfer points, in addition to the Dutch Mill Park & Ride (11/12).

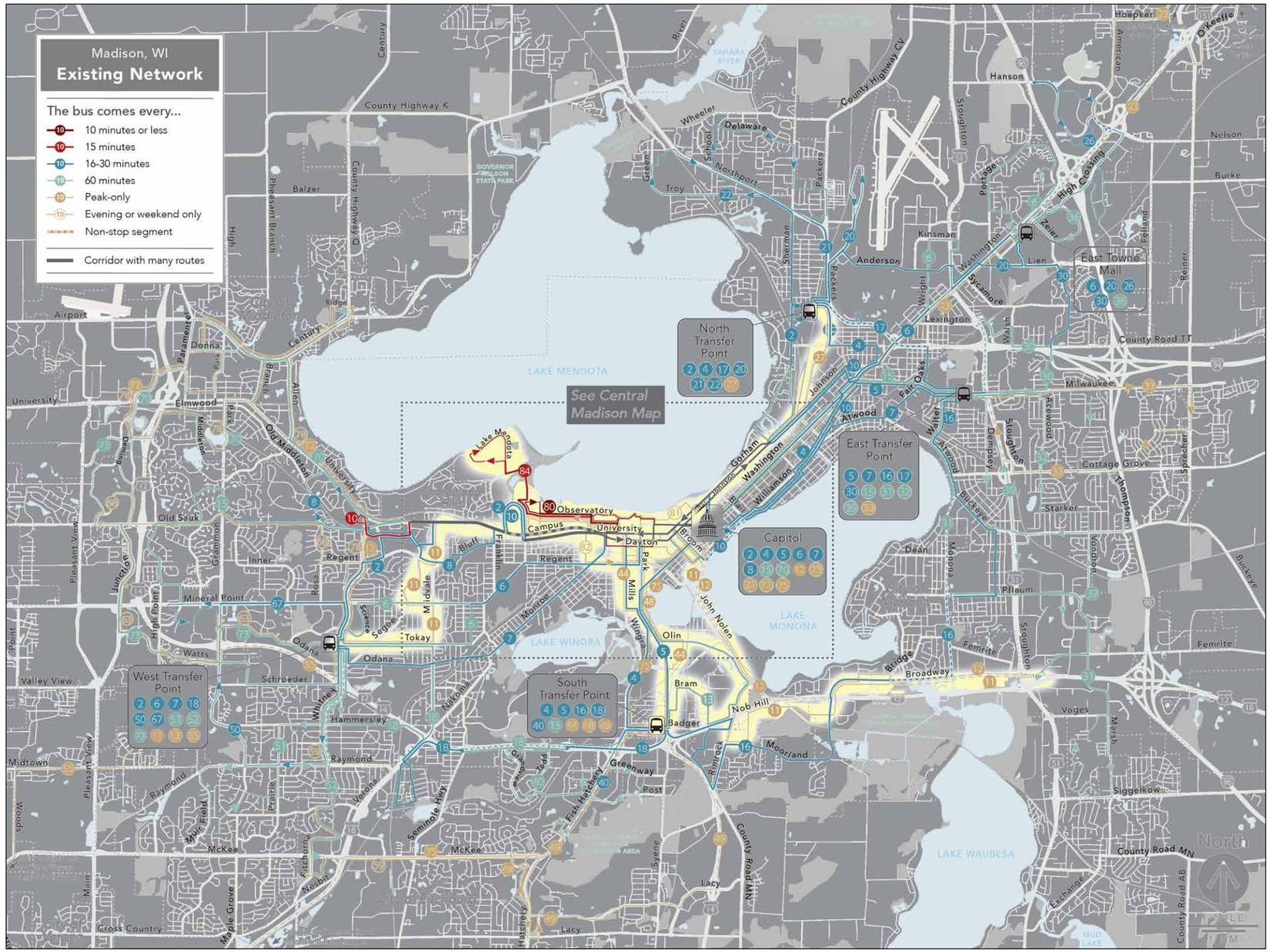


Figure 47: Metro Transit network of bus routes, as of early 2021, with University-oriented routes and their surrounding areas highlighted.

Outlying Routes are designed to "Pulse" at Transfer Points

Timed Connections at Transfer Points

Connections allows people to travel in many directions but the amount of time a transfer takes depends largely on the frequency of the connecting routes. For an untimed connection, transferring to a frequent route like UW's Route 80, which comes every 5 minutes when school is in session, would take on average just 2.5 minutes. However, transferring to a route that comes every 60 minutes could require a 30-minute wait, on average, and in the worst case a 59-minute wait!

To make connections between low-frequency routes more tolerable, transit networks are often operated with a "pulse" at a few key locations. To offer a pulse, an agency must design its routes to be a certain length so that buses can all arrive at the central hub at the same time, each hour or half-hour. The buses dwell together for a few minutes, passengers connect among them, and then they depart again. This can happen at any regular interval, though half-hourly and hourly pulses are common in most networks with a timed connections.

Most feeder and orbital routes in Madison do not go all the way downtown, but instead converge at one of four Transfer Points. Many of these routes, as described on page 45 and page 46, pulse with one another, allowing for relatively quick connections despite low frequencies.

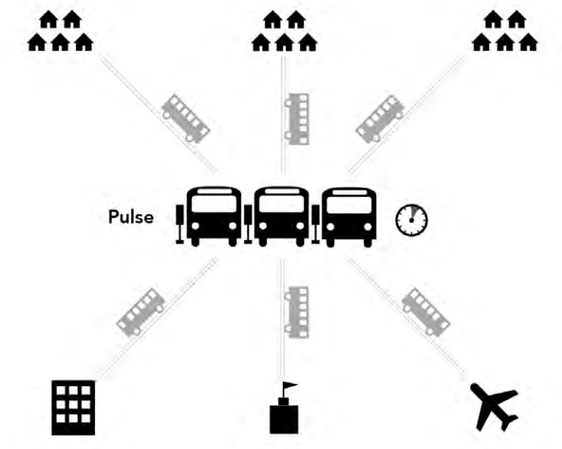


Figure 48: In a pulse, multiple low-frequency routes are scheduled to come together regularly, dwell for a few minutes so that passengers may transfer among them, and then depart again.

Pulses don't always work perfectly

In theory, pulse timing at Transfer Points means that every bus arrives five minutes before the departure time, drivers take a quick break, and then at the top of the hour (or whenever the pulse is scheduled for), every bus departs at the same time, allowing for every transfer to be made with just a five minute wait.

In practice, schedules are rarely perfect. Firstly, timed connections between routes half-hourly routes and hourly routes can only exist half the time. Secondly, unless the travel times happen to work perfectly, a route that operates as a loop, cannot be made to both depart from a Transfer Point on time, and return exactly five minutes before the next departure time without adding a layover somewhere along the route that inconveniences some people. Route 73 is an example of this. It departs at the top of the hour from West Transfer Point, loops around Greenway and Hammons, and returns to West Transfer Point 8 minutes before the next departure.

Pulses are fragile

There is a cost to pulsing. First, the routes must be designed so that they can make a round trip in the right amount of time to get back to the pulse with all of the other routes. This makes it hard to lengthen a route just a tiny bit in response to requests. In the case of Madison, it makes it challenging to relocate the transfer points based on the design of the future BRT system.

This inflexibility also means that any reduction in the speed of the bus can be threatening to the pulse, since that bus may not be able to do its round trip in the required amount of time. This is an increasing challenge for Metro Transit, as traffic congestion has gradually increased over the past 20 years throughout the region.

Also, the consequences of a bus arriving late to a pulse are more severe than that of an untimed connection. For an hourly route that arrives six minutes late and just misses a pulse, connecting passengers have to wait an extra 59 minutes for the next bus.

Service coverage is very high, but service usefulness is very uneven.

Proximity to Transit

By counting the number of people and jobs near service, we can estimate how well a transit network serves both coverage and ridership goals.

The charts at right report proximity to services of different frequencies. The distinction is important because frequent service is most liberating for people. Frequent service is also the most likely to attract high ridership relative to cost. Key findings include that:

- 82% of the city's residents and 89% of jobs are within 1/4-mile of a bus stop that offers at least minimal service
- In contrast, only 11% of residents and 17% of jobs are located within a 1/4-mile of frequent service (15 minutes or better at noon on weekdays). Most of this service is located in downtown and at the University of Wisconsin campus.
- Proximity to transit is relatively equitable across income and race.
  - 15% of people-of-color live near frequent service, compared to 11% of all residents. While this suggests that as a whole, minority residents are more likely to be located near frequent service, the experience of specific racial and ethnic groups vary significantly. The race dot-density map on Figure 32 on page 34 sheds some light on these differences.
  - 32% of residents in poverty live near frequent service, a much higher percentage than the general population, although it is likely that many of these residents are students, since so much Madison's frequent service is located near the university.
  - 80% of residents in poverty live near bus service that comes at least every 30 minutes, This stands in contrast with just 59% of the general population near 30-minute or better service.
- Service is not located advantageously to the young or the elderly. This reflects the fact that seniors are spread out throughout Madison at relatively low density. Youth, while largely reflective of the location patterns of the general population, are mostly absent from downtown and the university area.
  - Only 76% of seniors and 75% of youth live near the transit network, compared to 82% of all residents.
  - Only 3% of seniors and 4% of youth live near frequent service, compared to 11% of all residents.

The vast majority of Madison residents and jobs are near some transit service, but only 11% of residents and 17% of jobs are near service every 15-minutes or better.

