Transit Choices Report

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For Missoula Mountain Line

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1 Introduction

This report is the first step in Missoula Mountain Line's Strategic Plan. This introductory chapter contains highlights from the rest of the report, as well as some unique information.

Over the next six months, Mountain Line will ask the public, stakeholders and elected officials to make some difficult choices about the future of transit in Missoula. Their input on these choices will lead to short-term and long-term recommendations for the transit network, as well as for transit's partners in land use planning, street design and development.

Recent History

In 2012, Mountain Line adopted a short-range plan based on a "Focus Inward" strategy. This strategy was strongly supported by the public and transit stakeholders. It called for higher frequencies and longer spans of daily service within the developed, urban parts of Mountain Line's service area.

In 2013 and 2015, Mountain Line implemented the first two phases of service investment foreseen in that "Focus Inward" plan: increased frequencies on its highest-ridership routes, and lengthened spans of service on weeknights. In 2015 Mountain Line also began a three-year Zero Fare pilot program. Numerous other organizations in Missoula made financial contributions to make this possible. (The financial contributions were necessary to replace the small but real amount of revenue that fares raise.)

The graph in Figure 1 shows the change in ridership, service levels and productivity for each fiscal year from 2005 to 2016. The grey line represents service levels, and the large jump between 2014 and 2016 represents the service increase. Meanwhile, the blue line represents ridership, and shows a very large jump between 2014 and 2016, caused by the Zero Fare program and the increase in service.

Because ridership increased by much more than the supply of service, Mountain Line's productivity (shown in red) also went up in 2015. "Productivity" is what many lay-people mean when they speak of "transit efficiency": it is ridership relative to the total supply of service hours (a proxy for cost).

The Zero Fare pilot program runs through the end of 2017. This year, Mountain Line and its partners must decide whether and how to continue funding the program.

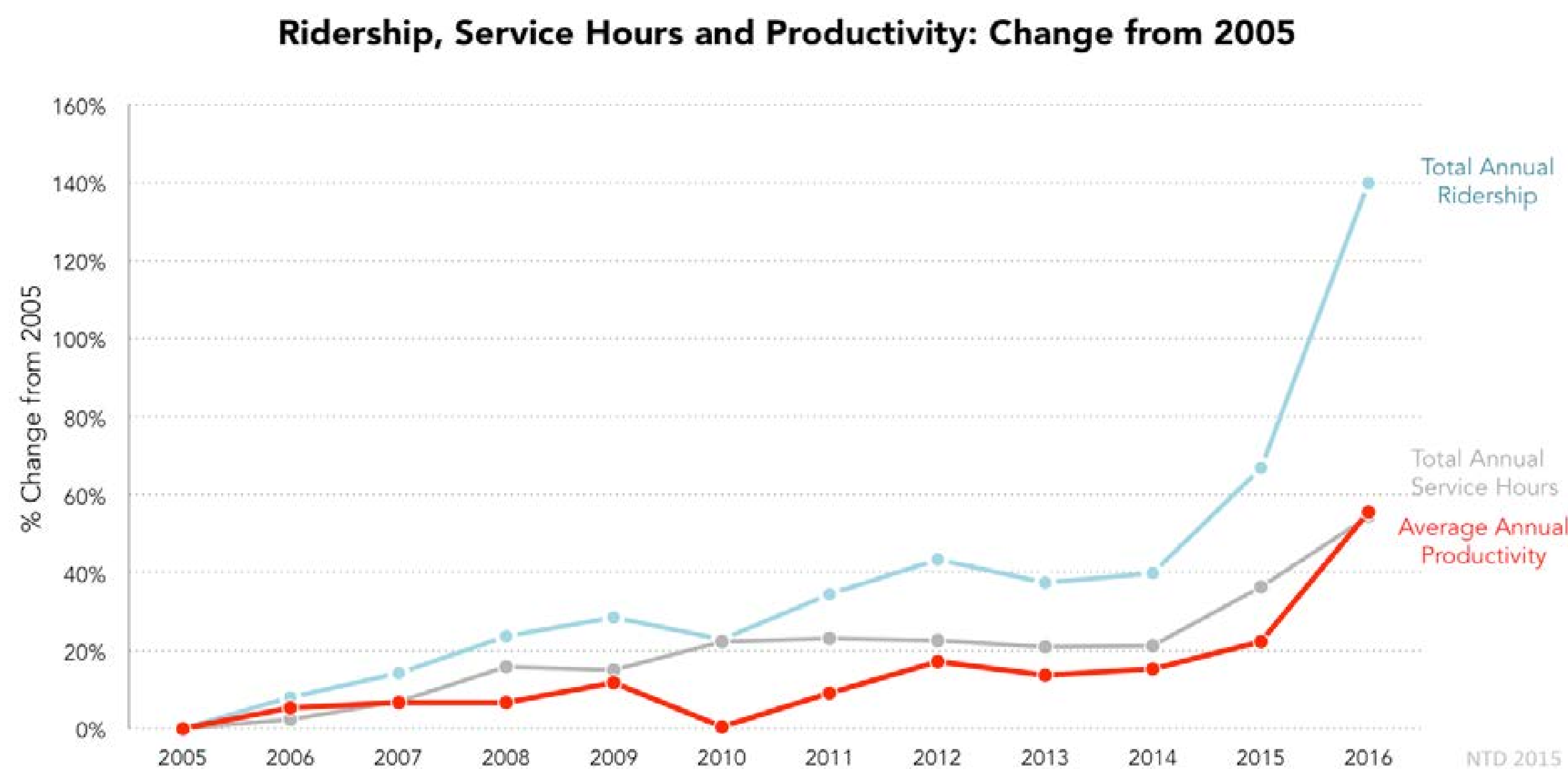


Figure 1: Graph of Changes in Service, Ridership and Productivity, 2005-2016

One of the major financial challenges facing Mountain Line today is the need to replace its aging bus fleet. The agency was planning to use $20 million in regional funding to purchase new buses, but in 2016 the MPO assigned that funding to complete the Russell Street Project instead. This has left Mountain Line unable to fund planned increases in service, because operating revenues must be set aside for fleet replacement.

While Mountain Line's budget balances through the year 2038, there are no additional revenues available to implement the later phases of the "Focus Inward" strategy: higher frequencies, longer spans of service at night and on weekends, and other service improvements. This means that, in the next few years, any service changes will need to "balance" within Mountain Line's fixed operating budget. This will force Mountain Line, and its stakeholders, to confront certain trade-offs and choices in planning for the future. Those choices are the subject of this report.

Maximizing ridership is not Mountain Line's only goal

If the Mountain Line system were designed *only* for maximum ridership, it would focus only on areas where there are many potential riders, and transit is useful for many of their trips. In other words, Mountain Line would be thinking like a private enterprise and targeting a market where its product is competitive.

Yet maximizing ridership is not the only goal of public transit systems. While private transit companies may focus on profits, and therefore on exclusively high-ridership routes, public transit is almost always expected to meet other goals. In nearly every city, there is an expectation that transit service should be provided in some or all places regardless of the ridership it attracts.

Unlike governments, businesses are under no obligation to open storefronts in places where they would spend a lot of money to reach few potential customers, or where their products can't compete. For example, McDonald's is under no obligation to provide a drive-thru restaurant within walking distance of every resident in Missoula County. If it were, then thousands of houses would need to have their own McDonald's at the end of the driveway. The company would quickly go bankrupt, as a result of operating all those restaurants across the state for tiny numbers of customers.

People understand that in a low-density, rural place they will have to drive many miles to reach a McDonald's, because McDonald's will be located only in cities with enough potential customers. We wouldn't describe this situation as McDonald's being *unfair* to people in rural areas; McDonald's is just acting like a business. It has no coverage obligation.

Some transit agencies are accused of failing to maximize ridership, as if that were their only goal. But they are not private businesses, and as public agencies they are intentionally providing coverage services that they know will not generate much ridership.

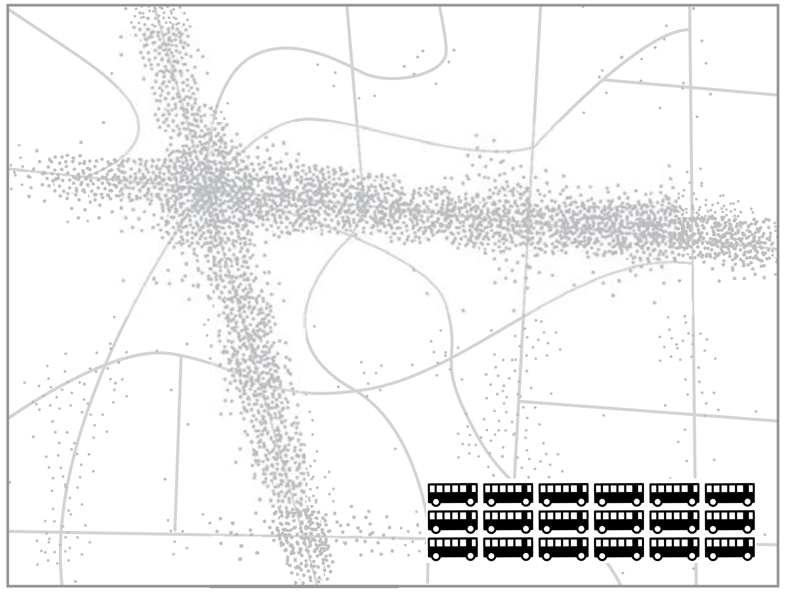
The officials who ultimately make public transit decisions hear their constituents say things like *"We pay taxes too"* and *"If you cut this bus line, we will be stranded"* and they realize that coverage, even in low-ridership places, is an important transit outcome to some people.

The Mountain Line Board of Directors considered how to balance high ridership against other potential goals, in the 2012 short-range plan (which was called a "COA").

One of the alternatives considered in that planning process was the "Focus-Inward" network, which was designed to get higher ridership than the (then) existing Mountain Line network. This strategy also echoed the City of Missoula's land use policy of focusing growth inward rather than continuing to sprawl outward.

The "Focus Inward" strategy was very strongly supported by the public during the City's land use process in 2008 and again during Mountain Line's transit planning effort in 2012. Since then, Mountain Line has implemented phases of the "Focus Inward" strategy, increasing frequencies and spans of service on existing routes.

High ridership, high frequencies and long spans have been a focus for Mountain Line since adoption of the 2012 plan. However, like all transit agencies, Mountain Line regularly hears from small numbers of stakeholders and community partners who would like to see transit service deployed in ways that do not maximize ridership, but are valued nonetheless.



In this imaginary town, you have 18 buses to use to run transit routes. How will you distribute your service?

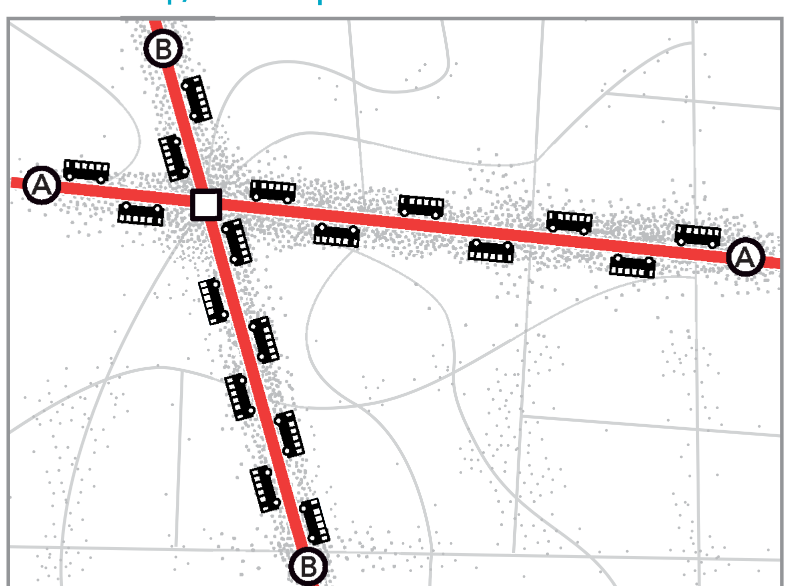
Ridership and coverage goals are in conflict

Ridership and coverage goals come into direct conflict with one another. If a transit agency wants to do more of one, it must (within a fixed budget) do less of the other, due to fundamental geometry and geography.

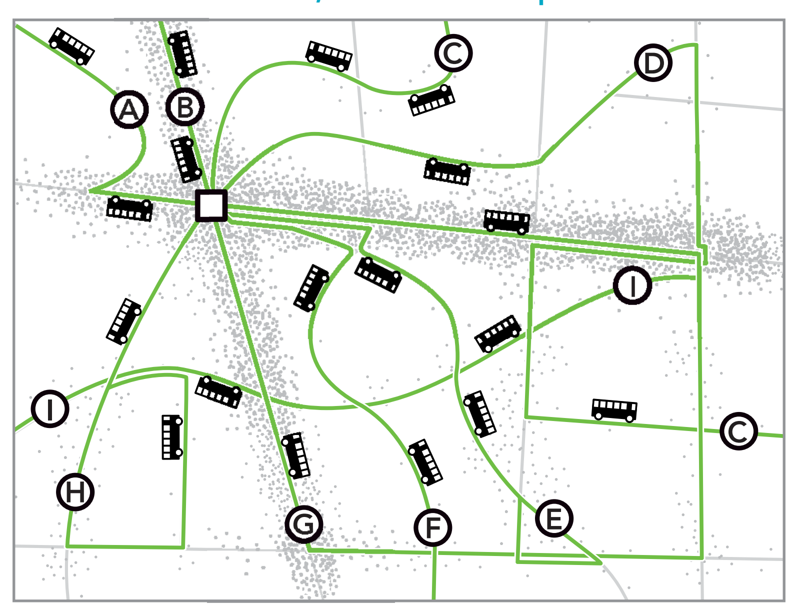
In the fictional town shown at left, the little dots indicate dwellings, commercial buildings and other land uses. The lines indicate roads. Most of the activity in the town is concentrated around a few roads, as in most towns.

A transit agency pursuing only a ridership goal would run all of its buses on the streets where there are large numbers of people, walking to transit stops is easy, and where they can run straight routes that feel direct and fast to customers. This would result in a network like the one at bottom-left, and total ridership would be high because many people would find the two frequent routes useful.

If you concentrate service in the busiest areas, your routes are very frequent, so waits are short. But people in less-populated areas have a much longer walk to service. You are maximizing total ridership, but some places have no service.



If you make sure every area is covered, everyone will have a bus stop nearby. But all routes are infrequent, requiring long waits, so very few people find them useful. Everyone has access to minimal service, but total ridership is low.



If the town were pursuing only a coverage goal, on the other hand, the transit agency would spread out services so that every street had some bus service, as in the network at bottom-right. As a result, all routes would be infrequent, even those on the main roads. Because service would rarely be coming when somebody wanted to travel, total ridership would be low.

In these two scenarios, the town is using the same number of buses. These two networks cost the same amount to operate, but they deliver very different outcomes.

While an agency can pursue ridership and provide coverage within the same budget, *it cannot do both with the same dollar.* Within any fixed budget, the more it does of one, the less it does of the other.

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

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

We estimate that, in the existing network, Mountain Line is spending about 70% of its service in ways and in places that generate high ridership, and about 30% in ways and places where low ridership is the predictable result.

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

In 2012, as part of a short-range planning process, Missoula transit stakeholders responded very positively to a high-ridership, high-frequency alternative called the "Focus Inward Alternative." The current balance of ridership and coverage spending in Missoula derives from that public input, and the policy decision made by the Mountain Line Board when they took action on the 2012 plan.

This 2017 Strategic Plan presents an opportunity for the community to revisit, potentially reaffirm, and refine that 2012 decision about how to resolve the conflict between ridership and coverage goals.

Key choices for the future of Missoula transit

At the end of this report, we present three key choices that the public, stakeholders and elected officials may want to make as part of this transit plan. These choices are suggested by the existing conditions and performance of transit and land use in Missoula.

Balancing ridership and coverage goals

In every public transit system, a basic trade-off must be made between doing things that increase ridership (such as concentrating service into more frequent routes) and doing things that increase geographic coverage.

How should Mountain Line balance ridership and coverage goals in its network? Is the current balance (which derives from a balance struck in the 2012 transit plan) the right one, or should the balance be shifted?

Within a fixed budget, a shift towards higher frequencies and higher ridership would require cutting coverage, and vice versa.

Lead vs. respond

Transit service can be designed to respond to existing ridership, in order to increase ridership in the short-term. It can also be designed to lead development, serving areas where there isn't presently high ridership potential but there are intentions of developing high ridership potential in the future. Leading development may increase ridership in the long-term, but it means accepting that ridership will be lower in the short-term (and it involves some risk that long-term land use or development plans won't come to bear).

Given Missoula's ambitions to develop new areas within the city, should transit service be maximizing existing ridership, by responding to today's conditions? Or leading development, in hopes of growing more ridership in the long term?

Balancing weekday, evening and weekend service

Mountain Line, like many small-city transit agencies, does not offer Sunday or holiday service, and service ends fairly early on weekday evenings. Yet most people still need to travel on weekends (especially people who work in the service industry). Surprisingly, ridership relative to cost is higher on Mountain Line's network on Saturdays than it is on weekdays!

Increasing evening, weekend and holiday service can serve ridership-related values (because all-week transit networks tends to attract higher ridership than limited-day networks) and coverage-related values (because low-income people, in particular, badly need to access jobs on weekends and holidays).

Given the transit demand, and the transit needs, observed on the weekends in Missoula, should any service be shifted from weekdays to weekends? Should service be shifted from weekday daytimes to evenings?

Within a fixed budget, lengthening the span of service each day or each week would require reducing weekday frequencies or reducing coverage (i.e. cutting some routes).

Chapter Summaries

Chapter 2: Assessing ridership potential

The next chapter of this report is an assessment of the potential for high ridership in Missoula. The way of thinking about ridership described in Chapter 2 is similar to the way a private business thinks about its market for sales – how many potential riders are there, how useful will they find the service, and how well does the service compete for their ridership.

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

- Reducing congestion or vehicle miles traveled,
- Reducing household transportation costs, and
- Keeping subsidy per passenger low.

Chapter 3: Assessing needs for coverage

In this report, we refer to transit services that are not operated with the goal of high ridership as having a *coverage goal*. Coverage goals reflect concerns about equity, and they also reflect social-service objectives, such as meeting the needs of people who are especially reliant on transit, whether due to age, disability, poverty or some other condition. Arguments for coverage services generally refer not just to *how many* people need transit service but also to the *intensity* of their need.

Transit coverage serves a set commonly-held values, like:

- Giving all residents equal access to transit, no matter where they live,
- Providing transit service to certain groups of people, because of how intensely they need access or because of civil or legal entitlements, or
- Spending tax revenues close to where they were levied.

If the severity of a person's need is a more important driver of transit service allocation than the number of people who will be served, that reflects a coverage goal.

An assessment of coverage needs is contained in Chapter 3.

Chapter 4: Summarizing recent trends

In Chapter 4, we summarize the recent history of Mountain Line, and its performance using a small set of measures.

Chapter 5: Analyzing Mountain Line transit's performance

Chapter 5 presents an analysis of Mountain Line's fixed route transit network performance, including:

- How the transit network compares to networks in peer cities, using a few key measures.
- How individual routes in the Mountain Line network perform.
- Certain features of the network that are difficult to understand simply by looking at a map.

Keep in mind that transit's performance is only partly a result of transit service. Land use and street design also play major roles in making transit useful and accessible, or not.

Chapter 6: Financial analysis

As Mountain Line comes to the end of the three-year Zero Fare pilot program, questions naturally arise about whether and how to continue funding Zero Fare; what other sources of revenue might be available; and what other costs are on the horizon for the agency. These questions are addressed in Chapter 6.

Chapter 7: Key choices for the future

The final chapter of this report lays out a few key choices that Missoula and Mountain Line may want to make as part of this Strategic Plan. These choices will be the focus of public and stakeholder involvement over the next few months.

Appendix: Individual route profiles

Anyone who wants more detail on an individual route should refer to the appendix. For each route, we report boardings and alightings by stop; ridership and productivity; and other operational data.

2 Assessing Ridership Potential

Effects of Land Use and Street Design

Some people have the impression that transit's success at attracting riders is within the control of the transit agency alone, but this is rarely the case. Land use, development, zoning, urban design, highways, railroads and street patterns all have effects on transit's usefulness and cost, and therefore on its ridership. For this reason, most cities coordinate their transit planning with their land use and transportation planning.

Land use, development and transportation planning are led by several agencies, among them the City of Missoula, the Metropolitan Planning Organization and the Missoula Redevelopment Agency. These factors are not directly controlled by MUTD, and yet they impact ridership and the costs MUTD must bear to attract that ridership.

If a transit agency is designing for high ridership, it will naturally focus service on places where ridership potential is high and cost is low.

Four key factors are:

- Density: How many people (or jobs, or other activities) are within a given distance of each stop?
- Walkability: Can people near the stop actually reach the stop?
- Linearity: Can transit serve an area in straight paths, or must it make time-consuming deviations?
- Proximity: Are there long gaps between destinations and strong markets that transit must traverse?

A simple way to visualize the different ways they impact ridership and costs is to ask: *"How far do we have to drive a bus to serve 100 people?"* The lower this distance is, the higher the ridership potential of an area and the lower the cost to serve it.

These factors determine both the costs of providing transit in a particular place and how many people are likely to find the service useful. Density and walkability tell us about the overall ridership potential of the market: *"Are there are a lot of people around, and can they get to the transit stop?"*

Linearity and proximity tell us about both ridership potential and cost: *"Are we going to be able to serve the market with fast, direct lines, or will we have to run indirect or long routes, which cost more to operate (and cost riders time)?"*

Four Geographic Indicators of High Ridership Potential

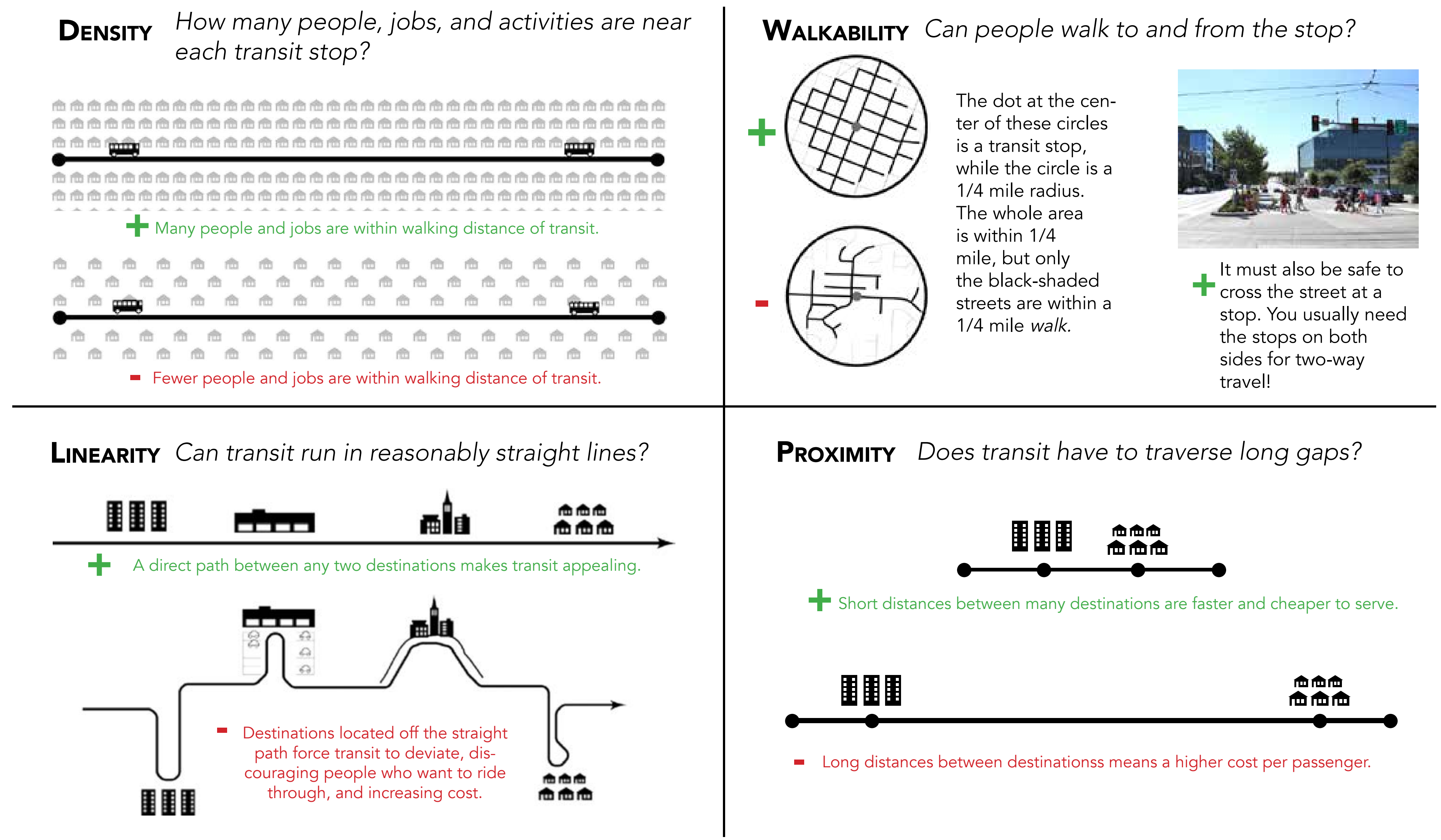


Figure 2: Illustration of the Ridership Recipe

A transit provider can influence the level of ridership their services generate, within their fixed budget, by targeting corridors and places where the "Ridership Recipe" is in effect. However, they cannot directly control the urban form of the places they serve. Without dense, walkable places with connected streets, where demand is continuous along linear transit paths, a high level of transit service alone is unlikely to achieve high ridership. The transit agency can try to provide a level of transit service that is as useful as possible, but the built environment has the power to limit transit ridership regardless of service.

In the following pages, we look at the potential for high transit ridership in Missoula with these considerations in mind.

Research describing the relationships among transit ridership, transit cost, and land use and street design factors is abundant. For an introduction, see *Travel Demand and the 3Ds: Density, Diversity and Design*, by Cervero and Kockelman and *Travel and the Built Environment: A Synthesis*, by Ewing and Cervero.

Density

The maps on this page and the following page show the densities of residents and jobs in Missoula.

In planning, people sometimes react strongly to the word "density" based on their emotional and cultural experiences. Yet density describes a simple geometric and geographic fact that matters enormously for transit: the number of people close to any given transit stop.

Residential density

Residential density is the simplest measure of public transport's ridership potential. While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at their place of residence every day.

The map at right shows the estimated residential density for Missoula and surrounding areas.[1] On this map:

- The lowest-density areas, which are left white, are mostly large-lot single family homes, undeveloped land, or rural and agricultural residences.
- Areas shown in light or dark orange are home to 2,500 - 7,500 people per square mile, typically with small-lot, single family homes.
- The highest-density areas are shown in dark red, and include apartments, manufactured housing parks, and dormitories at the University.

Most of the densely-populated parts of Mountain Line's service area are within the core area of Missoula, loosely defined as bounded by Reserve to the west, Mt. Sentinel to the east, I-90 to the north, and the South Hills. Within this core area, the highest-density areas are found closer to downtown, near the University, and extending southwest from downtown towards Southgate Mall.

Isolated pockets of high-density housing are scattered far from this dense core, in the Mullan area to the west, in East Missoula, and especially towards the southwest (e.g. Miller Creek). Dense pockets like these present a difficult challenge to transit agencies, because (referring back to the Ridership Recipe on page 11) they are not *proximate* to other density, and are mostly developed in street networks that don't allow *linear* routes to serve them.

Some of these pockets of density are also in places where *walkability* to and from any bus stop would be a challenge, such as along North and South Reserve. When a road is so wide and fast that it cannot be crossed on foot, that means that people can only access a bus stop in one direction – they can get there by transit, but they can't get back.

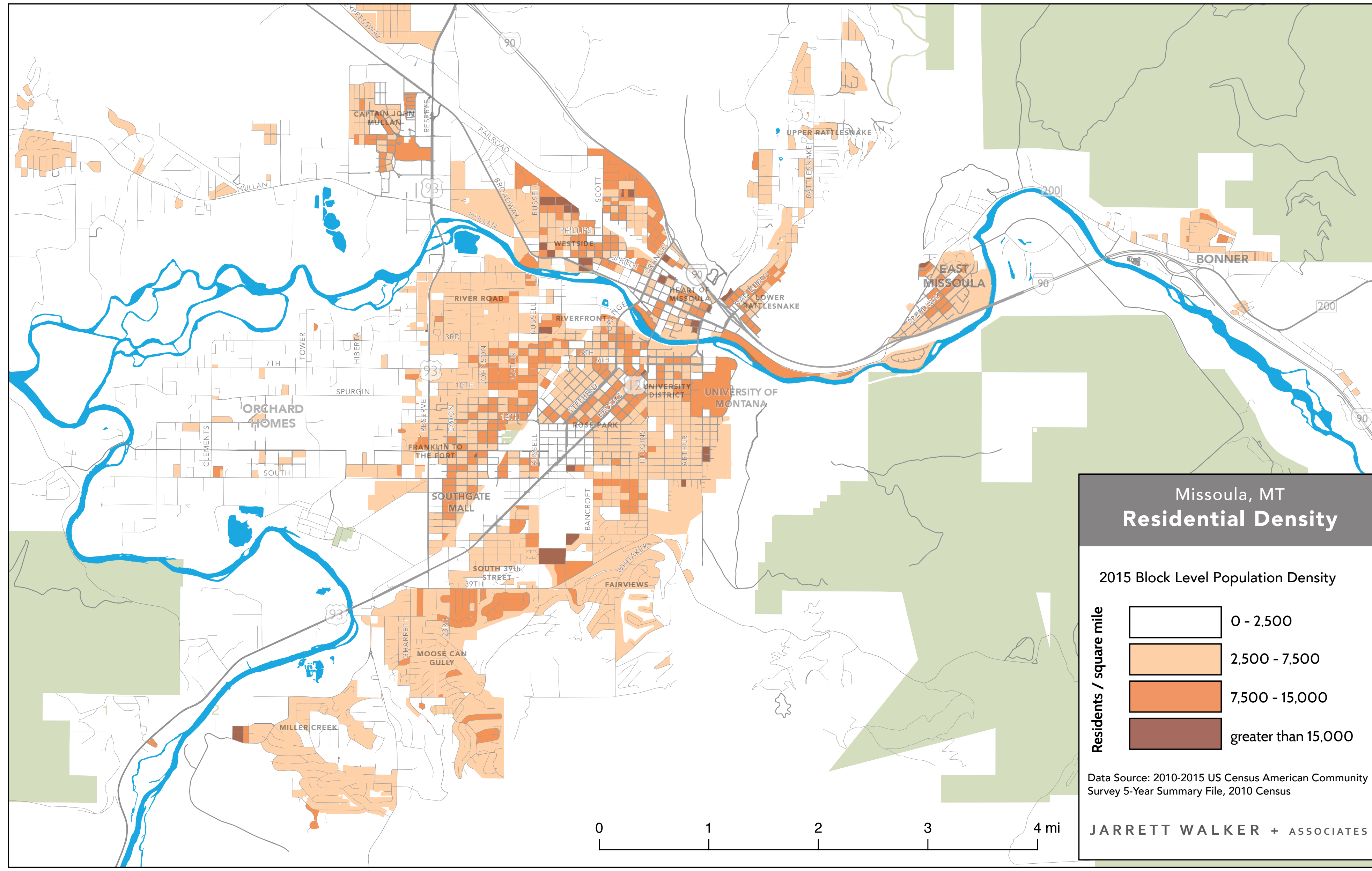


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Figure 3: Map of Residential Density

Some of the dense parts of Missoula seem close to one another on this map, but are in fact separated from one another (and in some cases from transit service, as we'll observe later in this report) by the railroad, I-90 or very wide arterial roads that are difficult to cross on foot.