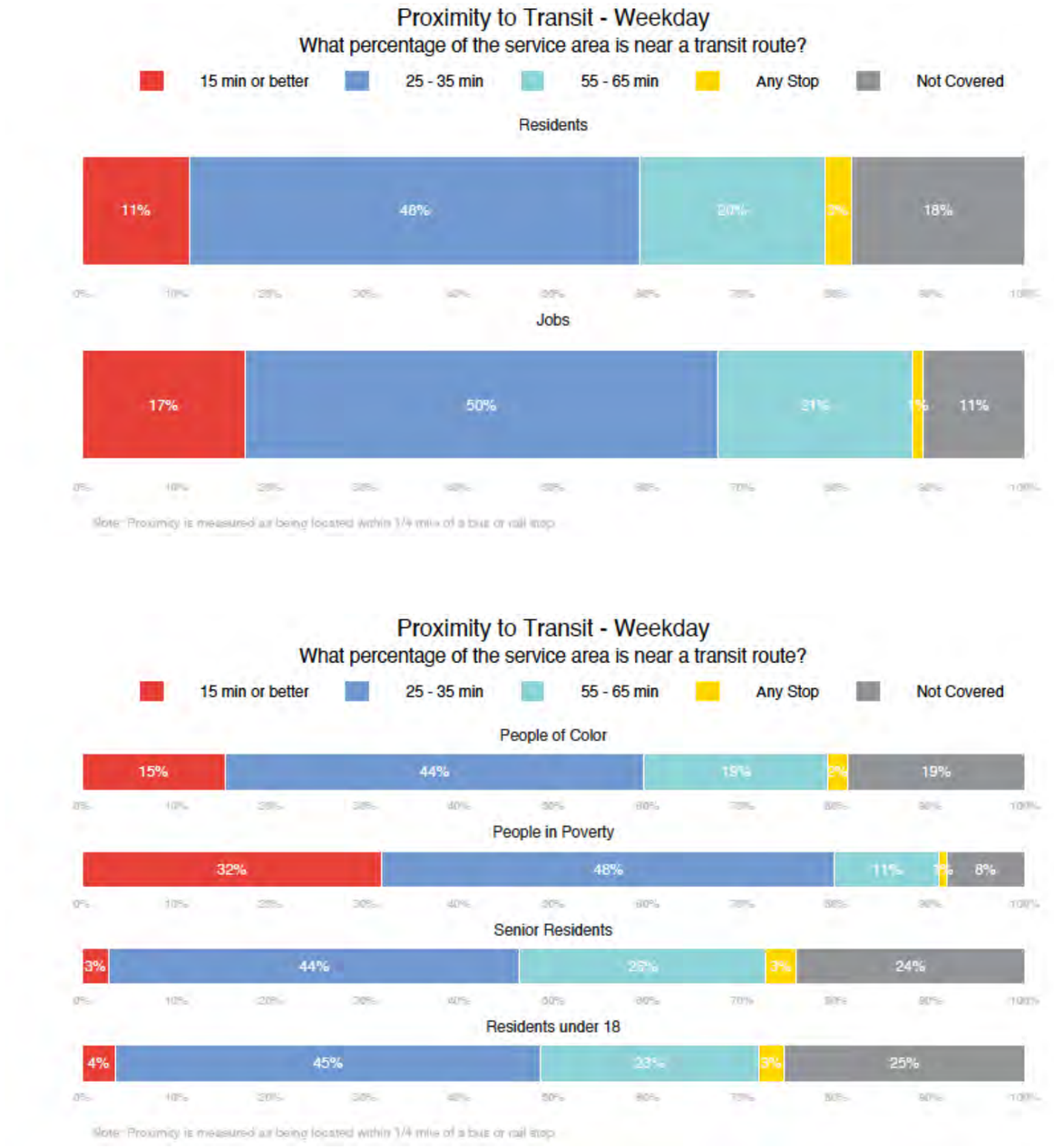
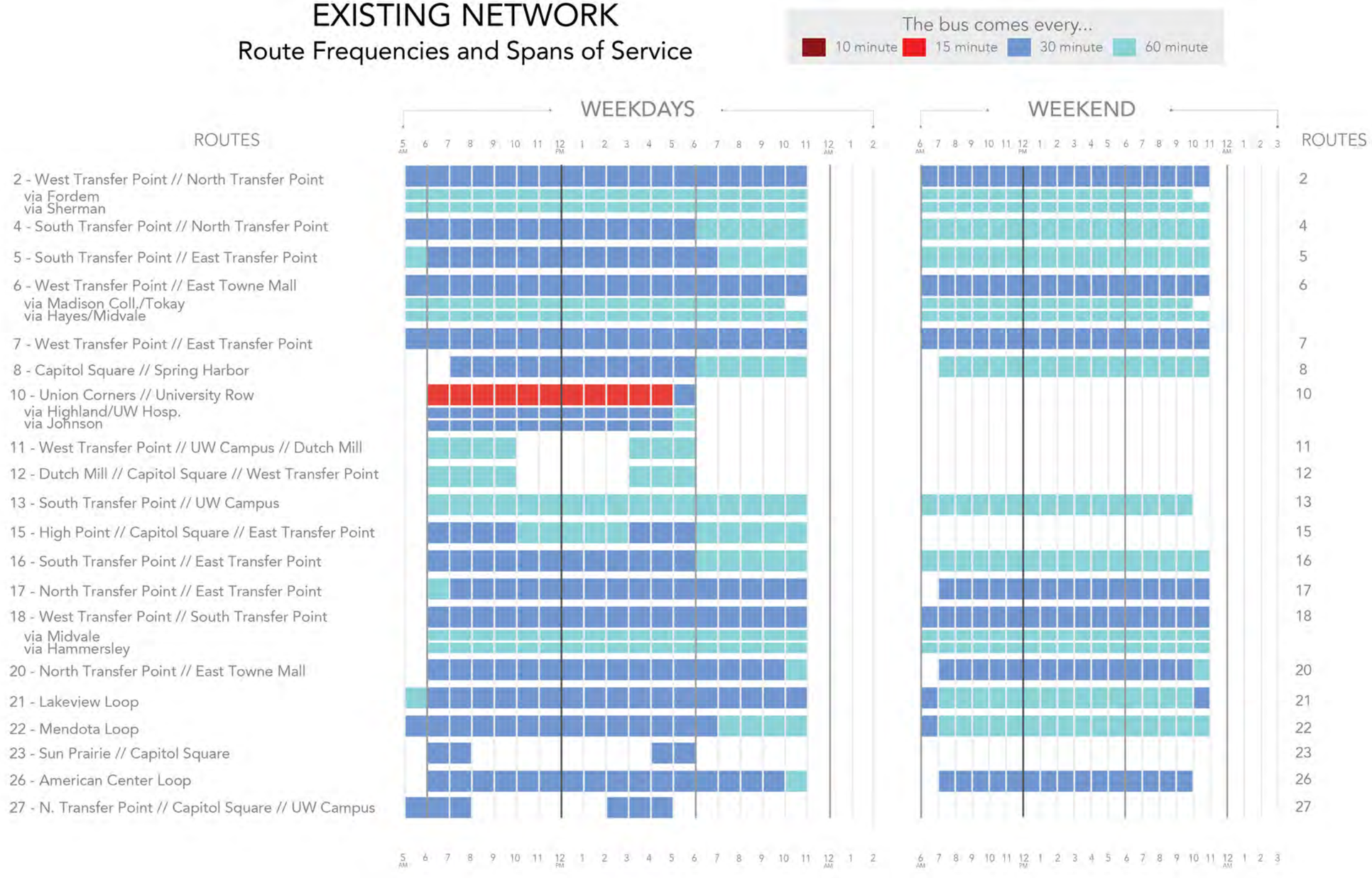


Figure 49: Proximity of Residents, Jobs, and Demographic sub-groups to transit. This chart shows percentage of people and jobs near service of different frequencies.

There is 40% less service on weekends and evenings than during weekdays.

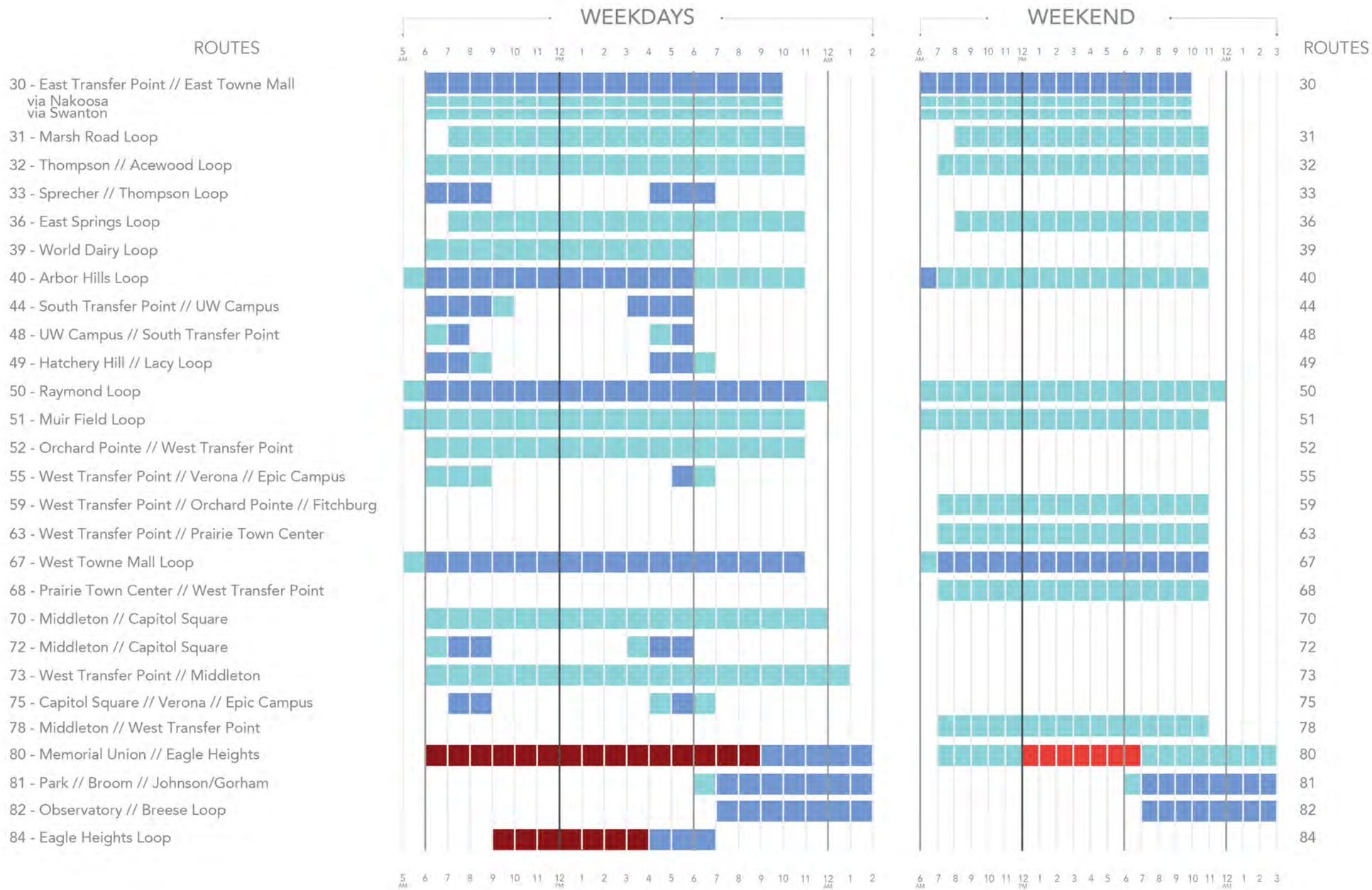
Figure 50: This chart shows approximately how often the bus runs throughout the day, on weekdays and weekends, on each Metro Transit route. Many routes with service every 30 minutes go to every 60 minutes after 6 PM and on weekends. Several routes that operate on weekdays don't feature any service on weekends.