1 Because block-level estimates from the U.S. census are only released for the Decennial Census (and not the annual American Community Survey), 2015 block-level estimates have been derived based on the Decennial Census and the change in residents in the parent Block Groups observed from 2010 to 2015. This distributes the change in population to the child Census Blocks in accordance with their population as a percentage of the Block Group's total.

Employment Density

Employment density is an even better predictor of transit ridership than residential density. This is because it represents places people travel for work, but also places people go for services, shopping, culture, health care, and more. A person's workplace may be, throughout the day, a destination for dozens or even hundreds of people.

The map at right shows the density of jobs in each Census block.[2]

Job density in Missoula is clustered in a few major locations:

- The two densest employment clusters are in downtown and at the University;
- Brooks St. is an axis of employment and commercial density, all the way from Reserve to Downtown. However, there is a big gap in employment density, between Mt Ave. and 6th Ave.
    - Unfortunately, the commercial developments along Brooks were designed for car access, not transit access. As a result, the development pattern presents barriers to walking, including numerous driveways, large parking lots, large intersections, the front doors of buildings set far away from the road, and Brooks being difficult to cross on foot.
- In addition to the job density shown at Southgate Mall, it is obviously a major destination for shopping, services and recreation.
    - The same can be said of the University campus, which is dense with jobs but even denser with students and activities, though they do not show up on this map.
- Areas around North Reserve have substantial job density, but are also car-oriented developments, presenting barriers to walking and therefore to high-ridership transit service.
- Rattlesnake, East Missoula, Bonner and Orchard Homes all present very low densities of jobs and commercial activities.

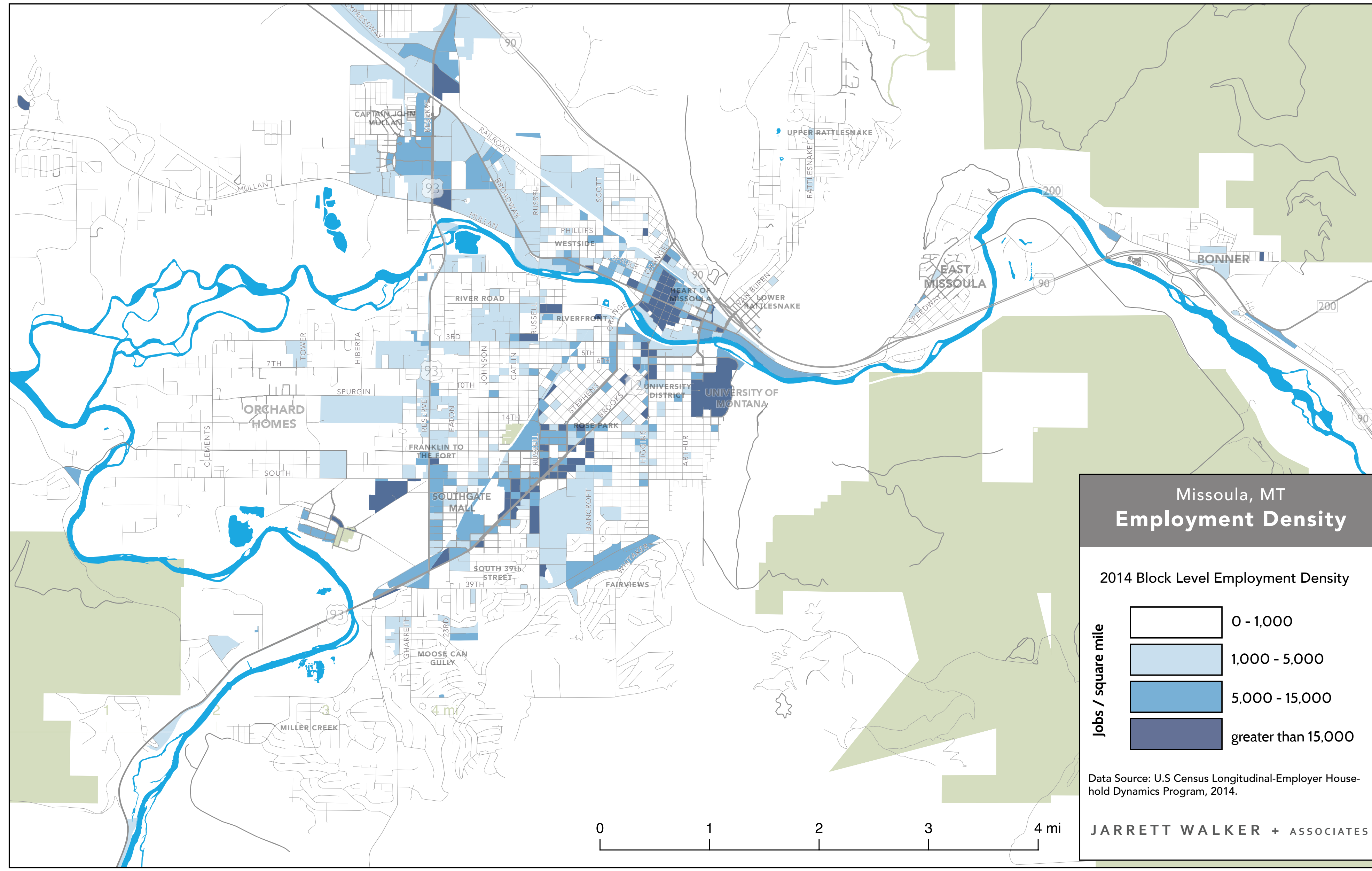

Figure 4: Map of Employment Density

2 This map may exhibit a common problem with job data, which is called "headquartering." Some large private and public organizations, whose workers are actually distributed across a large area or multiple job sites, record all of their workers' job sites as being at the headquarters.

Activity Density

Residential and job densities are combined into Activity Density in the map at right. This allows us to see how the total density of activities, the mix of uses, their proximity and their linearity could affect transit ridership across Missoula.

On this map, red represents residential density and blue represents job density. Shades of purple represent Census blocks with a mix of uses, but the highest-density mixed use blocks are shown in yellow.

We can observe that:

- A few linear corridors appear that have continuously high densities of either jobs or residences over long distances. In particular, Broadway, Russell and Orange (on both sides of the river), Brooks and, over a shorter distance, South.
- There are small dense pockets - of either housing or jobs - scattered all around the city, many of them far from any other dense development, and not arranged in a way that they could be served by a reasonably linear bus route.
- Activity density in Orchard Homes is extremely low.
- Rattlesnake, East Missoula and neighborhoods south of 39th are almost entirely residential, and low density.
- There are some areas of moderate job or residential density in (or near) Bonner, they are far from one another, rather than concentrated in a central area or on a corridor.
- Despite being very auto-oriented and pedestrian-hostile, the areas around North Reserve are home to high densities of residents and jobs. Yet transit on Reserve can only be safely accessed in one direction or the other, because it is so hard to cross the street.

Though it is not one of the four major factors named in the Ridership Recipe, the *mix* of residential and job density along a corridor affects how much ridership transit can achieve, relative to its cost.

This is because a mix of uses tends to generate demand for transit in *both* directions, at *many times of day.* Transit lines serving purely residential neighborhoods tend to be used in only one direction – away from the residential neighborhood, towards jobs and services. This limits how much ridership the service can attract relative to its cost, because:

- If ridership is only high during the morning and evening rush hours, that means the transit agency must pay to run mostly-empty buses during the rest of the day (or must pay drivers to take awful split-shifts, which go from very early to very late, and must buy extra buses for those few hours of peak service each day).
- If ridership is only high in one direction during each peak, then the provider must pay to run mostly-empty buses back in the other direction. The service may not even be advertised as two-way, but the operating costs are always two-way.

All-day and two-way demand, along an entire route, results in higher ridership relative to cost. All-day and two-way demand tends to arise on corridors that have mixtures of housing, retail, services and jobs.

Universities are also sources of all-day all-directions transit demand. This is partly because they are dense with jobs and housing. It also relates to the type of "job" done there: students come and go depending on their class schedules, from morning through the evening. Professional, retail and facilities staff have their own commute patterns. The sum of all these patterns is generally high demand, all day, every day (even, in some places, days when school is not in session).

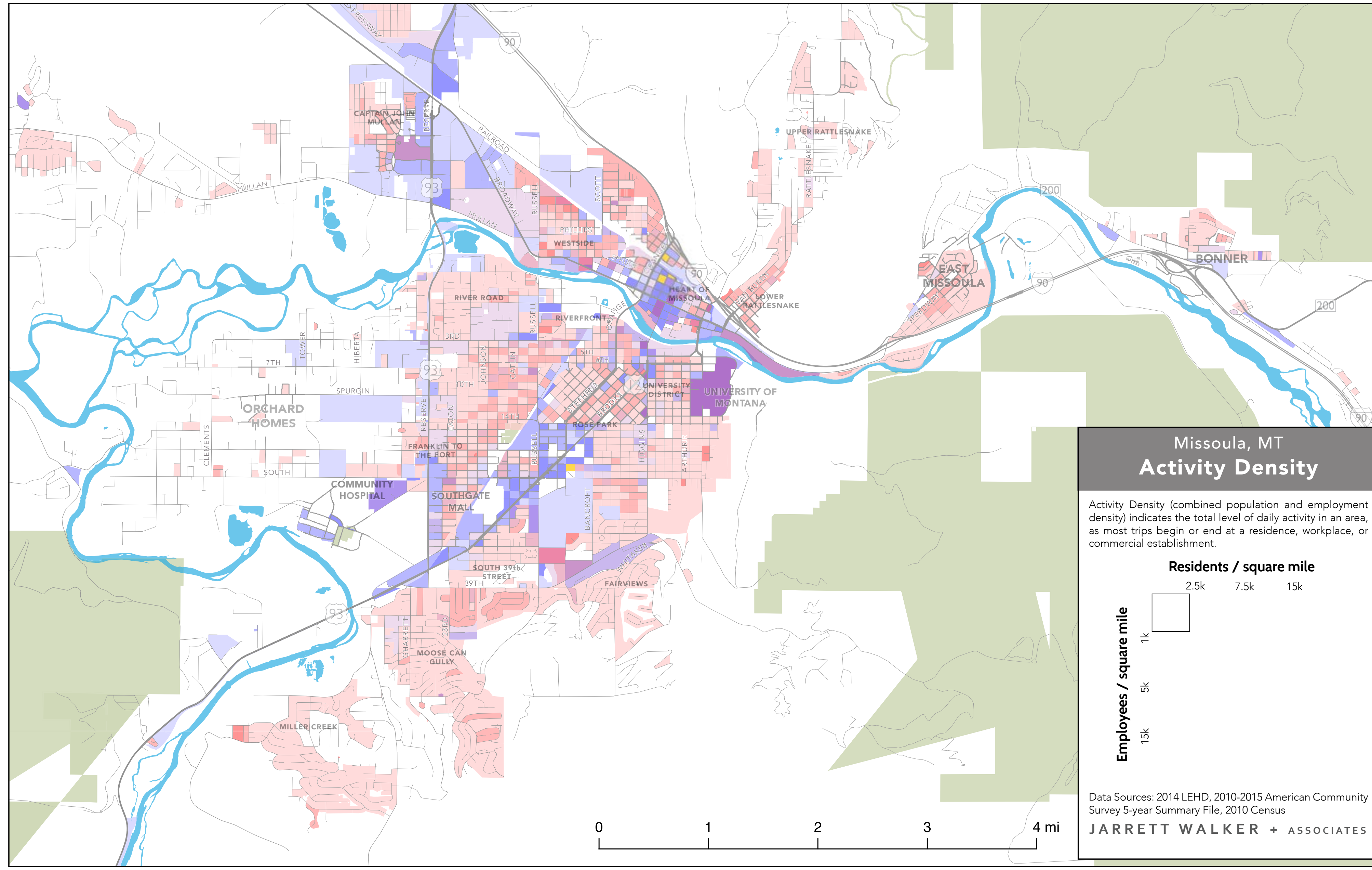

Figure 5: Map of Activity Density

Long-Term Forecast Growth in Residential Density

The Missoula Metropolitan Planning Organization (MPO) forecasts how land will be used in the future. These forecasts are based on future plans, existing land uses and the travel behaviors of existing or past residents.

Of course, the future is hard to predict accurately. Major policy decisions – from the City level on up to the Federal level – could change the forecast. Local and national financial changes, changes in the price of gas, the price of wood, the climate, the rise of new technologies, may all cause our best predictions to turn out wrong. Finally, a land use or transportation forecast is always an answer to the question, "What will happen if we do things the way we plan to do them?" Yet communities have a choice to change their own futures, by planning for things to be different.

The map at right shows where the density of residents is planned and expected to change between now and 2045. Significant increases are shown in shades of yellow and orange, while decreases are shown in violet. Areas that would experience little change are shown in tan.

This map makes visible a few major projected changes:

- The core area of Missoula is planned to intensify, especially in the Riverfront area north of 3rd Avenue between Reserve and the Orange St. bridge.
- The North Reserve area is planned to intensify.
- The lowest-density segment of Brooks Street (between Mt Ave. and 6th Ave.) is not expected to get any denser. However, blocks around Brooks Street just south of Mt Ave. (which are currently commercial) are expected to get much denser with housing.
- A great deal of new housing is expected to grow between 3rd Ave. and the river, especially near Russell Street.
- Some development is expected to continue in the Miller Creek and Moose Can Gully areas of the South Hills.
- Some development is planned along 3rd Ave. east of Reserve, but hardly anywhere else in Orchard Homes.
- Scattered blocks within the city, and larger areas at the edge of the city, are expected to become less dense with residents. Notably, this includes the neighborhood south of the University, along Arthur Ave.

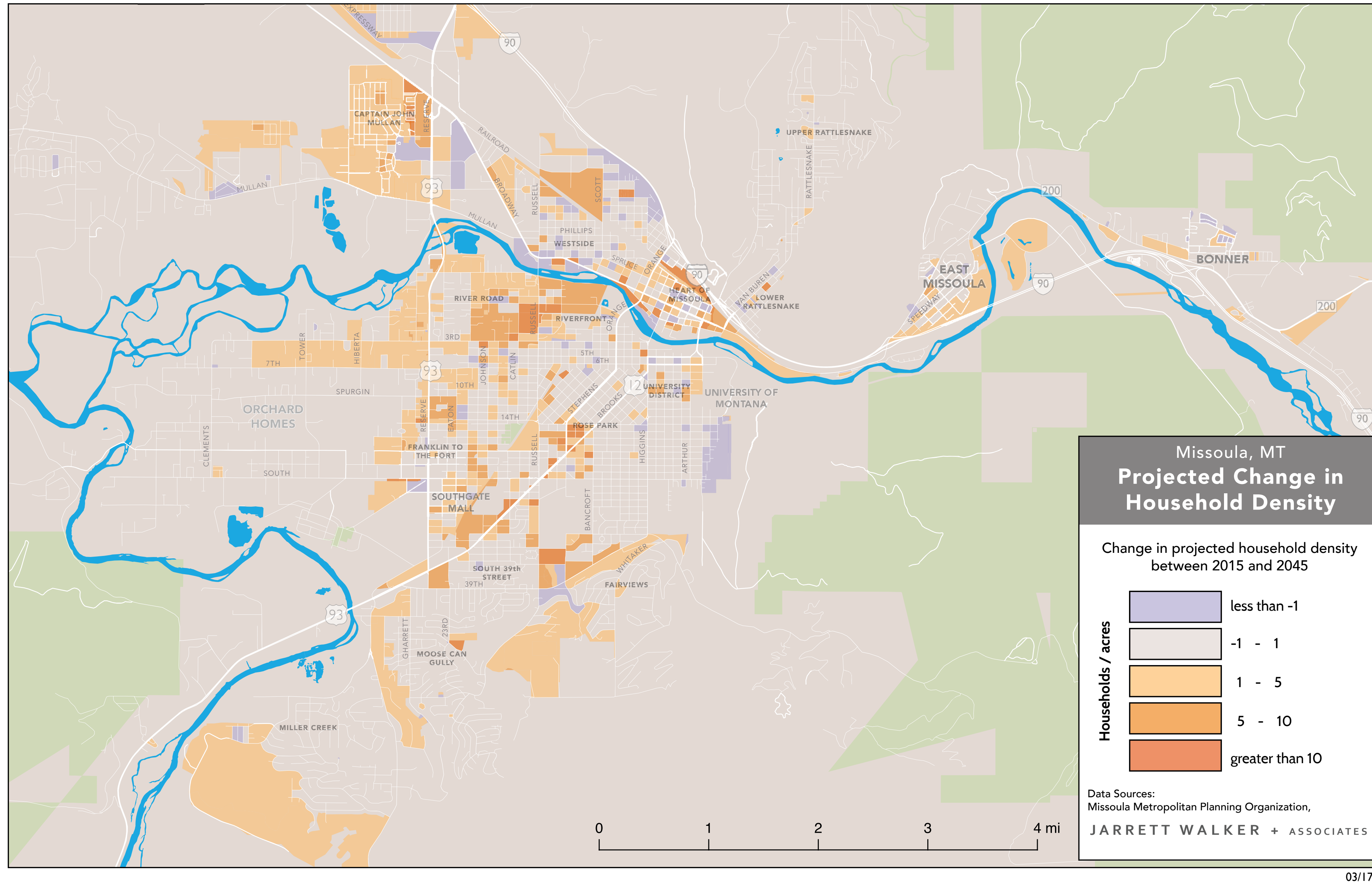

Figure 6: Map of the Projected Change in Household Density, 2015-2045

In general, Missoula MPO's land use predictions are reflective of the City's (and Mountain Line's) "focus inward" policy. Apart from continued development of low-density housing in a few specific outlying areas, the great majority of new housing growth near Missoula is predicted to be within the existing urban area, and in fact to be within walking distance of an existing Mountain Line route.

Note that this map shows degree of change, but not overall density. Thus some areas that are shown to have a high degree of change may still not be very dense in 2045, if today they have very low densities.

Also note that this map does not show change in *job* density. Because commercial and employment developments are on much larger parcels, they are even harder to forecast accurately than residential developments. The map on the next page shows much shorter-term growth data, and does include commercial developments.

Short-Term Development

The map at right shows all of the building permits issued in 2016, for different densities of housing and for commercial buildings. In the background the Mountain Line transit network is shown, color-coded by midday frequency.

Multifamily housing holds the most promise for increasing nearby transit ridership (because it causes so many residents to be within walking distance of a transit stop). The bulk of multifamily permits (shown as red dots) were issued for housing within the core of Missoula, especially between S. Stephens and Johnson. A few additional multifamily permits were issued on Mullan: two near N. Reserve and one far to the west, beyond the reach of the transit network.

"Missing Middle" housing is slightly denser than single-family homes on single lots, and includes duplexes and "granny flats." "Missing Middle" permits are shown as orange dots, and are more scattered around the city.

Single-family home development permits, which present low densities and therefore don't indicate much added transit ridership potential, are scattered all over the city (shown as yellow dots). One cluster of yellow dots, at S. 3rd and Hiberta, actually represents rowhouses, which are fairly dense, but we can see by comparing this map to the existing density map on page 14 that the surrounding neighborhood is quite low-density.

Commercial permits (shown as blue squares) were issued for locations all over the city, and in fairly small numbers in 2014. Of course, these permits only tell us about new commercial construction; many more businesses will move among existing buildings in a given year.

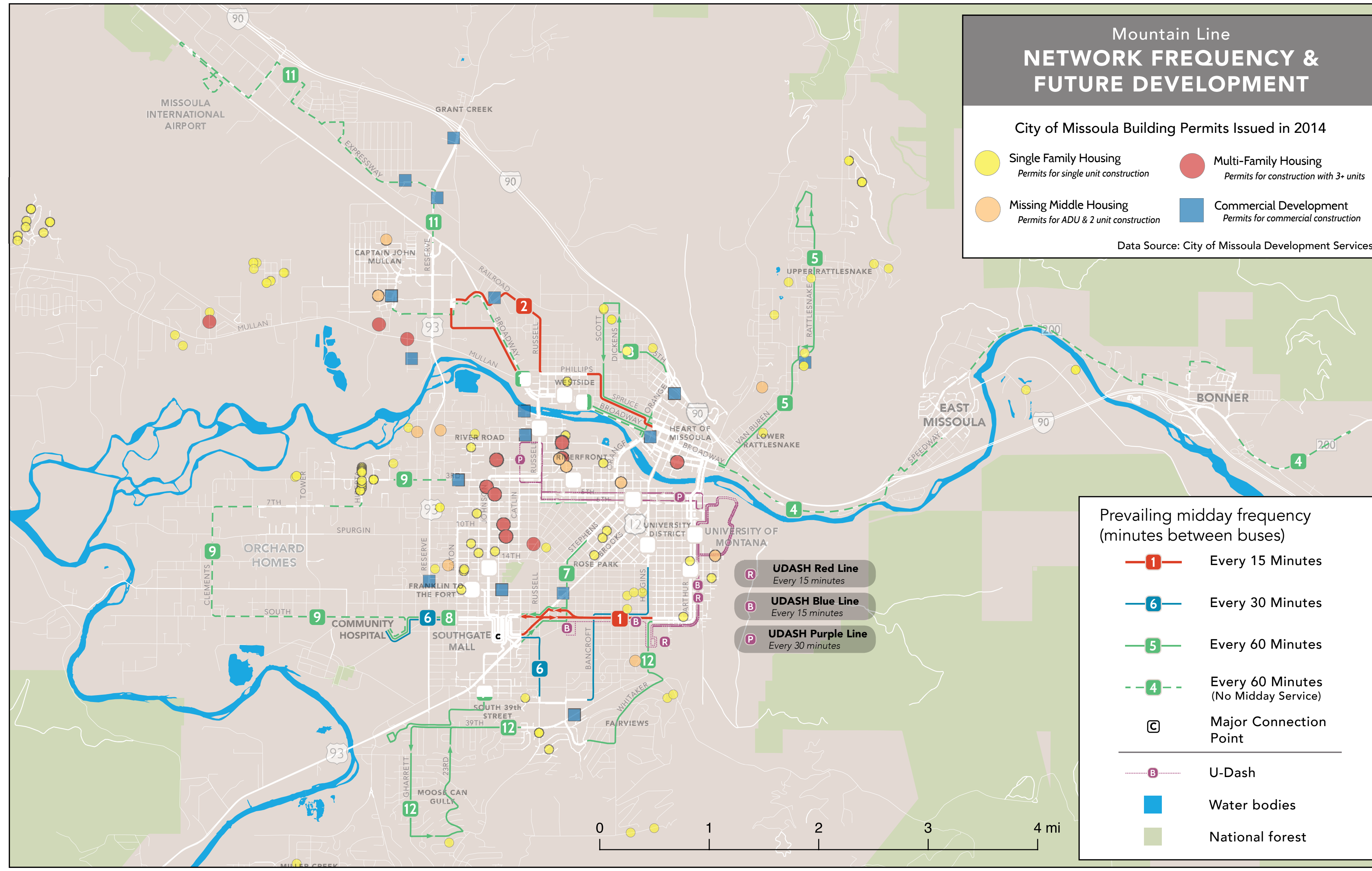

Figure 7: Map of Building Permits Issued in 2016

3 Assessing Coverage Needs

Poverty Density

Transit is often tasked with providing affordable transportation for low-income people. When this is done in the absence of high ridership, it represents a type of coverage goal. Federal laws also protect low-income people from disparate transportation impacts, which can lead agencies to provide transit service in places where poverty is high even if it does not maximize ridership.

However, an examination of the distribution of poverty in Missoula arguably belongs in the preceding chapter, because people who are living in poverty can represent *either* a strong market for transit *or* a need for coverage service (regardless of ridership), depending on the built environment around them. Understanding where large numbers of low-income people live (and where they need to go) is thus important in terms of ridership goals and coverage goals.

A common misconception is that transit, especially all-day transit, is only useful to low income people who cannot afford a car. This is a simplistic view on a complex matter. People at all points on the income spectrum make choices about how to travel, based on their personal evaluation of a set of factors including cost, travel time, safety and comfort.

It is certainly true that people with fewer resources have an incentive to spend less on transportation. The more carefully a person must manage their money, the more attractive transit's value proposition may be. However, this doesn't mean that lower-income people will automatically choose transit because it's the cheapest option. The service available to them must be useful and reliable for the kinds of trips they need to make. Nor does it mean that a person further up the income spectrum will not use the same transit services as low-income people, if they find those services sufficiently useful.

The map at right shows the density of people living in poverty in each Census Block Group in Missoula.[3] The areas that have the greatest concentration of residents living in poverty are quite close to the center of the city (and to the most frequent Mountain Line routes). There are moderate densities of people in poverty slightly further out, in particular in East Missoula and at the edge of the south hills, just south of 39th.

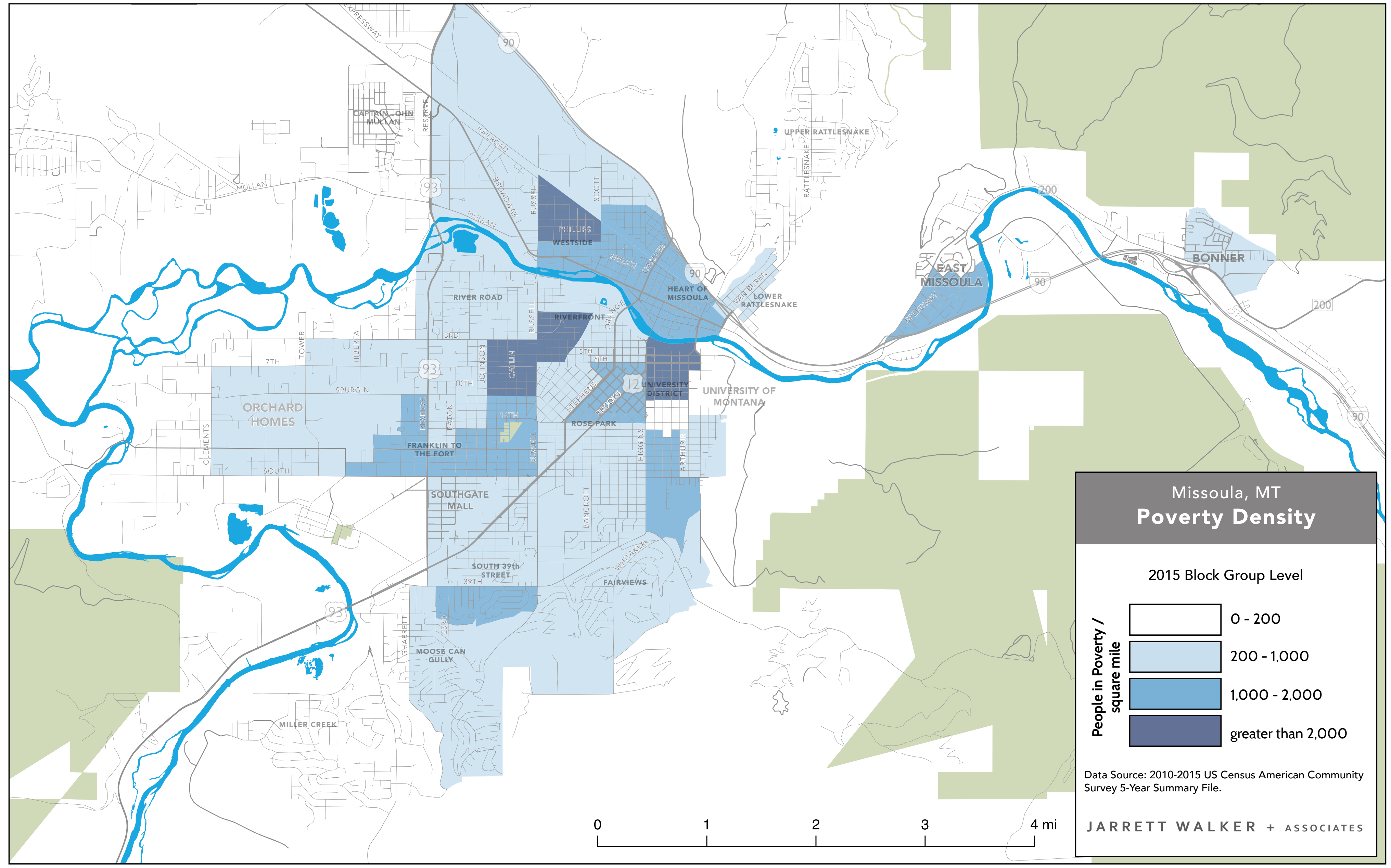

Figure 8: Map of Poverty Density

3 Unlike population, employment and age data, data on income is not available at the finer Census Block level. Block Groups are enormous, and thus a fairly crude tool for understanding demographics and conditions at the walking-distance scale, which is the scale that matters for transit. These Block Groups present an aggregate level of household income that obscures differences within each Block Group.

Median Household Income

Where the map on the previous page showed the density of residents in poverty, the map at right shows the median household income for any number of residents living in each Census Block Group. Some of the areas shown on this map contain very few residents, but they are color-coded based on the incomes of those few residents.

This map allows us to see where there might be small numbers of people, living at low densities, with very low incomes. The Block Groups east of Reserve, north of the river and just south of the river, are such areas. Downtown is another such area: there are very few residents, but the few that are there have low incomes.

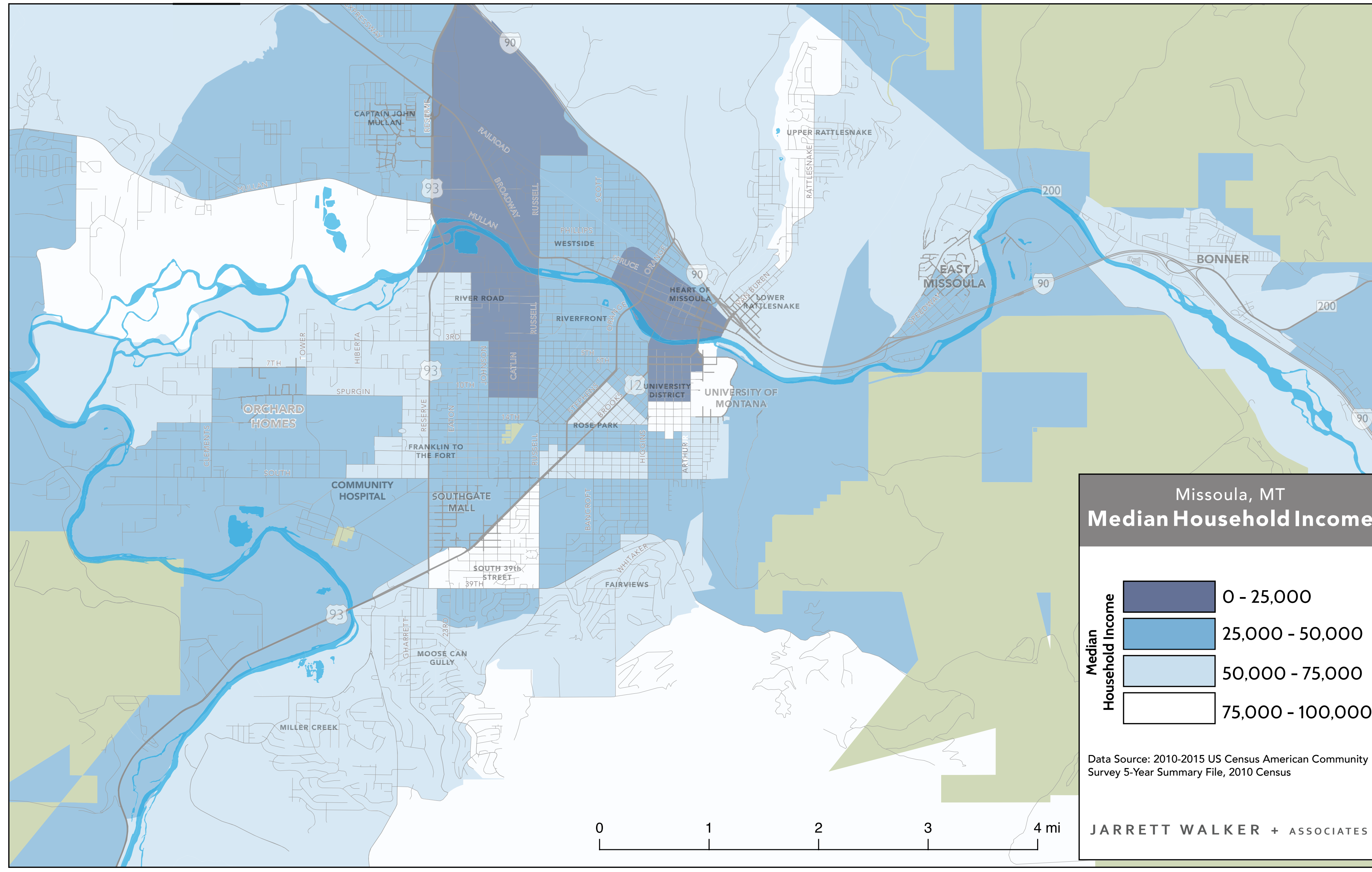

Figure 9: Map of Median Household Income

Race and Ethnicity

Federal civil rights law protects people from discrimination in the provision of transit service on the basis of their race or ethnicity. It is important to understand where large numbers of non-white people live, so that service changes can be evaluated in light of impacts to those people.