Notes:

1. Route 11, 12, 44, 48 and 49 run only in the peak direction.
2. On Fridays and Saturdays during UW session, route 80 runs until 3am.
3. Route 81 and 82 run only when UW is in session and run until 3am on Fridays and Saturdays.
4. Frequencies on the 80 and the 84, are lower when UW is out of session.

Low frequencies on evenings and weekends make it les likely for transit to be useful for some retail and service sector workers.



The transit network offers limited usefulness for trips outside central Madison

Access to Jobs

Wherever you are, there is a limited area you could reach within a reasonable amount of time. The extent of this area affects your options in life: for employment, school, shopping, or whatever other places you might want to reach.

The number of destinations you can reach within a set amount of time is called access, and we discuss this concept in more detail in Chapter 2 on page 20.

Transit is useful when it increases the number of useful places people can access in a reasonable amount of time.

Figure 51, at right, is a map showing the number of jobs reachable in 45 minutes or less by transit and walking from every area in the city. Job access is the highest in the central areas of Madison because there are many more jobs located closer together to start with, but also because transit is more frequent and abundant there.

Within the central area roughly bounded by the North, East, South, and West Transfer Points, people can reach at least 40,000 jobs within 45 minutes. Beyond these Transfer Points, access drops dramatically.

Within the central area roughly bounded by the four Transfer Points, people can reach at least 40,000 jobs within 45 minutes. Beyond these Transfer Points, access drops dramatically.

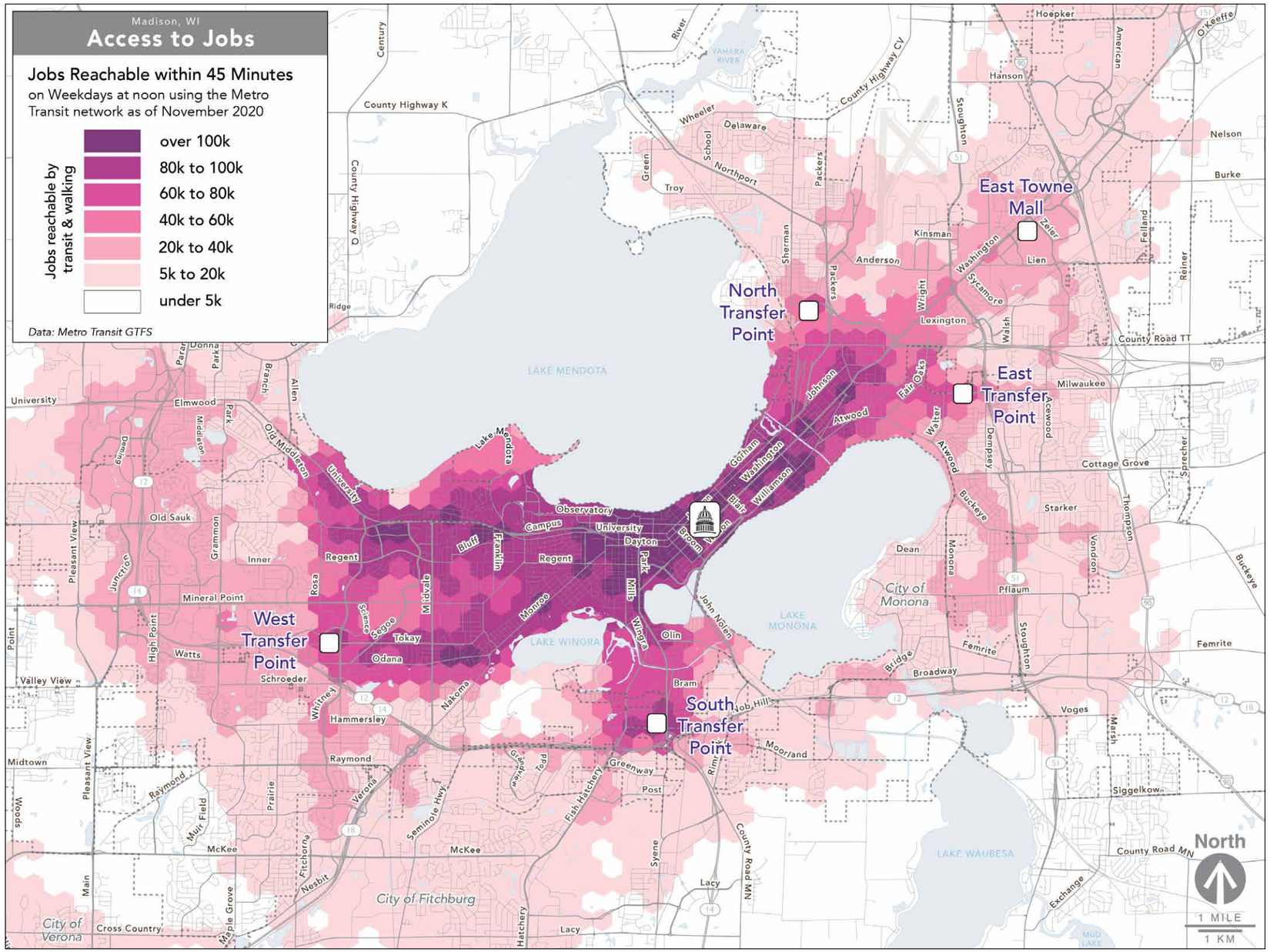


Figure 51: Map showing the number of jobs accessible in 45 minutes or less by transit and walking, on a weekday at noon. Transit provides relatively high levels of access to jobs and opportunity in central Madison, and very low levels of access in areas farther out than the Transfer Points.

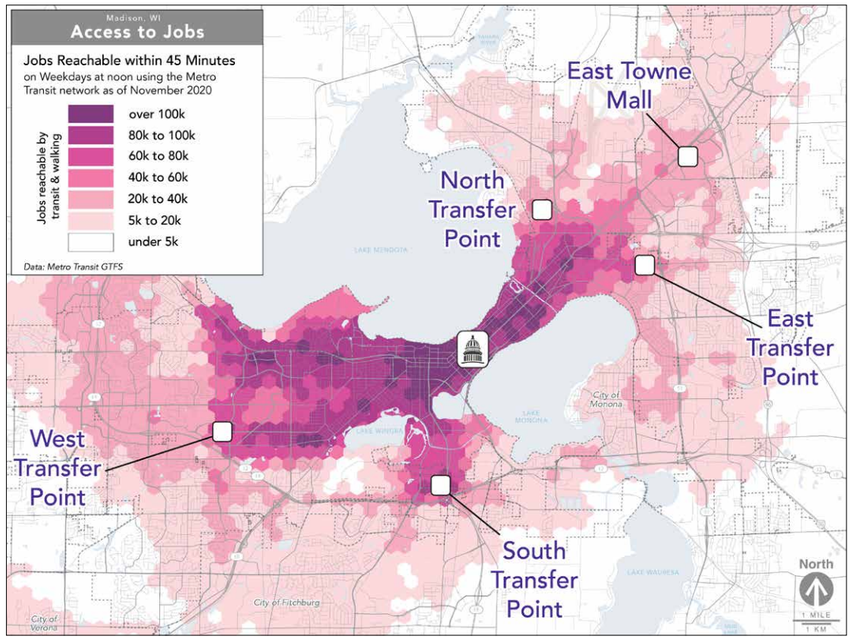
The limitations of the network fall hardest on outlying low-income areas...

There are two kinds of poverty that are most prevalent in Madison:

- **Students in poverty.** Because it's hard to work and outlying full-time, college and university students often have low incomes. But statistically, most students will go on to lead mid- to high-income lives. Reflecting the broader situation, they tend to be mostly White, with a substantial Asian minority.
- **Generational poverty.** People born in low-income or low-wealth households are more likely to experience low incomes for much of their lives. Although people of all races and ethnicities experience generational poverty, it is statistically more prevalent among Black and Latino people, as well as certain Asian groups such as the Hmong.

Students in poverty tend to live in areas well served by transit. They are heavily concentrated within 2 miles of the University of Wisconsin.

In contrast, **people who experience generational poverty are much more likely to live outside central Madison**, such as on the South and North Side, pockets of the northeast, and in areas south of the Beltline. **They are concentrated in the areas where transit provides the least access to the city**.



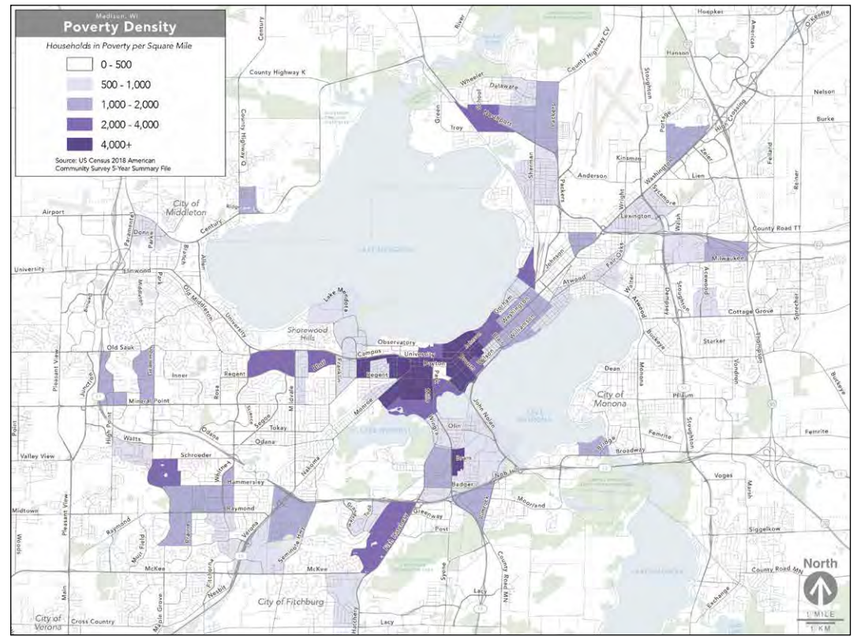
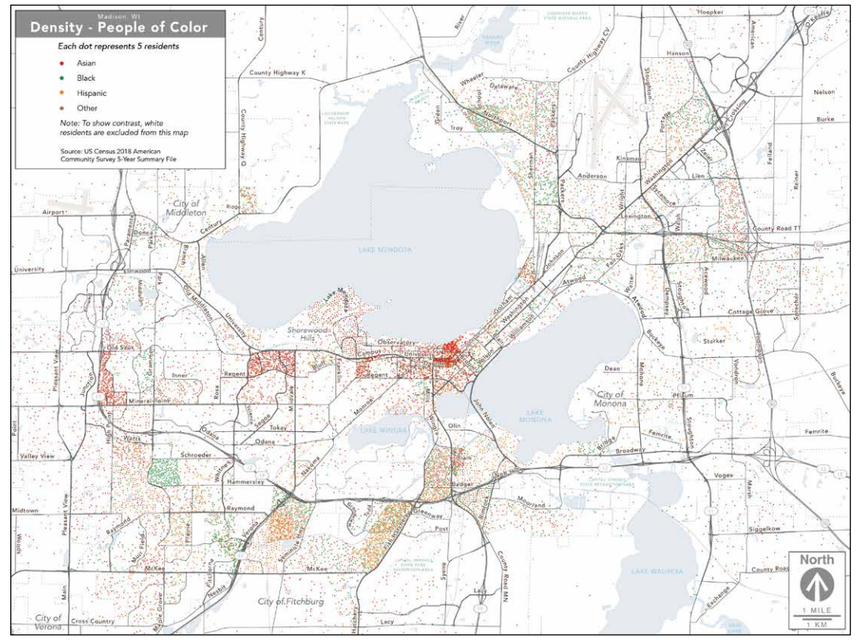


Figure 52: (Top Left) Map of jobs accessible in 45 minutes or less by transit and walking, on a weekday at noon.