While information about someone's income tells us something about their potential interest in riding transit, information about ethnicity or race do not (except to the extent that race or ethnicity correlate with income, and in certain cases they do). However, avoiding placing disproportionate burdens on non-white people through transportation decisions is essential to the transit planning process.

The map at right shows where the 11% of Missoula residents who are non-white reside. Neighborhoods south of the University, between S. Reserve and Russell, and on the westside are somewhat more diverse than neighborhoods elsewhere in the transit district.

This information about where non-white people live is helpful not only for assessing coverage needs and civil rights, but also for thinking about where people's involvement in this Strategic Plan process might be hampered by language or cultural barriers.

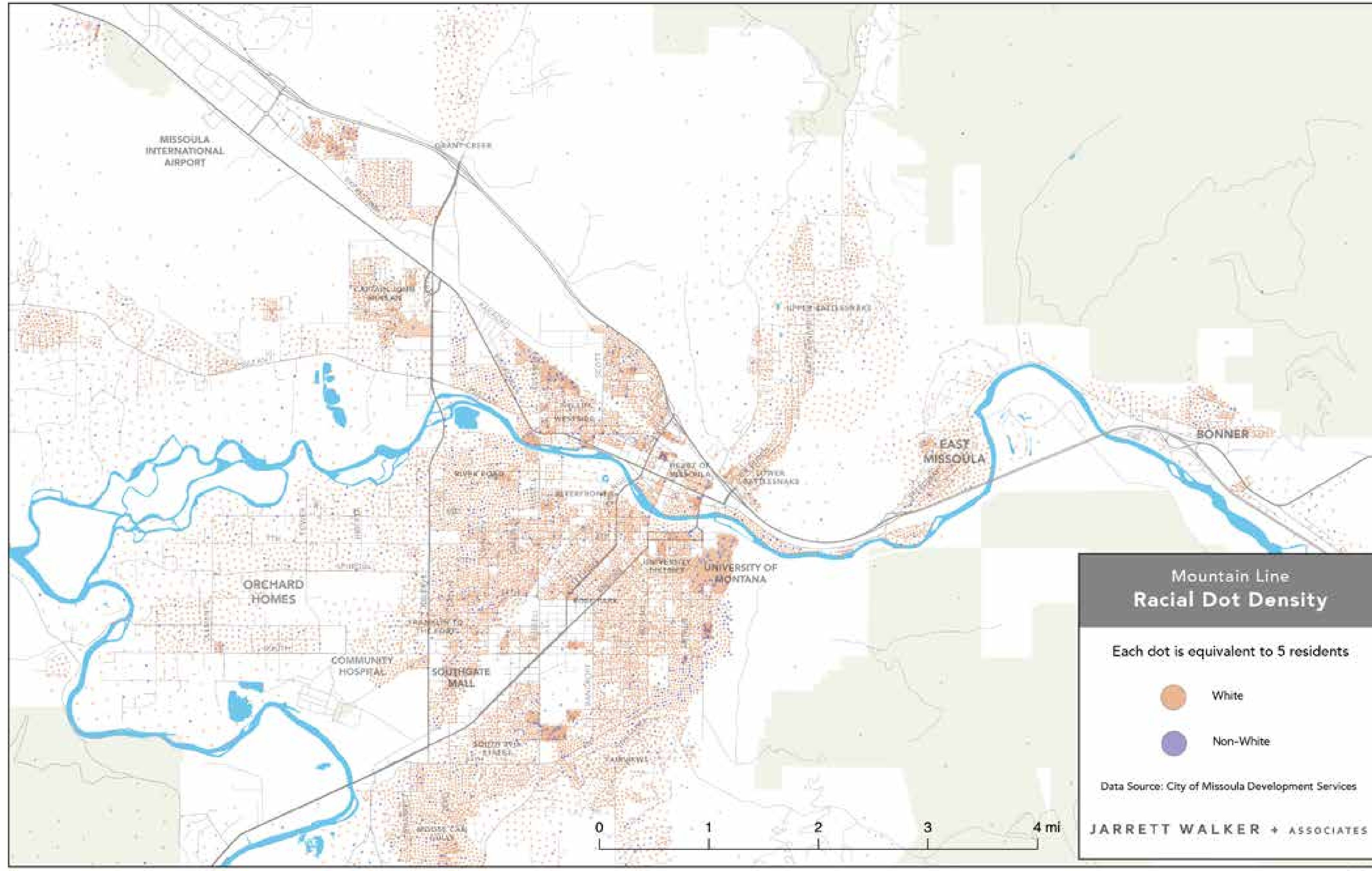

Figure 10: Map of Residential Density by Race or Ethnicity

Senior Density

One of the major drivers of transit coverage is the need for mobility among people who cannot drive. This need is particularly acute among seniors, many of whom cannot or choose not to drive themselves.

The map at right shows the density of senior residents of each Census block in Missoula. While moderate numbers of seniors live throughout the central neighborhoods of Missoula, a few high-density senior housing developments further from the center are visible on this map: near or on Reserve, in the south hills, and on Mullan.

When considering how transit service can and should serve seniors' needs, we must keep in mind that seniors' needs and preferences tend to be different from those of younger people:

- Seniors are more likely to be discouraged by long walks to transit, because of limits on their physical ability, or because of concerns for their personal safety. This is particularly true where sidewalks and crossings are poor or lacking.
  - According to the Centers for Disease Control, the rate of any physical difficulty among people ages 65 or older is slightly less than 30%, compared to a rate of 15% for the adult population as a whole.[4] If they do fall into this category, then a walk (or roll) of any distance may completely prevent them from accessing transit.
- Seniors are much less likely to be discouraged by long waits for transit, because they are less likely to be employed. Thus, fewer of their trips are time-sensitive, compared to those of the general population.
- For the same reasons, seniors are less likely to be discouraged by slow or indirect routes that take them out of their way, since they are less time-sensitive than the general population.

Seniors are more likely to be low-income than working-age people (as are youth), but their needs and concerns related to income (such as sensitivity to fares) are similar to those of low-income people of any age.

The same forces that make seniors less sensitive to long waits and slow bus rides make them more influential in transit debates. Because they are less likely to be employed or raising children, they are more likely to have free time to devote to transit planning and transit conversations (along with many other important civic matters).

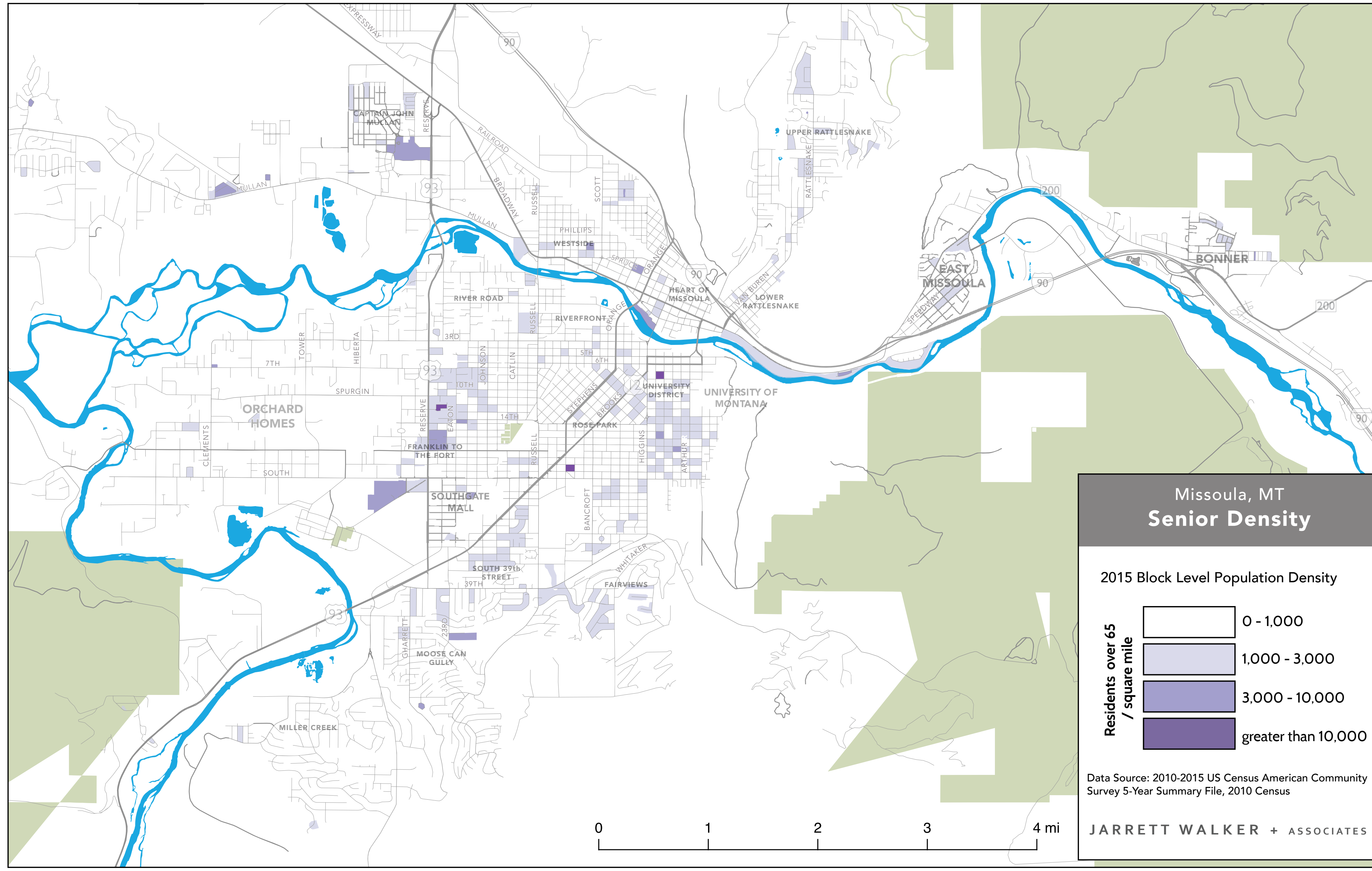

Figure 11: Map of Senior Density

The amount of input that transit agencies receive from seniors is often disproportionately high, compared to their prevalence in the population. Most transit agencies find that they must deliberately balance seniors' preferences and influence with the preferences of the rest of the population.

4 Centers for Disease Control and Prevention National Health Interview Survey, 2015.

Youth Density

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 in Missoula.

We can observe a greater scattering of young people all over the city than we do in the previous map showing the density of senior people.

(Beyond the northern edge of this map, there is also a high concentration of young people in the dense residential development bordered by Expressway, I-90 and a large gravel storage area.)

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

However, young people and seniors are very different in their ability and willingness to walk to transit service. Most young people can and will walk farther to reach service than seniors.

Whatever effect an increase in price has on ridership among working-age people, it will have an even stronger effect on ridership among young and old people. (This is why most transit agencies, along with movie theaters and other for-profit businesses, offer a discounted price for seniors and children.)

Because Mountain Line is fare-free, it is likely attracting much more ridership from price-sensitive seniors and youth than it otherwise would.

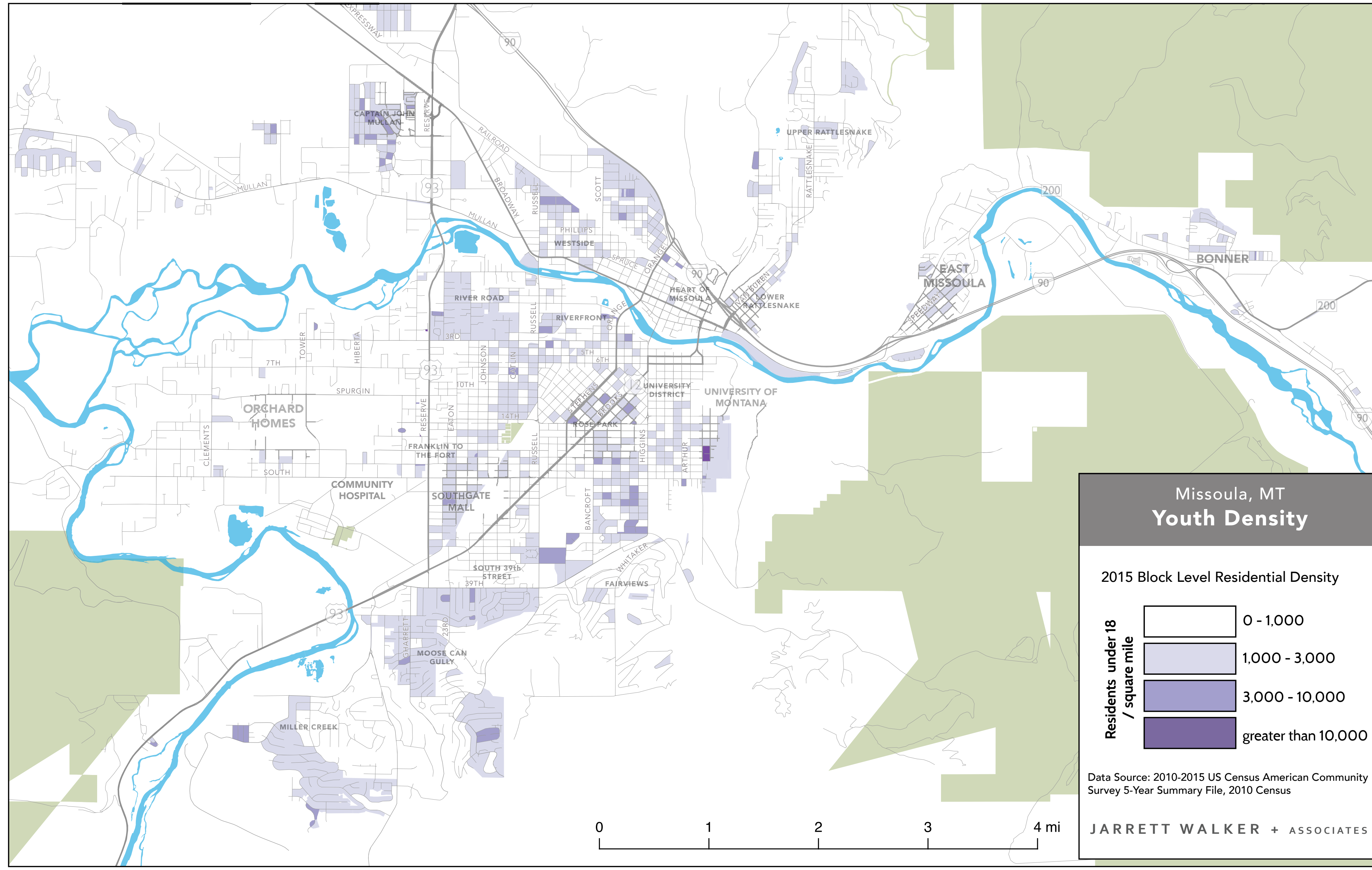

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Figure 12: Map of Youth Density

Access to a Vehicle

Not everybody has ready access to a personal automobile, and people who have less or no access will depend on other modes when they need to travel. This might include walking, cycling, getting a ride from a friend or family member, or, if it is reliable and available when they need to travel, transit.

The map at right shows each Census Block Group in Missoula shaded by the average number of vehicles available to each resident.[5] (Children of any age are counted as residents in this analysis.) Vehicle availability is lowest near the core area of the city: Downtown, around the University, where there are student apartment buildings, and near the river.

Access to vehicles is extremely low in the nearly rural areas south of Mullan, west of Reserve. There are very few residents in this large area. The large tan area between Mullan and I-90 reflects a much larger number of residents, though they live in only small subparts of that large area.

We can see that in part of Orchard Homes access to vehicles is relatively low. However, this map does not give us any information about *how many people* live in this area. By referring back to maps of residential and poverty density, we can see that Orchard Homes is very low-density, so the *number* of people who have low access to vehicles there is also low.

In contrast, the area just south of 39th in the South Hills appears to have low access to vehicles. Referring back to density maps on previous pages, we can see that this area is also moderately dense with residents.

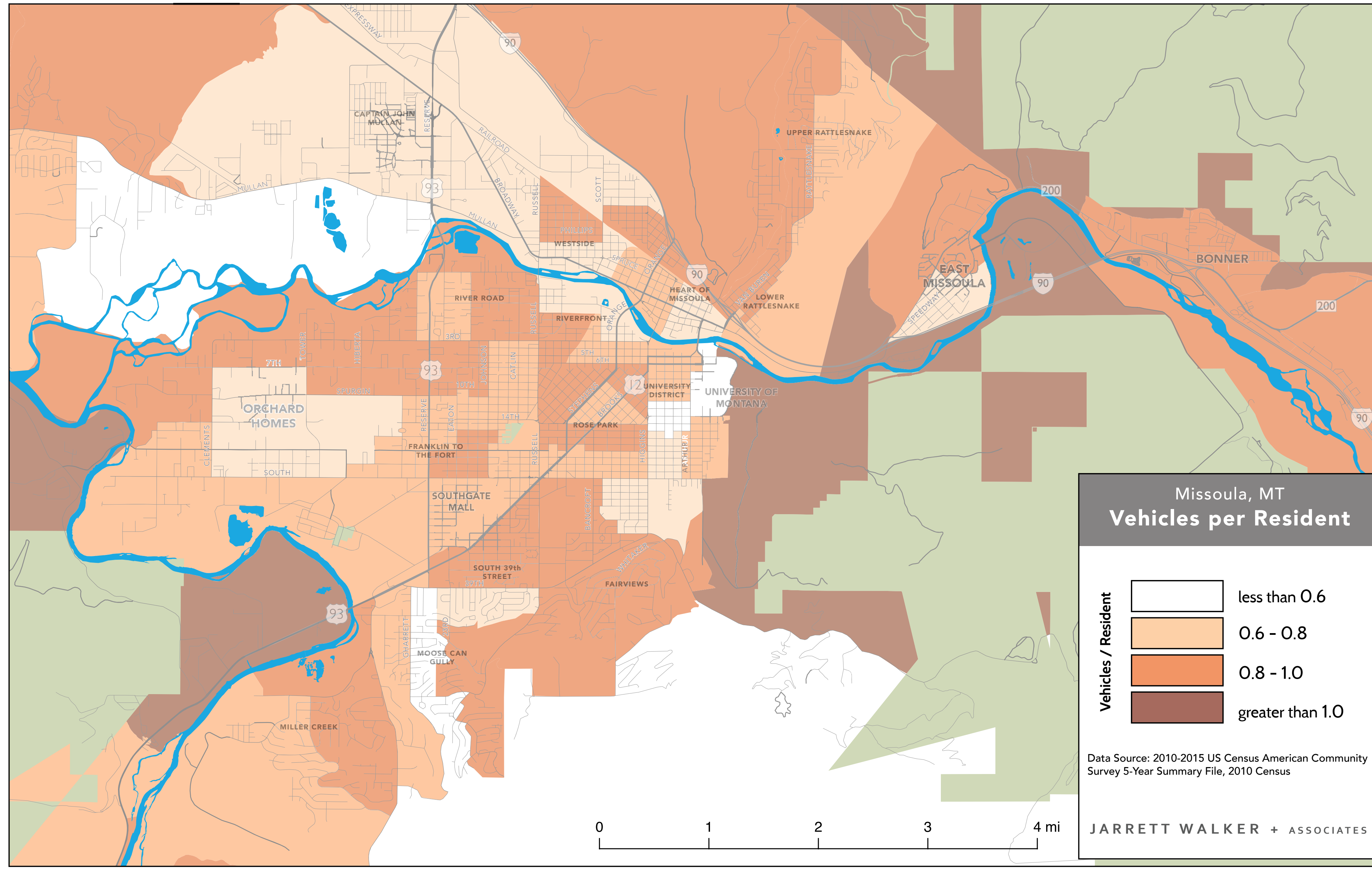


Figure 13: Map of Vehicles Available per Resident

5 Unlike population, employment and age data, data on income and vehicle ownership are not available at the finer Census Block level. Block Groups are enormous, and thus a fairly crude tool for understanding demographics and conditions at the walking-distance scale, which is the scale that matters for transit. These Block Groups present an aggregate level of vehicle availability that obscures differences within each Block Group.

Taxing District

In conversations about transit coverage, one value that often arises is that people who pay taxes for transit should feel that they are getting some transit in return. This can also be described as a "return to source" philosophy.

The type of tax in question can sometimes have an effect on transit coverage, if people have an expectation that the transit service will "return to source:"

- When transit is paid for by a sales tax, there may be an expectation that transit cover major retail areas or even big-ticket retailers like auto sales lots.
- When transit is paid for by a payroll tax, there may be an expectation among large employers that they will have transit service nearby.
- When transit is paid for by property taxes, there may be an expectation that all taxable properties in the district will be near some transit service.

A strict "return to source" approach to allocating transit in the Missoula area would have Mountain Line spreading routes very thinly to get close all of the taxpaying parcels. (The tax district parcels are shown in yellow in the map at right.) This would result in very low-frequency routes covering a vast area. Service would be circuitous and infrequent. In most places there would be only small numbers of people near any bus stop, and in those places walking conditions are rough. As a result of all of these factors, ridership would be very low. But every tax-paying parcel would have a bus stop nearby.

Instead, Mountain Line has "Focused Inward," concentrating service into high frequency routes in urban, walkable areas, and achieving high ridership. This approach was strongly supported by the public and stakeholders during the last strategic planning process in 2012, even though it obviously does not bring transit routes close to all taxpayers.

There are many reasons that people are willing to support a transit tax on parcels that aren't in transit-supportive places. However, in debates about the value of transit coverage, stakeholders sometimes express a desire for transit to get close to those who pay for it. This "return to source" value is one of multiple reasons why transit agencies might provide wide geographic coverage, even if it means lower frequencies and lower ridership. For that reason, it has been included in this chapter along with other potential coverage needs.

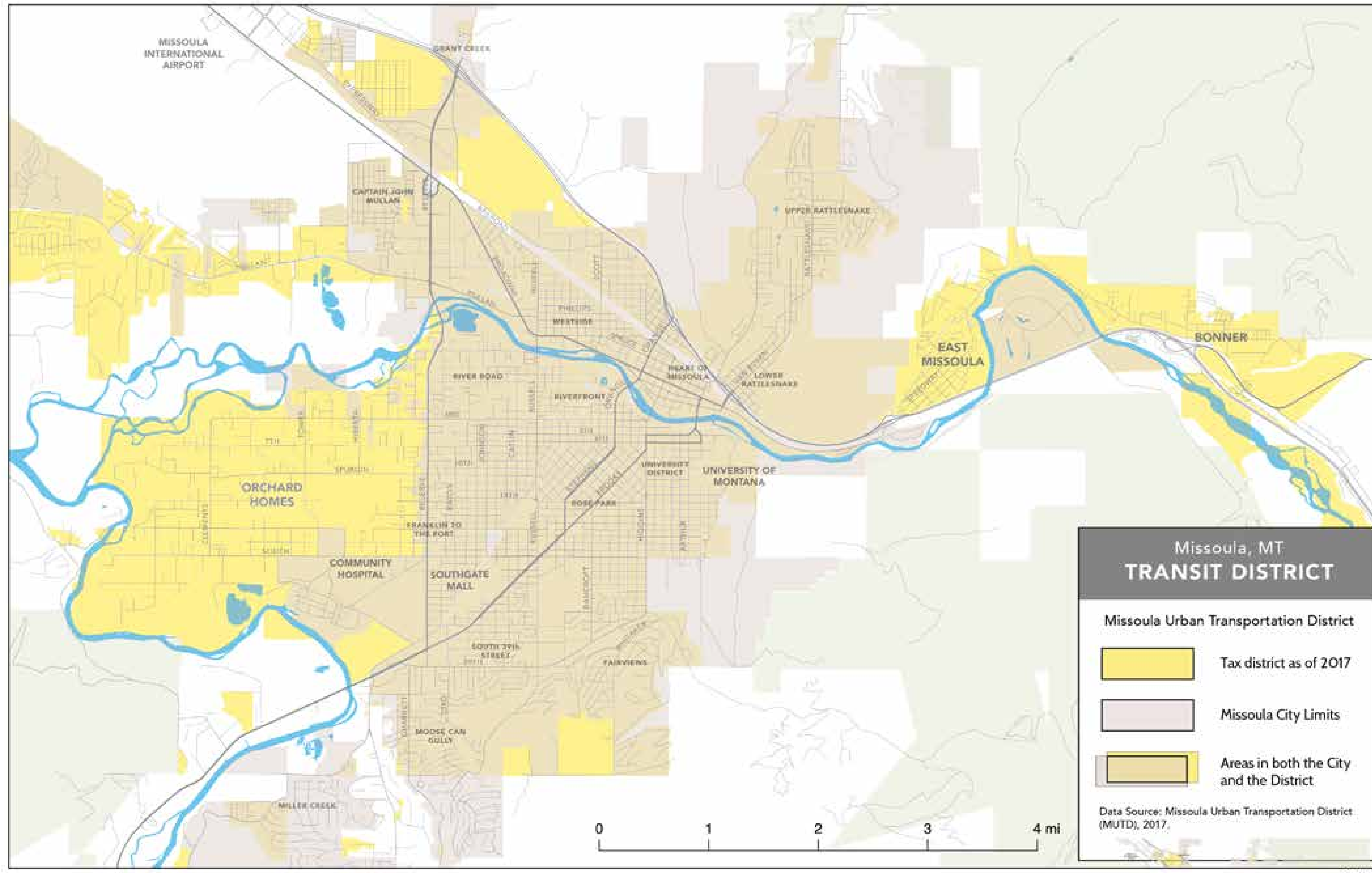


Figure 14: Map of Vehicles Available per Resident

4 Recent Trends

Service Levels, Ridership and Productivity

Ridership on Mountain Line has grown nearly every year, since 2005. Ridership increased a great deal between 2014 and 2016 (as shown in the graph below).

At the start of January 2015, Mountain Line buses went Zero Fare, thanks to a partnership of public agencies and community organizations in Missoula. This contributed to the big increase in total boardings in 2015 and 2016.

In addition, Mountain Line added more service in January 2015, which likely contributed to the increase in ridership.

Because so much of transit's operating cost relates to human labor, and humans are generally compensated based on their time, the bulk of transit operating cost arises from hours of service (rather than distance, or the size of vehicles, or other factors).

Thus "service hours" describes the sheer quantity of transit service provided, without consideration for how much it costs the agency to deliver each hour of service. The service hours required to operate any given route will increase if:

- The length of the route increases.
- The frequency of the route increases.
- The span (hours of operation) of the route increases.

Mountain Line made investments of the latter two types in January 2015: The frequencies of two routes were increased, and the span of evening service was lengthened on six routes. This increased the total annual service hours between 2014 and 2016, as shown in the graph in Figure 16.

Productivity is a transit industry term for what lay-people might call "efficiency." If ridership is an outcome people care about, then ridership relative to cost describes how "productive" an agency is towards that outcome. The productivity ratio is:

Productivity = Ridership / Cost = Boardings / Service hour

In 2005, an average of 17.5 people boarded a Mountain Line bus per service hour provided. In 2016, an average of 27.2 people boarded per hour. Thus while Mountain Line increased the denominator of the productivity ratio (by providing more service hours), ridership grew even faster, so productivity increased.

Productivity is strictly a measure of achievement towards a ridership goal. Networks that are designed for wide geographic coverage will naturally achieve lower productivity, reflective of their non-ridership goals.

Decreasing transit fares is known to increase ridership, even when service levels are held constant. We can intuit that reducing fares to zero would have a particularly big impact on ridership because it reduces two kinds of costs for potential riders: the dollar cost of the fare itself, and the hassle of getting information about the fare and then finding a way to pay the fare. (It also speeds up bus service, which allows the transit provider to run more efficiently.) Meanwhile, increasing the total supply of service, and specifically increasing frequencies and spans on existing routes, are also known to increase ridership. There is no question that making these changes in 2015 led to the growth in ridership and productivity shown in the graphs on this page.[6]

6 "Transit supply causes the highest impact on transit travel demand...the greater the supply, the greater the demand for transit... an inverse relationship exists between transit fare and transit demand [and between] average headway and transit demand. Gas price is the sole external factor that emerged as a significant explanatory variable of transit travel demand by bus." Bhuiyan, A., et. al. 2015 *Investigating the Determining Factors for Transit Travel Demand by Bus Mode in US Metropolitan Statistical Areas.* Report 12-30 of the Mineta Transportation Institute.