Figure 53: (Top Right) Map of density of people in poverty in different parts of Madison.

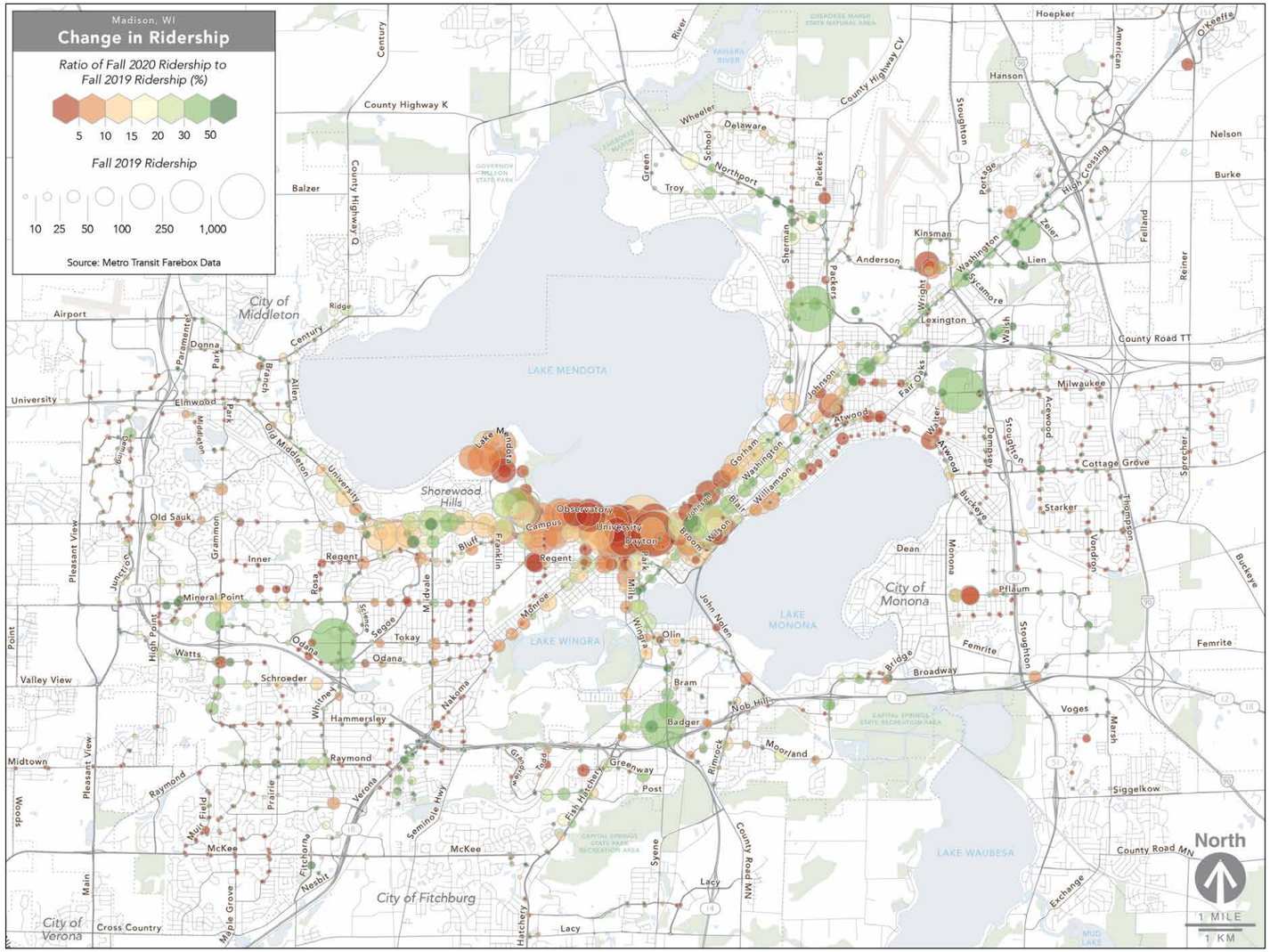
Figure 54: (Bottom Right) Map showing density of people of color in different parts of Madison.

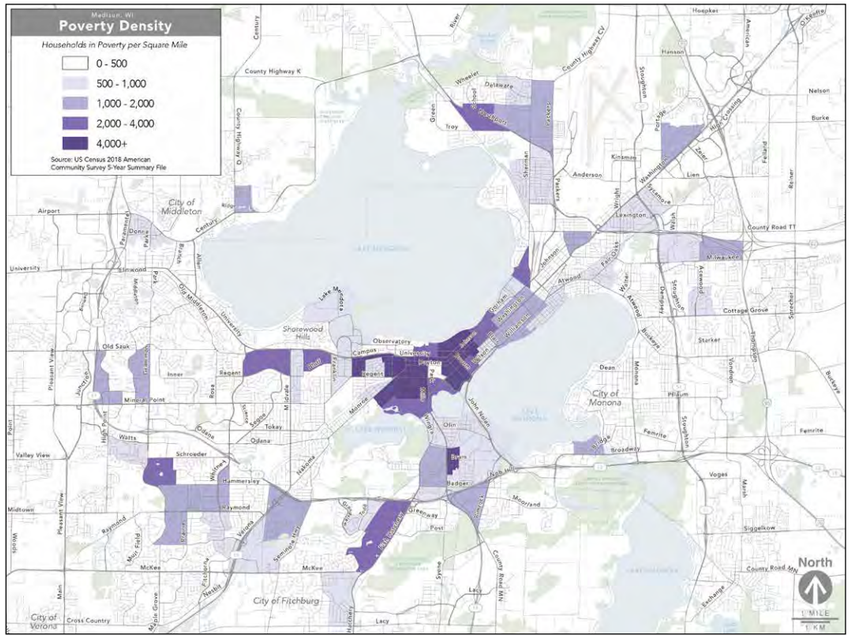


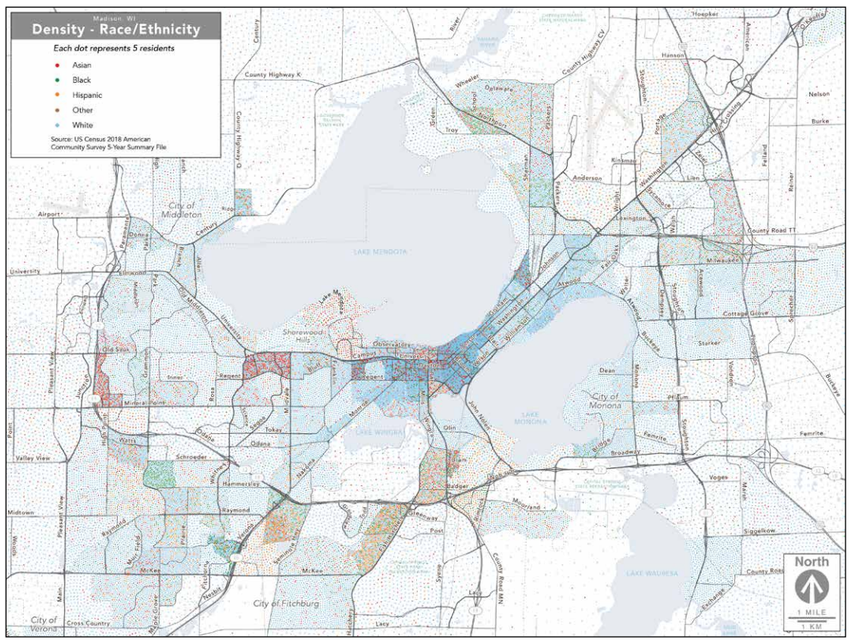
...where pandemic-era ridership suggests people need service the most.

Figure 55: The map on the left of this page shows ridership changed from Fall 2019 to Fall 2020. Each dot represents one bus stop. The larger the dot, the more people used this bus stop in Fall 2019. Red and orange dots are stops where ridership fell the most from 2019 to 2020. Green dots are stops where ridership fell the least.

Figure 56: The maps on the right show where people in poverty and people of different racial and ethnic groups live in Madison. It is clear from this map that (a) the strongest ridership drops were in the vicinity of the University of Wisconsin, and (b) there was the least change outlying low-income areas, where people of color disproportionately live.







This is partly because outlying areas are farther from jobs and opportunity...

The job density map we saw in Figure 26 on page 29 shows that Downtown is not the only concentration of jobs in Madison. Many new job centers have emerged around the Beltline and in other outlying areas.

But older and more central areas of Madison are still much denser than these new, auto-oriented areas. So even though only about 1/3 of jobs are located in central areas, people in central Madison are far more likely to live near many jobs and other opportunities.

This is reflected on the map in Figure 57, which shows that someone located between the Capitol and the University of Wisconsin is within 1.5 miles of over 50,000 jobs. In contrast, most people living near the Beltline are within 1.5 miles of fewer than 10,000 jobs.

This means that **outlying areas are fundamentally more difficult and expensive to serve with transit than central areas, simply because people must travel farther to reach the same number of opportunities.**

So, for example, any amount of transit service provided on the outer North Side would provide access to fewer jobs overall as the same amount of service provided in a more favored location, like the inner West Side.

If more equitable access outcomes are an important goal for this network redesign, Metro Transit could choose to invest more service per person (or per square mile) on the North Side than on the West Side. But this may not be the highest-ridership investment, because the amount of access to jobs generated per amount of dollars invested would likely be lower on the North Side, simply because destinations are farther away.

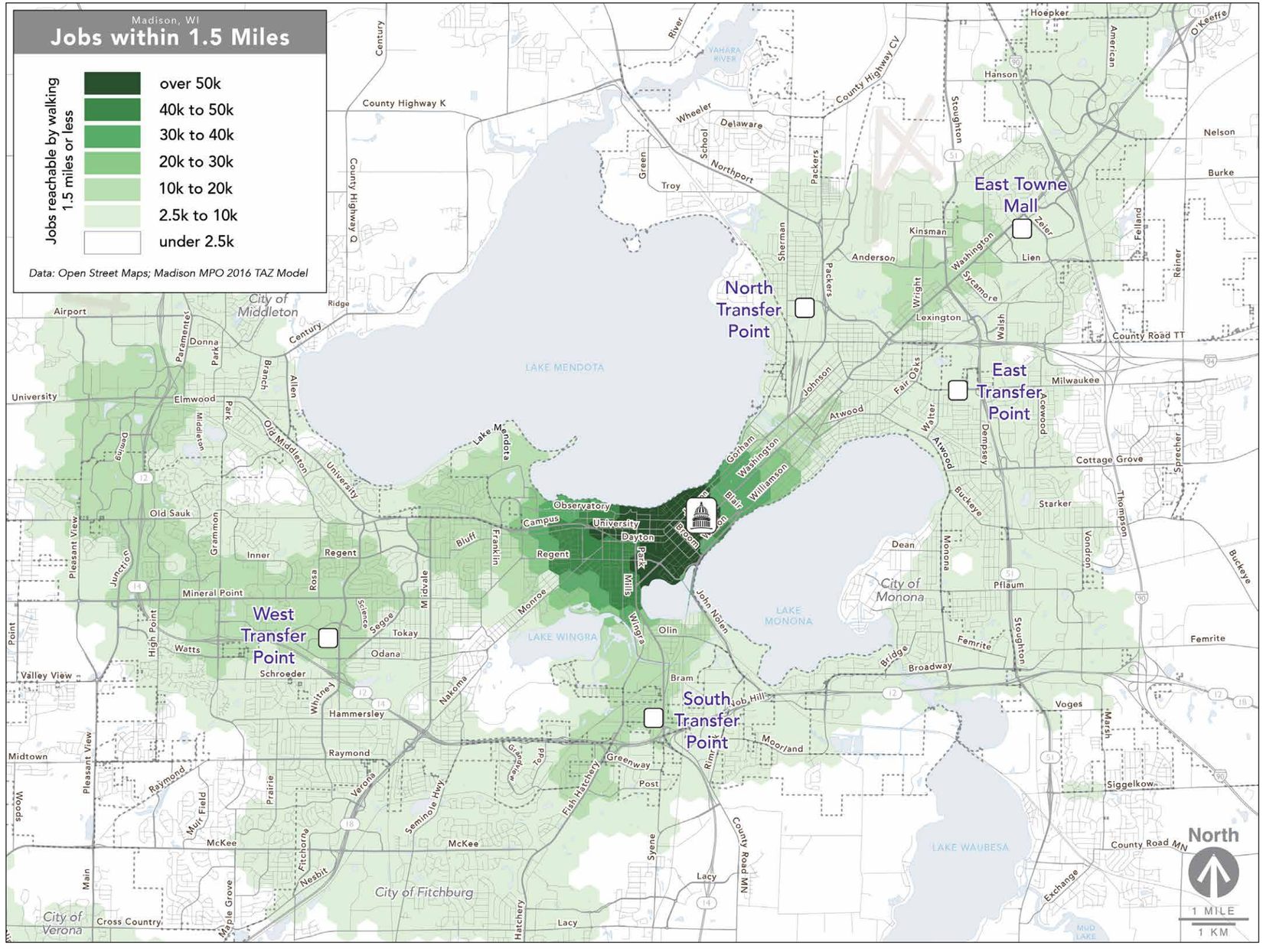


Figure 57: Map showing the number of jobs within 1.5 miles of anywhere in Madison.

...but also because transit service is both infrequent and very complex.

Although outlying areas are more difficult to serve, we have seen in previous pages that transit in Madison requires a lot from its users:

- **Long waits.** The system overwhelmingly operates at frequencies of every 30 to 60 minutes. In the worst cases, those waits happen at a bus stop or Transfer Points, in the cold of winter. But even when people have the ability to read a schedule in advance, and wait at home or any other location protected from the elements, they are still in that moment not going where they want to go.
- **Detailed, in-depth knowledge and advance preparation.** Metro Transit's published schedules display an admirable amount of detail about exactly where each bus is coming from and where it goes. Anyone who really wants to know how to get from point A to point B can find out the best way to do so with paper schedules, or an online trip planner. But for many transit trips, the best path from A to B changes over the course of the day and week. Often the best possible path is only available at certain hours of certain days.

Both of these issues disproportionately impact outlying areas that depend on feeder service, where schedules are most variable and complex, and passengers are most likely to need to transfer along the way. So it may be possible to make marginal improvements to access in outlying areas by:

- Making service simpler and more consistent across different times and days of the week.
- Reducing the number of trips that require a second wait at a Transfer Point.

Figure 58: Map of jobs accessible in 45 minutes or less by transit and walking, on a weekday at noon.

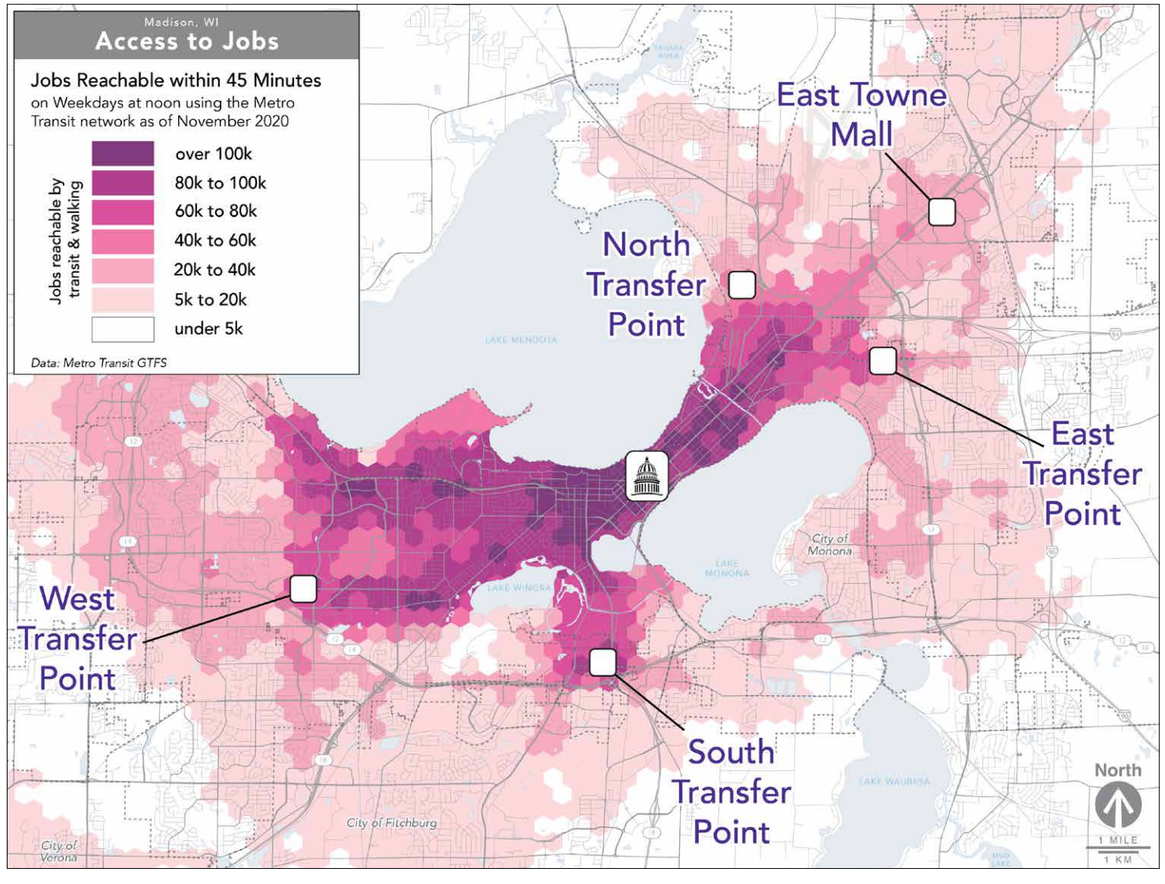
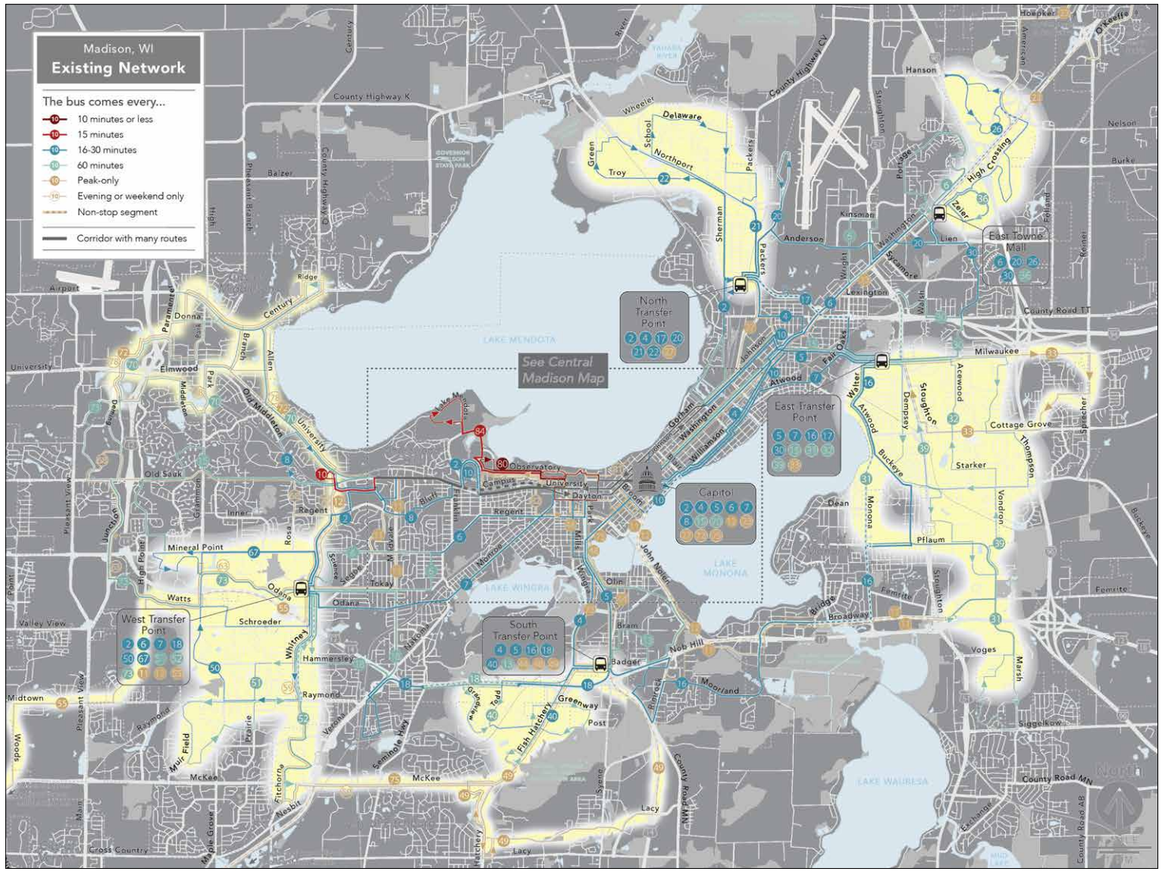


Figure 59: Map of areas served by feeder routes that take passengers to the Transfer Points.