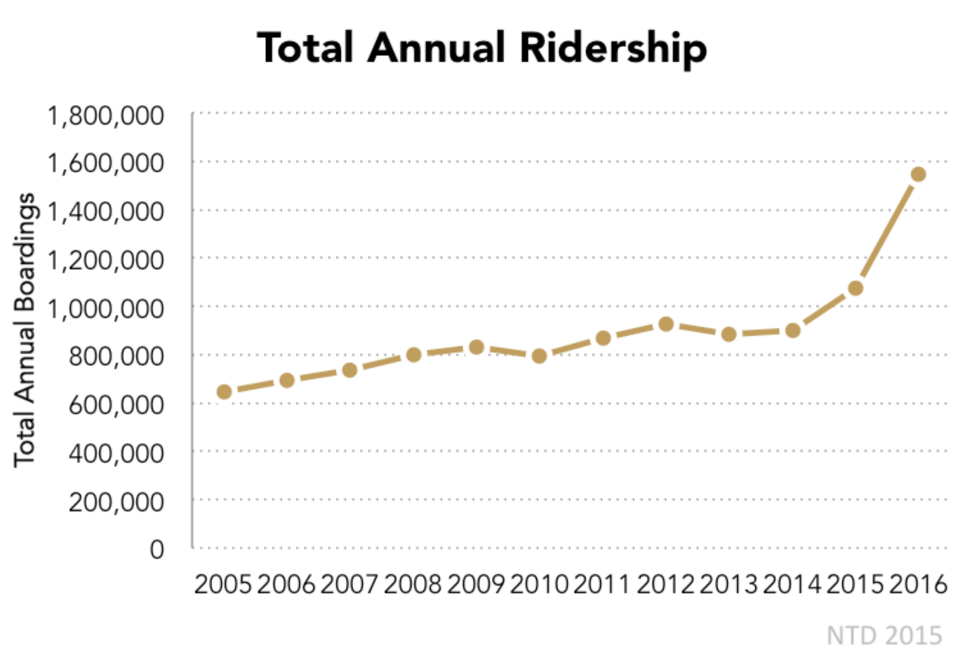


Figure 15: Graph of Total Annual Ridership 2005-2016

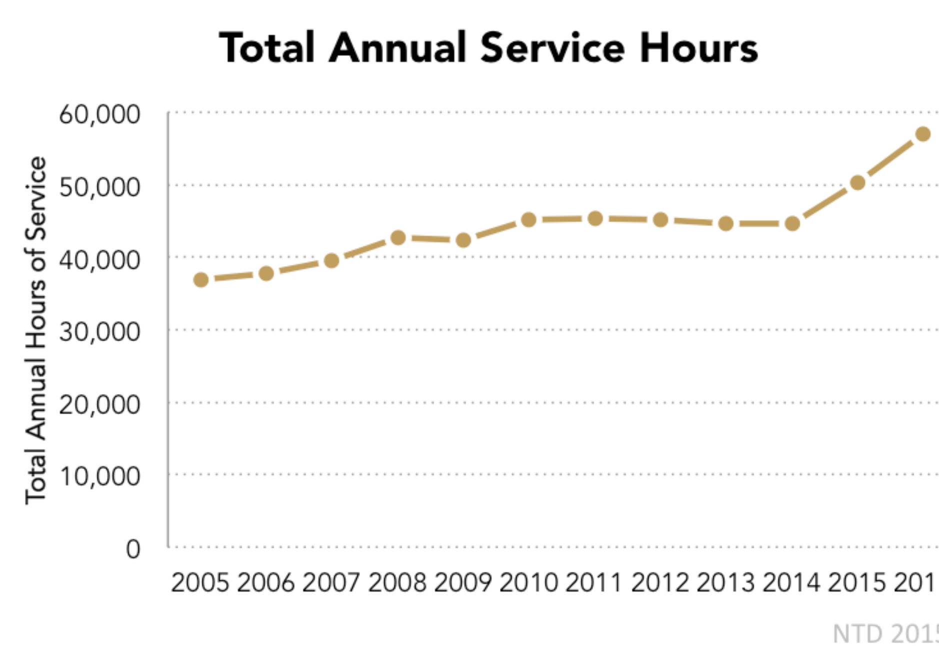


Figure 16: Graph of Total Annual Service Hours 2005-2016

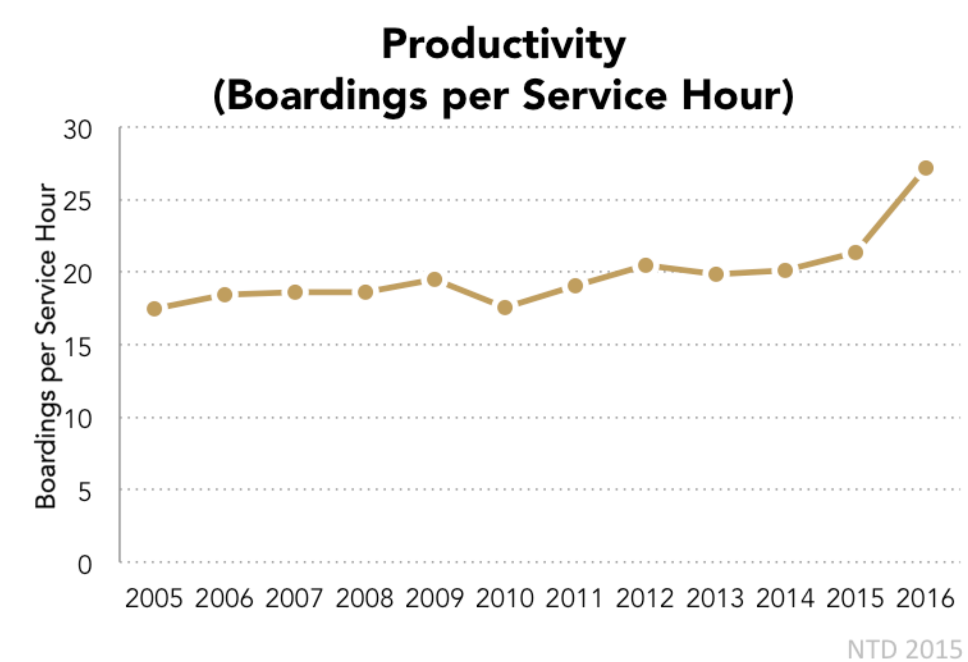


Figure 17: Graph of Annual Average Productivity 2005-2016

The graph in Figure 18 summarizes the data shown on the previous page. Ridership, service hours and productivity for each year are shown relative to 2005.

Since 2005, total annual ridership has increased by 140%, while the supply of service has increased by only 54%. Thus productivity (ridership relative to cost) has also increased, by 55%.

The graph in Figure 19 shows total Mountain Line ridership levels, by month, from July 2007 through February 2017. A large jump in ridership can be seen in January 2015, when Zero Fare was begun (and service levels were increased).

While Mountain Line ridership and productivity were increasing in 2015 and 2016, the same measures among other small and mid-sized U.S. cities declined slightly, due to cheap gas, cheap debt and high employment.

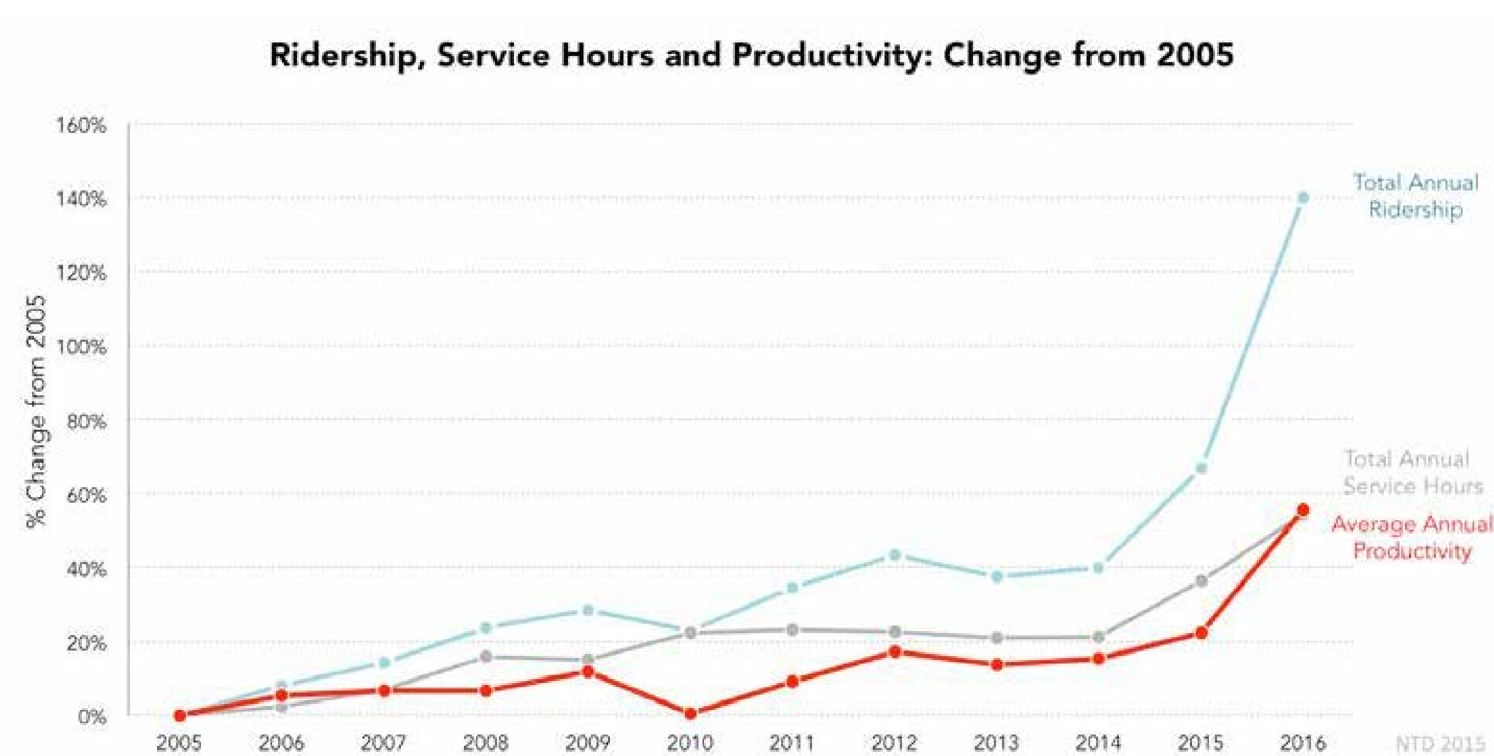


Figure 18: Graph of Change in Ridership, Service Hours and Productivity by Year, 2005-2015

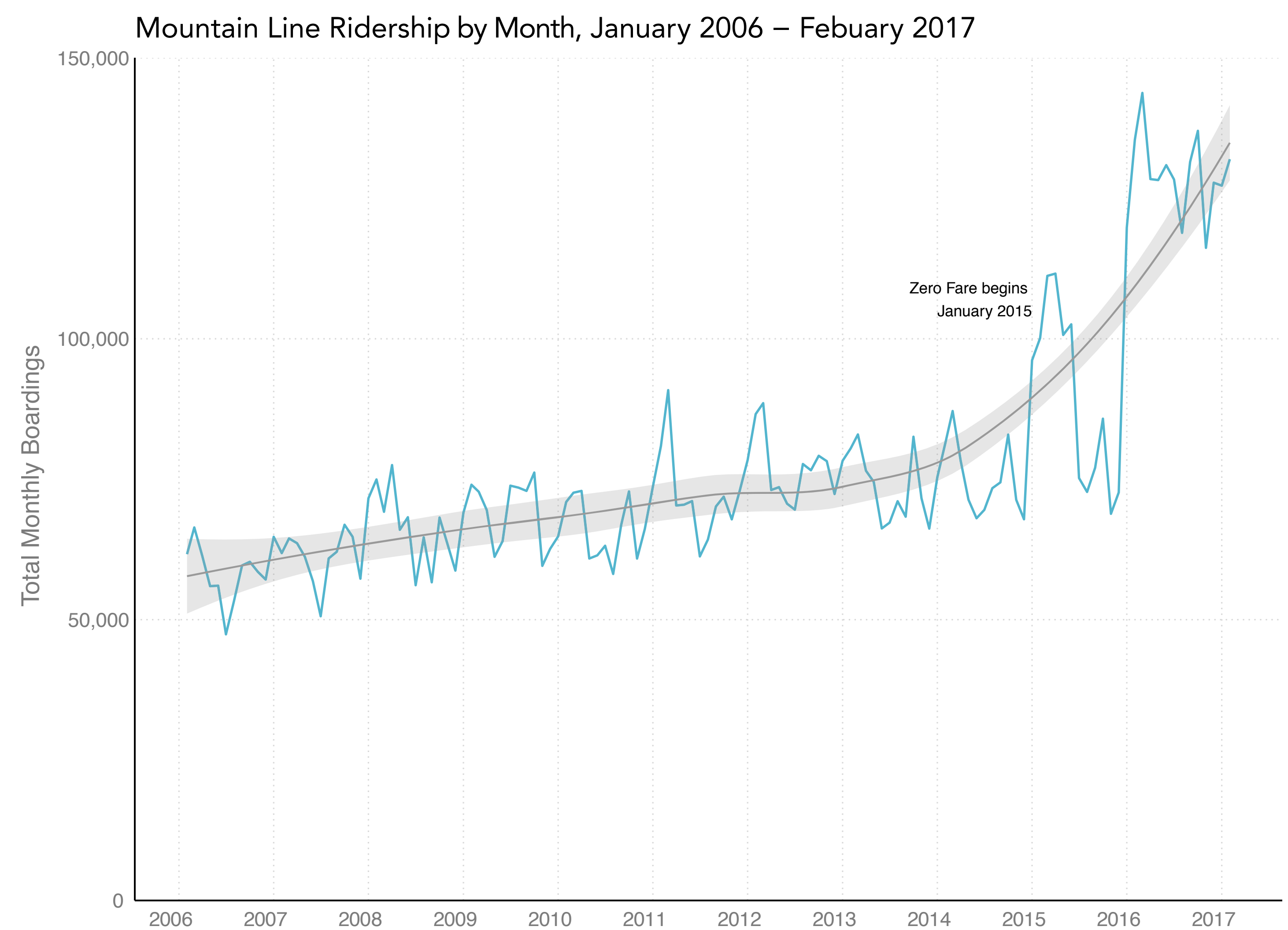


Figure 19: Graph of Change in Ridership by Month, 2007-2017

5 Transit Service Analysis

Peer Comparison

The performance of Mountain Line's individual routes can be evaluated in comparison to one another, since they represent a wide range of service design choices and performance results.

For performance of the entire network, and as an aide in thinking about Missoula's particular transit choices, it helps to compare Mountain Line to peers. Obviously no place precisely replicates Missoula's economic, demographic and geographic conditions, so a group of peers provides a range rather than a prescriptive target.

The peers shown in the charts below are all small U.S. cities with historic downtowns and large public universities.

Investment, relevance and productivity

The pair of charts at right show how much a region invested in transit service (Figure 20) and how relevant transit was to the life of the community (Figure 21) in fiscal year 2015. (2015 is the most recent fiscal year for which national data is available.)

Missoula's level of investment in service, relative to its population, is second-lowest among these peers. The ridership its network attracts, relative to population, is lowest among these peers.

The fare arrangements made between universities and transit systems can have a big impact on how the public transit systems appear to perform in the measures at right. Whether and how a university provides its own, separate shuttle service can also have a big impact on these measures. For example:

- In Bloomington, university students pay for transit through a mandatory annual fee, so each bus ride is free.
- In Flagstaff, students get free rides on the public transit route that connects the university to student housing and downtown, though not on the rest of the public network.
- The student shuttle system at the university in Corvallis is more geographically limited than the shuttles in other cities, such as the U-Dash in Missoula.
- Missoula and Corvallis are the two cities among these peers that have gone fare-free for all riders (not just for university students and staff).

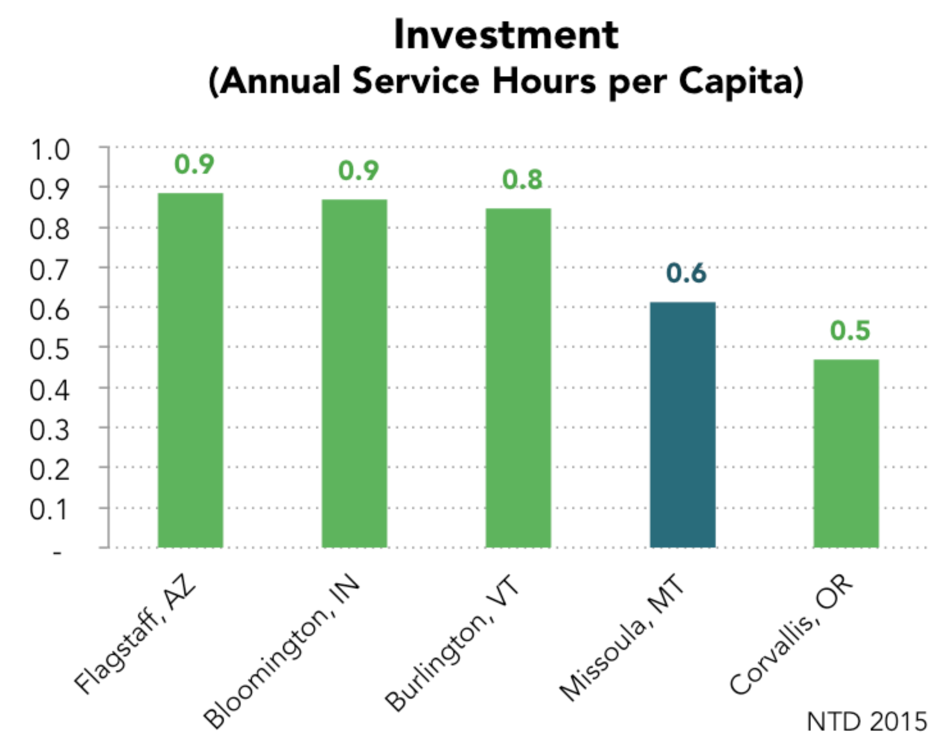


Figure 20: Graph of Investment per Capita Among Peer Cities

This data includes only 1/2 year of Missoula's Zero Fare program, which substantially increased ridership (and productivity). The number of boardings per capita and per service hour in Fiscal Year 2016 were higher because of the Zero Fare program.