Many everyday transit trips to and from outlying areas are very complicated.

Example Trip Itineraries

The following trip examples showcase the difficulty in using transit for many trips that:

- Are 3 to 6 miles long, a common and reasonable distance for transit trips
- Connect areas with some multifamily housing, and some low-income population to a major citywide destination.
- Would be relatively straightforward in a car.

In other words, **although we can't guarantee that a network redesign would improve these specific trips, these are examples of the kinds of trips that a well-functioning transit network might reasonably be expected to serve.**

The selected examples are all commutes to work or school. This is because commutes tend to be people's most time-constrained trips. It's hard to hold a job or complete a course if you consistently show up late. So people often structure their broader decisions about transportation, like whether or not to buy a car, around how they could make this trip work.

The examples featured here show trips selected by seeking directions from Google for Wednesday, February 17 (weekday) and Saturday, February 20, 2021 (weekend).

Waiting time counts!

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). Not many people have the liberty of arriving when they please for all their trips, or are able to control appointments or social activities to end exactly at the right time to catch the bus home. Riding transit means waiting somewhere. The more frequent the service, the shorter the wait.

For these trip examples, we have included three minutes of waiting at the beginning of each trip to account for the fact that you have to get to the stop a little early to make sure you don't miss the bus. Wait time at the end of the trip, before the start tine of work, or classes, is also included.

Calculating Travel Times

Every transit trip is made up of walking, waiting, and riding.

Often when people think of riding somewhere by transit they only consider the time spent on the bus or train. It is important to remember that every transit trip is made up of time spent walking (or rolling) and time spent waiting.

Walking to and from a stop

Most transit trips begin and end with walking (or rolling) to and from your destinations. Under a High Ridership Concept walking may be increased as routes are consolidated to create more frequent service.

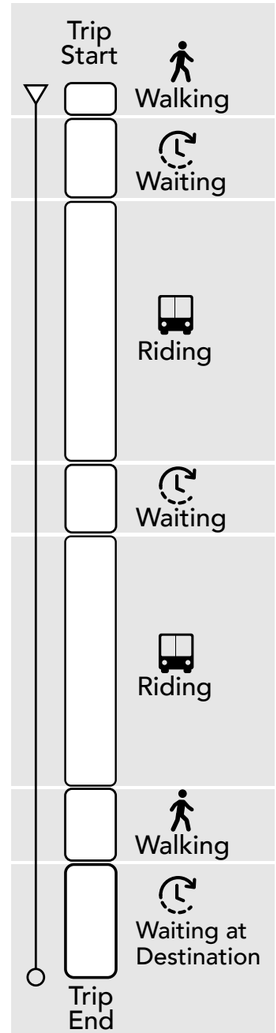
Waiting for the next bus or train

Waiting doesn't just happen at the start of your ride, it also happens at the end. You may not need to leave the house long before your departure, but if your bus is infrequent, you have to choose between being very early or too late.

For these trip examples, we assume you arrive at the first stop three minutes early to make sure you don't miss the bus. We also count the difference between your intended, and scheduled arrival time as waiting time.

Riding to your destination

Time spent riding transit will remain similar between the Existing Network and the Concepts. We assumed no speed changes between the Existing Network and the Concepts and used corridor speeds for new alignments.



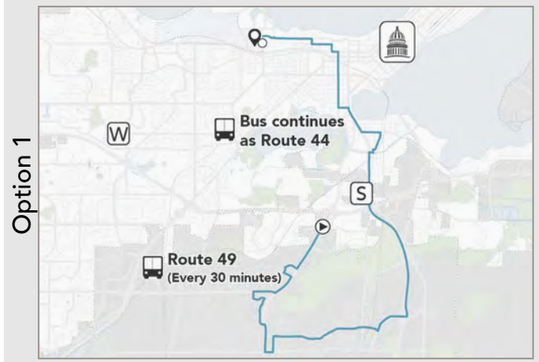
The Hospital Worker

How do you get from Fish Hatchery Rd. near Pike Drive to UW Health Hospital?

Hospital staff are the ultimate frontline workers during the pandemic. But even before COVID-19, hospitals have always been major sources of transit ridership, because many people work there, and they attract large numbers of commutes and visits at all times of day and night.

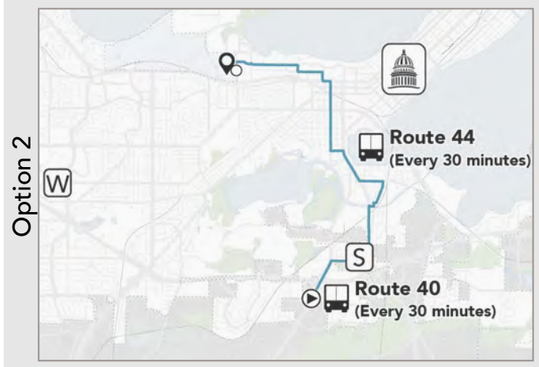
For the purposes of this example, let's imagine a worker who needs to get to the hospital on time for their shift. Hospital shifts can start at a variety of times, so we can imagine three possibilities.

Example 1: Arrive by 8 AM on a Weekday



1 Hour 20 Minutes
5 minutes walking, 19 minutes waiting, 56 minutes riding

- Start trip at Fish Hatchery and Greenway Cross at 6:40am
- Walk 2 minutes to a stop on Fish Hatchery Rd.
- Wait 3 minutes for Route 49.
- Ride **Route 49** southbound, looping back into the city, for 56 minutes, to Highland & Observatory. This bus becomes Route 44
- Walk 3 minutes and arrive at UW Health Hospital at 8:44am
- Wait 16 minutes for start of work at 8:00am.



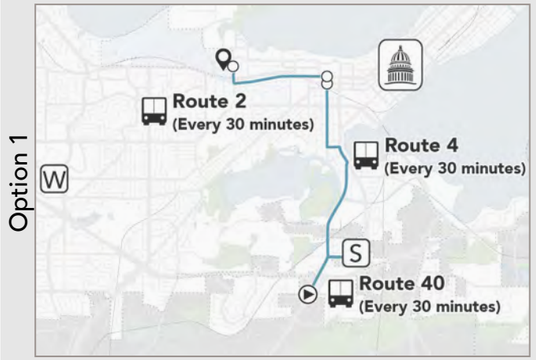
1 Hour 15 Minutes
5 minutes walking, 36 minutes waiting, 34 minutes riding

- Start trip at Fish Hatchery and Greenway Cross at 6:45am
- Walk 2 minutes to a stop on Fish Hatchery Rd.
- Wait 3 minutes for Route 40.
- Ride **Route 40** for 5 minutes to South Transfer Point.
- Wait 17 minutes for Route 44.
- Ride **Route 44** for 29 minutes to Highland & Observatory.
- Walk 3 minutes and arrive at UW Health Hospital at 8:44am
- Wait 16 minutes for start of work at 8:00am.

Two options are possible. Both require about an hour to travel 6 miles and involve at least one significant inconvenience:

- Option 1 is a one-seat ride but requires riding through a circuitous loop in the wrong direction.
- Option 2 requires a connection at South Transfer Point with a 17 minute wait.

Example 2: Arrive by 1 PM on a Weekday

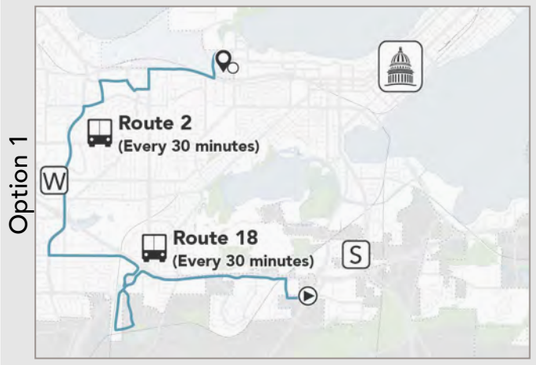


1 Hour 45 Minutes
5 minutes walking, 43 minutes waiting, 27 minutes riding

- Start trip at Fish Hatchery and Greenway Cross at 11:45am
- Walk 2 minutes to a stop on Fish Hatchery Rd.
- Wait 3 minutes for Route 40.
- Ride **Route 40** for 5 minutes to South Transfer Point.
- Wait 5 minutes for Route 4.
- Ride **Route 4** for 14 minutes to Johnson & Mills.
- Walk one block north and wait 11 minutes for Route 2
- Ride **Route 2** for 8 minutes to Highland & Observatory.
- Walk 3 minutes and arrive at UW Health Hospital at 12:36pm
- Wait 24 minutes for start of work at 1:00pm.

The most convenient path would take the worker through similar areas, but on different buses and with different transfers. They would be dependent on not one but two transfers, and if everything works ideally they'd get to work with 25 minutes to spare, time they could have spent elsewhere doing something more pleasant.

Example 3: Arrive by 1 PM on a the Weekend



1 Hour 2 Minutes
5 minutes walking, 18 minutes waiting, 39 minutes riding

- Start trip at Fish Hatchery and Greenway Cross at 11:58am
- Walk 2 minutes to a stop on Fish Hatchery Rd.
- Wait 3 minutes for Route 18.
- Ride **Route 18** for 22 minutes to West Transfer Point.
- Wait 5 minutes for Route 2.
- Ride **Route 2** for 17 minutes to Highland & Observatory.
- Walk 3 minutes and arrive at UW Health Hospital at 12:50pm
- Wait 10 minutes for start of work at 1:00pm.

Hospitals are 24/7 operations, and many shifts are on weekends. What if this worker needed to get to work at 1 PM on a Saturday or Sunday instead of a weekday? On weekdays, the simplest path is usually (not always) through the South Transfer Point, which is also the nearest one to Fish Hatchery Road.

But on weekends, the best path actually goes through West Transfer Point, so every part of the trip would look different.

The Retail Worker

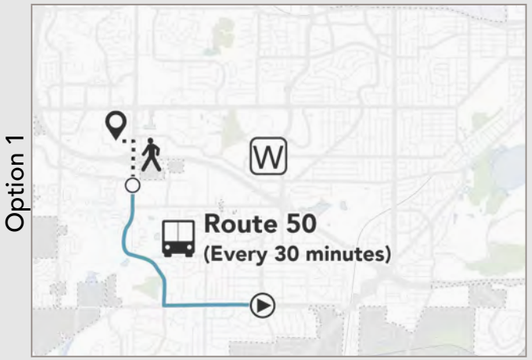
How do you get from Raymond Road & Whitney Way to West Towne Mall?

Retail and service businesses are often "All hands on deck" on evenings and weekends, and most people working in retail or restaurants are only offered a job if they can commit to work at these times. A transit network that offers lot of service during rush hour on weekdays, but not on weekends, doesn't work well for low-income service workers.

Let's imagine you are a worker who lives near Raymond Road and Whitney Way and needs to get to work at West Towne Mall for the day-shift on both weekdays and Saturdays.

Example 1: Arrive by 10 AM on a Weekday

Option 1

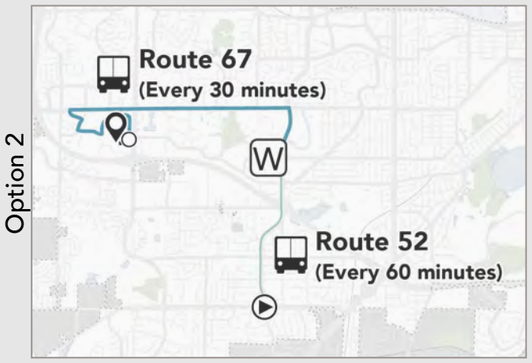


29 Minutes

13 minutes walking, 8 minutes waiting, 7 minutes riding

- Start trip at home near Raymond Rd. and Whitney Way at 9:31am
- Walk 2 minutes to a stop on Raymond Rd.
- Wait 3 minutes for Route 50.
- Ride **Route 50** for 7 minutes to Gammon Rd. & Watts Rd.
- Walk 12 minutes and arrive at West Towne Mall at 9:55am
- Wait 5 minutes for start of work at 10:00am.

Option 2



47 Minutes

3 minutes walking, 22 minutes waiting, 22 minutes riding

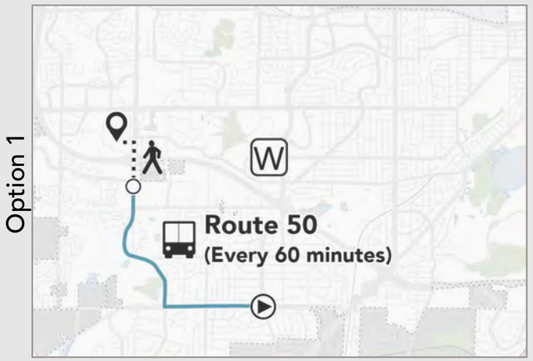
- Start trip at home near Raymond and Whitney at 9:13am
- Walk 2 minutes to a stop on Raymond Rd.
- Wait 3 minutes for Route 52.
- Ride **Route 52** for 8 minutes to West Transfer Point.
- Wait 4 minutes for Route 67.
- Ride **Route 67** for 14 minutes to West Towne Mall.
- Walk 1 minute to get to the front entrance at 9:45am.
- Wait 15 minutes for the start of work at 10:00am.

Two options are possible.

- Option 1 is faster, but requires a long, unpleasant and potentially hazardous walk through a highway interchange.
- Option 2 doesn't require as much walking, but does require a connection at West Transfer Point. It's a timed connection, so assuming that buses are on time, the wait isn't too long.

Example 2: Arrive by 10 AM on a Saturday

Option 1

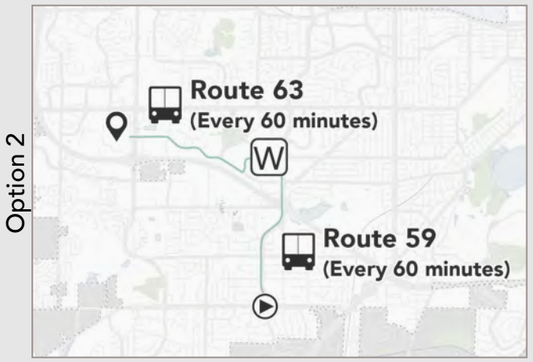


59 Minutes

14 minutes walking, 38 minutes waiting, 7 minutes riding

- Start trip at home near Raymond Rd. and Whitney Way at 9:01am
- Walk 2 minutes to a stop on Raymond Rd.
- Wait 3 minutes for Route 50.
- Ride **Route 50** for 7 minutes to Gammon Rd. & Watts Rd.
- Walk 12 minutes and arrive at West Towne Mall at 9:25am
- Wait 35 minutes for start of work at 10:00am.

Option 2



47 Minutes

3 minutes walking, 30 minutes waiting, 14 minutes riding

- Start trip at home near Raymond and Whitney at 9:13am
- Walk 2 minutes to a stop on Raymond Rd.
- Wait 3 minutes for Route 59.
- Ride **Route 59** for 7 minutes to West Transfer Point.
- Wait 6 minutes for Route 63.
- Ride **Route 63** for 7 minutes to West Towne Mall.
- Walk 1 minute to get to the front entrance at 9:39am.
- Wait 21 minutes for the start of work at 10:00am.

Two options are possible.

- Option 1 requires you to leave home nearly an hour before the start of your shift and gets you to work much too early. It also requires a long, unpleasant and potentially hazardous walk through a highway interchange. With buses are running hourly, if anything goes wrong, you have the potential for being very late. This option, although getting you to arrive at work much too early, leaes some time for making alternative plans in case something goes wrong with Route 50.
- Option 2 doesn't require as much walking, but does require a connection at West Transfer Point. It's a timed connection, so assuming that buses are on time, the wait isn't too long. It still gets you to work too early, but it's not as early as Option 1. With buses running just once an hour, this option is a little risky.

The Community College Student

How do you get to Madison College (MATC) from 3 miles south of there? (E.g. Cottage Grove & Acewood)

Let's imagine you are a part-time student taking classes on Evenings and weekends who lives near Cottage Grove & Acewood, and needs to get to Madison College for classes on Weekdays evenings and occasionally on Saturdays.

Example 1: Arrive by 6 PM on a Weekday

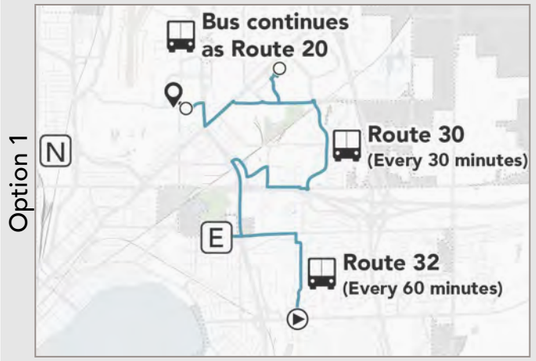
1 Hour 2 Minutes

4 minutes walking, 27 minutes waiting, 31 minutes riding

- Start trip at home near Acewood & Cottage Grove at 4:58pm
- Walk 2 minutes to a stop on Cottage Grove Rd.
- Wait 3 minutes for Route 33.
- Ride **Route 33** for 7 minutes to East Transfer Point.
- Wait 5 minutes for Route 15
- Ride **Route 15** for 7 minutes to Washington & S Fourth
- Cross the street and wait 18 minutes for Route 6
- Ride **Route 6** for 13 minutes to Kinsman & Wright
- Walk 2 minute to get to the Madison College at 5:55pm.
- Wait 5 minutes for start of class at 6:00pm.

While the origins and destinations are not very far apart, this trip requires two transfers. It also takes you a little out of the way towards the Isthmus on Route 15 before travelling back out towards Madison College.

Example 2: Arrive by 11 AM on a Saturday



1 Hours 33 Minutes

3 minutes walking, 48 minutes waiting, 37 minutes riding

- Start trip at home near Acewood & Cottage Grove at 9:27am
- Walk 2 minutes to a stop on Acewood Blvd.
- Wait 3 minutes for Route 32.
- Ride **Route 32** for 9 minutes to East Transfer Point.
- Wait 25 minutes for Route 30
- Ride **Route 30**, which becomes **Route 20** for 28 minutes to Anderson & Wright
- Walk 1 minute to get to the Madison College at 10:40am.
- Wait 20 minutes for start of class at 11:00am.

This trip takes a very long time because of a long wait while connecting between two infrequent routes at the East Transfer Point. It also requires riding through a very circuitous path on Route 30.

5 Key Choices for the Post-Pandemic Transit Network

Key Choice: Ridership vs. Coverage

The Metro Transit Network Redesign is a unique opportunity to rethink the purpose of Madison's transit system, and how it relates to other ways of getting around such as cycling and driving.

The most basic choice is the degree to which the transit system should be pursuing ridership or coverage.

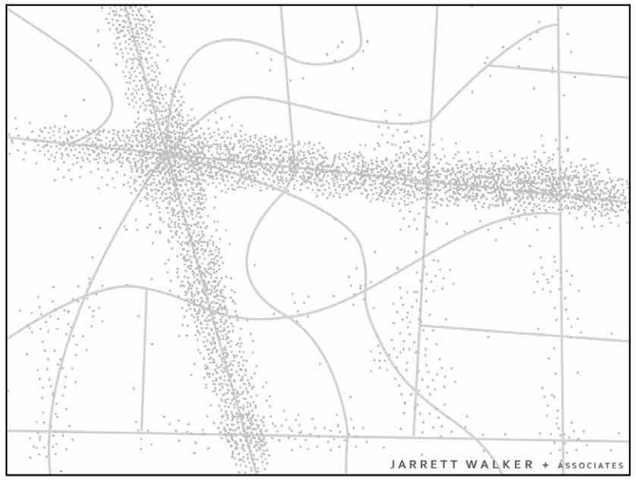
Designing a transit system for **high ridership** serves several popular goals, including:

- Competing more effectively with cars, so that the city can grow without increasing traffic congestion.
- Reducing the public subsidy needed for each ride by carrying more passengers and by collecting more fare revenue.
- Minimizing climate impact by replacing single-occupancy vehicle trips with transit trips, reducing greenhouse gas emissions.
- Supporting dense and walkable development.

On the other hand, many other popular goals for transit don't require high ridership. Designing a transit system for **high coverage** serves these goals:

- Ensuring that everyone in the service area has access to some transit service, no matter where they live.
- Providing access for people without access to personal vehicles.

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 high frequency along a dense corridor is a dollar that cannot be spent bringing transit closer to each person's home or reaching areas at the edge of the city, and vice versa.



Imagine you are the transit planner working in this fictional neighborhood.

The dots scattered around the map are people and jobs.

The 18 buses 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?

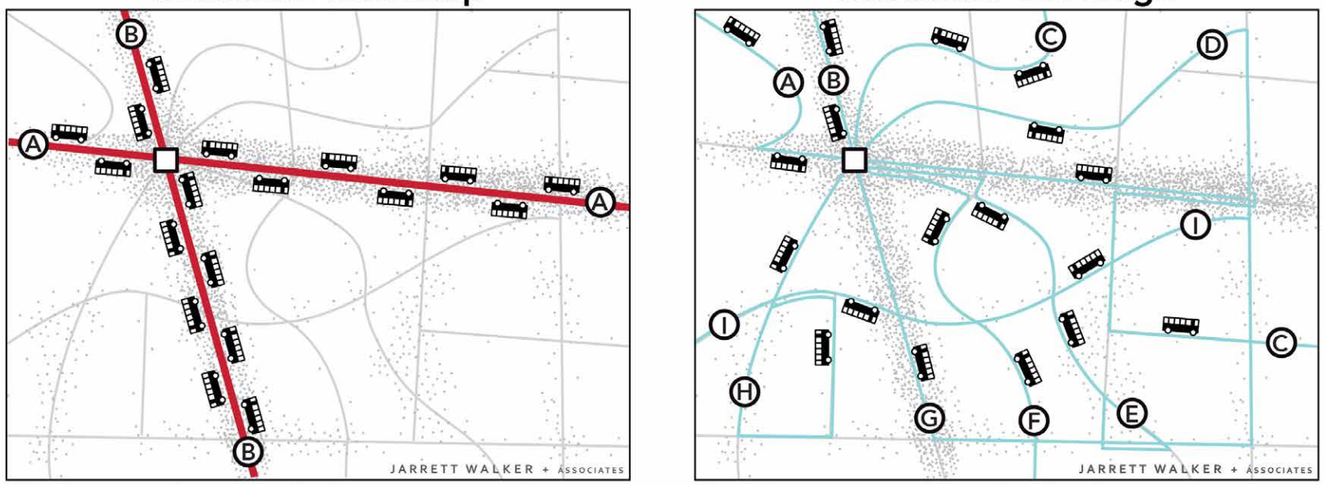


Figure 60: Comparing an imaginary town where transit is run with the goal of maximizing frequency and ridership (left) vs. the same town where transit is run with the goal of providing a little service near everyone (right). The maximum ridership (left) network has very frequent service, but only on the roads where the most people live and work. The maximum coverage network has service on every road, but it doesn't come very often. Madison's existing network looks more like the one on the right. Should a redesigned network focus more on frequency, even if some people will have to walk farther to reach service?

How the Pandemic Changes This

Many people who used transit before are not during the pandemic. It's unclear when many people will once again consider transit as an option.

So a more frequent network might not result in higher ridership immediately. Those effects take time. For example, some people will choose where to live based on bus service, and only then begin to ride.

But regardless of ridership, a more frequent network would increase the amount of access provided between different parts of Madison, and make transit useful for more trips.

The key challenge remains whether it is acceptable for some people to walk further to reach their bus stop, or for some areas not to receive service.

Key Choice: Walking vs. Waiting

Is it more important for bus service to be very frequent, or for service to be available very nearby?

Most people in Madison live and work close to bus service, but very little of that service is coming soon.

- 82% of residents and 89% of jobs in the city of Madison are located within 1/4-mile of a bus stop.
- Only 11% of residents and 17% of jobs are near a route where the bus comes every 15 minutes or better throughout the day.

These two facts are connected. Metro Transit's network is designed to reach every neighborhood in the city, and to provide a bus stop within a 5 minute walk of most front doors. As a result, the network is stretched thin. Most routes run every 30 to 60 minutes, and many streets only have bus service in one direction.

If Metro Transit planned a network around longer walks to service, more bus routes could operate frequently, every 15 minutes or better. In turn, many riders would wait less and would get to their destination sooner.

But longer walks can be challenging for many people, including some who really need transit. This includes some people who experience physical disabilities, but also people traveling with young children, older adults, or anyone carrying a large enough bag.

Frequent service that gets people where they are going sooner tends to generate higher ridership, even when it requires longer walks**.** This is one of the core principles underlying BRT. Should it be extended to more routes, or generalized?

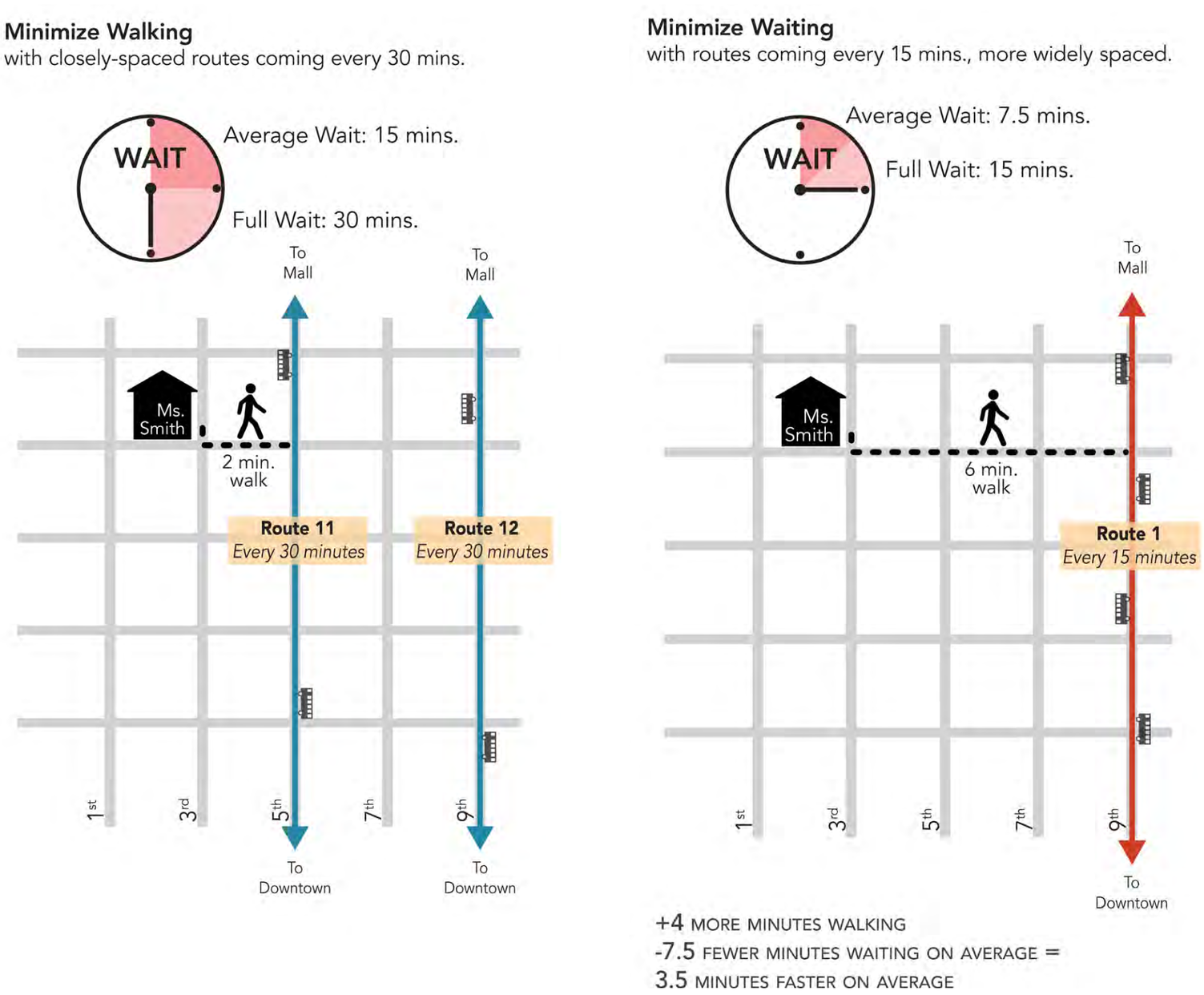


Figure 61: In some situations, consolidating parallel routes onto fewer streets can make the average person's trip faster. There are many areas where Metro Transit could consider doing this, but only if people value shorter waits and longer spans of service more than they value shorter walks.

One-Seat Rides vs. Transfers

Is it more important to focus on one-seat trips to Downtown, or to plan a network that relies on people changing buses along the way?

Metro Transit's existing network is built around the idea that people can use transit to travel in many directions if they are willing to change buses along the way. This is undermined by low frequency. **Who wants to take a short trip with a wait of up to 30 minutes, only to be delayed another 5 to 10 minutes by a transfer?**

The impacts of such long waits are disproportionately felt by low-income riders in outlying areas who have few if any alternatives.

Published schedules help, but aren't a cure-all: sometimes a bus is late, and people can't always control when they need to leave somewhere or arrive somewhere else.

But if Metro instead shifts to more one-seat rides[1], this would further increase the focus on Downtown and the University of Wisconsin. These two areas remain by far the largest hub of jobs and other destinations. Even though most trips in the city are going somewhere else, there are very few places in Madison where you would serve more trips by orienting service to go somewhere other than Downtown.

So a "one-seat ride" network would likely feature many more buses travelling through the Isthmus, and few if any improvements in direct service between outlying areas.

1 A "One-Seat Ride" refers to a trip on public transit which does not require transfers and can be completed on a single vehicle.

Peak vs. All-Day Needs

Is it more important to provide high levels of service at rush hour, or to provide consistent levels of service all day and all week?

Prior to March 2020, in Madison:

- Twice as many Metro Transit buses operated at rush hours than in the middle of the day.
- Saturday and Sunday service levels were around 60% lower than on weekdays.

This matches the travel patterns of State government employees and UW students and staff. Both institutions generate huge numbers of 9-to-5 commutes and (prior to the pandemic) lots of transit riders.

However, running a bus only during the peak hour is expensive, because of three inefficiencies:

- Short shifts are less efficient for drivers.
- The agency must own many vehicles that it doesn't use very much.
- Peak demand tends to be in one direction, but the buses must all return empty in the other direction, because driver shifts must end where they began.

In addition, transit service that is much more convenient at peak times does not match the needs of many lower income people, whose jobs are more likely to have nontraditional work schedules, or to include work on weekends.

As the pandemic has proceeded, **the combined impact of remote learning and white-collar work-from-home has greatly reduced peak-hour transit ridership,** and reduced the difference between weekday and weekend travel patterns.

But the pandemic won't last forever. It's likely that a substantial fraction of University and white-collar ridership will return as schools and offices reopen. But no one knows exactly when this will happen, or what percentage of pre-pandemic ridership will come back.

So, in a post-pandemic environment:

- Should transit service once again focus most on weekday peak hours, so the capacity for high ridership is there if peak demand comes back?
- Or should Metro transit focus instead on providing the best possible service throughout the day and on weekends, even if that might result in some overcrowded buses at rush hour if peak demand comes back?