The productivity of these peer systems (the ridership they achieve relative to cost) is compared on page 35. As of fiscal year 2015, Mountain Line was slightly less productive than these four peers. However, increases in Mountain Line ridership (and decreases in ridership on other systems) in 2016 may have changed the relative productivities of these peers.

Cost per unit of service

The graph in Figure 22 shows how much it cost each peer agency, in 2015, to operate each hour of service.

Missoula has the second-lowest operating cost per service hour. This suggests that Mountain Line has been doing a good job of keeping its operating costs low, even while increasing the amount of service it provides to the city.

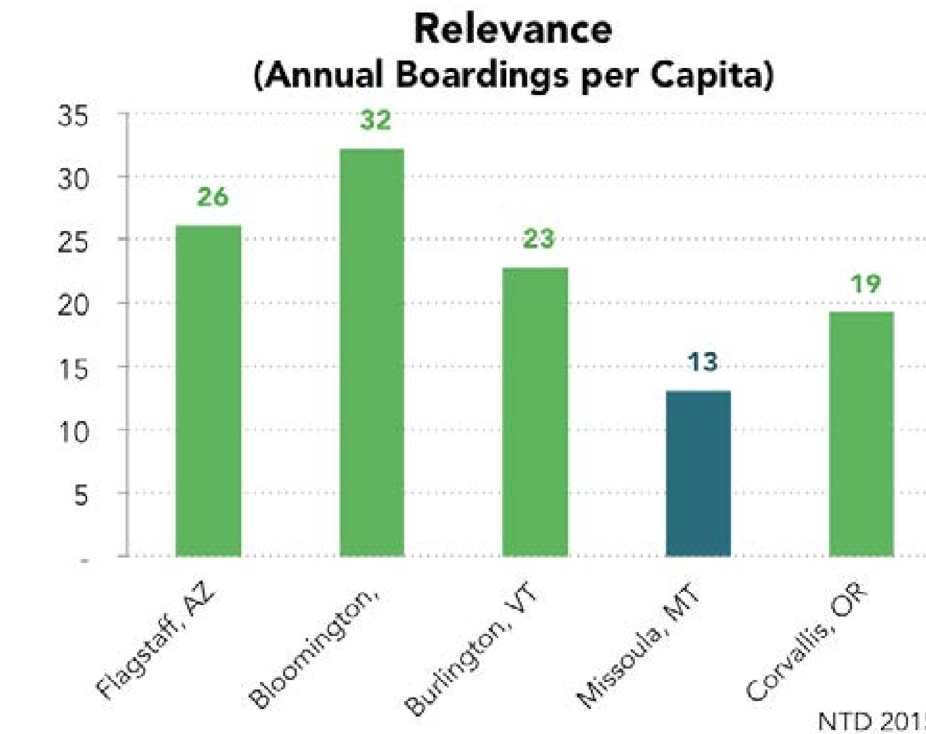


Figure 21: Graph of Boardings per Capita Among Peer Cities

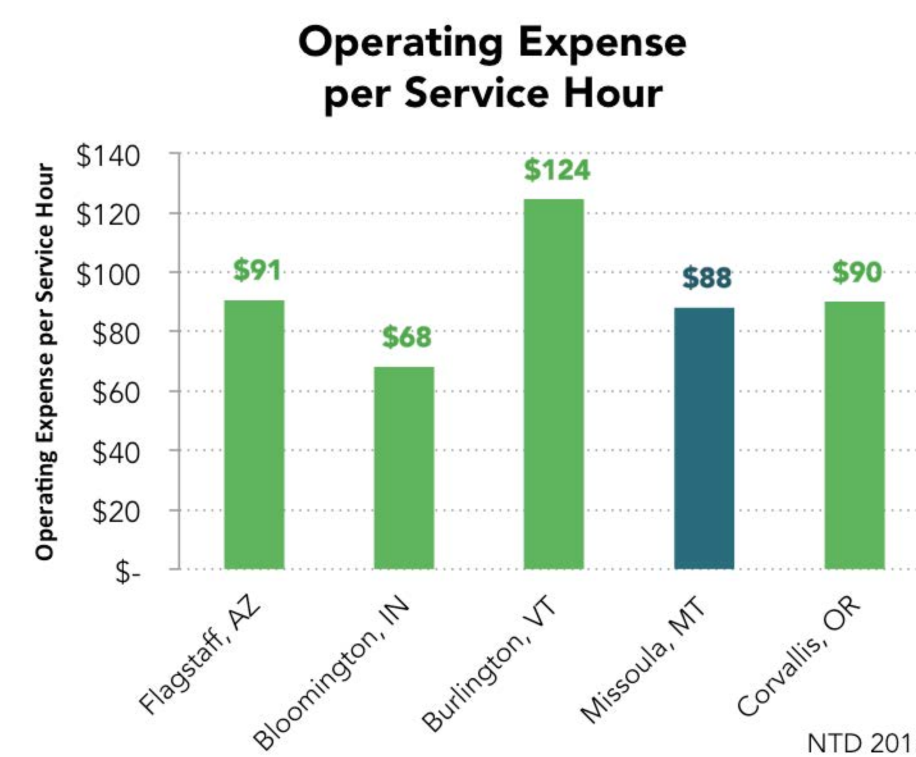


Figure 22: Graph of Operating Expense per Hour Among Peer Cities

Frequency is Freedom

In transit conversations there is always a great focus on *where* transit is provided, but unfortunately little concern about *when* it is provided. The "when" of transit service is described as frequency (how many minutes between each bus) and span (how many hours a day, and days a week, it runs).

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

Even though Google Maps or an app on a phone can be consulted for directions, frequent transit service is effective at attracting ridership because it has the simplicity of a road: you can use it anytime you need to. Frequent service allows someone to maintain a map of the transit system that is much like a road map, in that no schedule is needed to know how to go places whenever you want to.

Mountain Line currently offers two routes that meet this "no schedule needed" threshold. Routes 1 and 2 come every 15 minutes on weekdays (but only once an hour on Saturdays). These two routes are shown in red in the map on the next page.

Frequent service:

- Reduces waiting time (and thus overall travel time).
- Improves reliability for the customer, because if something happens to your bus, another one is always coming soon.
- Makes transit service more legible, by reducing the need to consult a schedule.

Many people assume that today, with real-time transit arrival information and smartphones, nobody needs to wait for a bus anymore, and frequency therefore doesn't matter. If a bus only comes once an hour, that's fine, because your phone will tell you when it is a few minutes away and you should start walking.

Despite all these new technologies, frequency still matters enormously, because:

- 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 much before your departure, but if your bus is infrequent, you have to choose between being very early or too late.

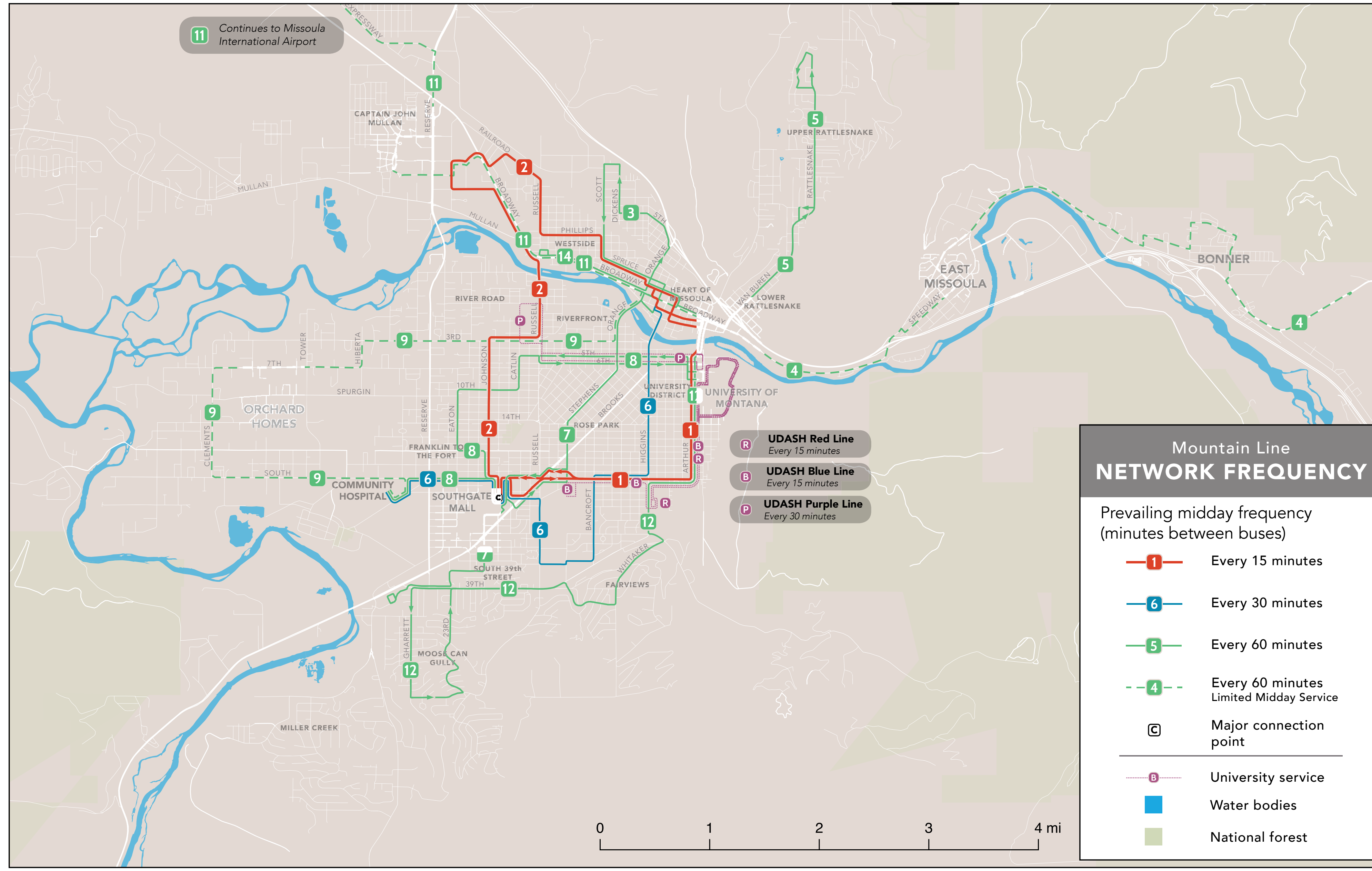


Figure 23: Map of the Mountain Line Transit Network

- Many of the places we go don't let us hang out until our bus's arrival is imminent. We can easily do this when leaving home, but it is more awkward when leaving a restaurant or a workplace that is closing.
- Real-time arrival information doesn't make the bus more reliable, but frequency does. Your smartphone can tell you when your bus is arriving, but it cannot prevent your bus from having a problem and being severely delayed, or not showing up at all. Only frequency – which means that another bus is always coming soon – can offer this kind of reliability.

Routes 1 and 2 are Mountain Line's most frequent, and longest-span routes (running latest every evening). They are also among the most productive in the network, attracting not just high ridership, but high ridership *relative to their cost.*

The free and student-operated U-Dash system comprises three routes. Two of them (the Red and Blue lines) run every 15 minutes during school days, while the Purple Line runs every 30 minutes. All three are open to the public. U-Dash also runs a late-night shuttle every 30 minutes, among downtown, campus and student housing.

Span

The other element of the "when" of transit service is span: the hours of operation of a route each day, and the days of operation each week and all year. If someone is considering using a low-frequency service, they may be disappointed to find that it requires a long wait. In considering a short-span service, someone may find that it simply isn't there at the time of day, or on the day of the week, when they need it.

Each Mountain Line route's frequencies and spans of service is summarized in the table below.

On weekdays, all Mountain Line routes make their last trip around 9:00 pm. This is similar to the weekday spans of service offered by peer agencies. (Note that the University downtown shuttle operates long after 9:40 pm.)

Mountain Line offers lower frequencies and shorter spans on Saturdays (and two routes don't run at all). There is no service on Sundays or on holidays. All of the peer cities described on earlier pages run Saturday service, and many of them run Sunday and holiday service as well.

The transportation profession has long been focused on the weekday peaks, because those are the times when our road capacity is most-used and congested. Yet people need to travel at all times of day and week, and if a transportation option is only available during the weekday peaks, they are unlikely to rely on it.

	Weekdays					Saturdays	
Route	Frequencies AM	Frequencies Midday	Frequencies PM	Frequencies Evening	Span (hours)	Frequency	Span (hours)
1	15	15	15	60	15.0	60	8.5
2	15	15	15	60	15.0	60	8.5
3	45	60	30	30	12.5	60	6.8
4	60		60	60	12.3	60	7.5
5	60	60	60		11.5	60	8.0
6	30	30	30	60	15.0	60	8.4
7	30	60	30	60	15.0	60	8.5
8	30	60	60	60	11.5	60	8.5
9	60		60		5.5		
11	60		60	120	14.7		
12	30	60	30	60	12.8	60	7.5
14	60	60	60	60	11.3	60	7.8

Figure 24: Table of Mountain Line Routes' Frequencies and Spans

Service workers tend to work from very early in the morning to midday, or from midday to late at night, and the service industry peaks on weekends. People who hold two jobs may need to commute to both of them on a single day, leaving home early and returning late. And of course anyone taking an evening class, pursuing a hobby, going to worship, or staying late at work to finish a report needs a bus ride home outside of the traditional 8-to-5 workday.

As of the 2010 Census, 29% of U.S. workers did not work a traditional weekday, daytime schedule. Add to this population the large proportion of people who are employed part-time, are studying, are retired, or are not working, and we can imagine the proportion of Missoula residents whose essential travel needs go far beyond the morning and evening weekday peaks.

Ridership

We analyzed ridership data for every service day in November, 2016. In that month, on an average weekday, about 5,700 people boarded a Mountain Line bus. However, this ridership was not evenly distributed: nearly half of those boardings occur on Routes 1 and 2.

The average ridership in each hour of the day, totalled for all routes, is shown in the graph in Figure 25.

Not all routes are running at all times of day, and people can't ride buses that aren't there. Thus the shape of demand shown in Figure 25 is as much a response to the service that is offered as it is an expression of underlying travel demand.

Weekdays

On weekdays, ridership was high starting with the 7:00 am hour and continuing through the midday. A large peak began in the 2:00 pm hour and drops off by 6:00 pm.

The AM rush hour shows barely more ridership than the midday, even though frequencies are higher during the AM rush hour than during the midday on four Mountain Line routes.

In the early afternoon, when schools let out, there is a very large peak soon after 3:00 pm. Mountain Line's existing transit schedules are designed for this afternoon school peak. Routes 3, 5, 7 and 12 have at least a short period of 30-minute frequency beginning after 3:00 pm.[7]

This is a very common shape for daily transit demand. We have observed this pattern (relatively low AM ridership compared to service levels; high midday ridership; and very high early-afternoon ridership) in numerous small cities with large Universities. No single hour of the day apart from 3:00 - 4:00 pm exhibits ridership more than 16% greater than the daytime average.

These shapes suggest that the traditional rush-hour commute is less dominant on the system than:

- University-related commutes, which begin shortly before a student's first class of the day, whenever that is each academic quarter.
- People riding to service jobs, some of them probably only one-way, since their shift likely begins or ends when Mountain Line isn't running.
- People running errands in the midday.
- Kids taking transit home from school. They may have gotten a ride with family in the morning, but they get themselves home in the afternoon when family members are at work.

Ridership clearly drops off in the evening, and is very low after 7:00 pm. Yet this is also when service supply drops off severely. The frequency of Routes 1 and 2 goes from every 15 minutes to *every 60 minutes* starting around 6:00 pm. Route 6, the next most frequent route in the system, also goes to hourly service around 6:00 pm. The last buses are off the road by 9:45 pm, though the last buses at most bus stops go by much earlier than that.

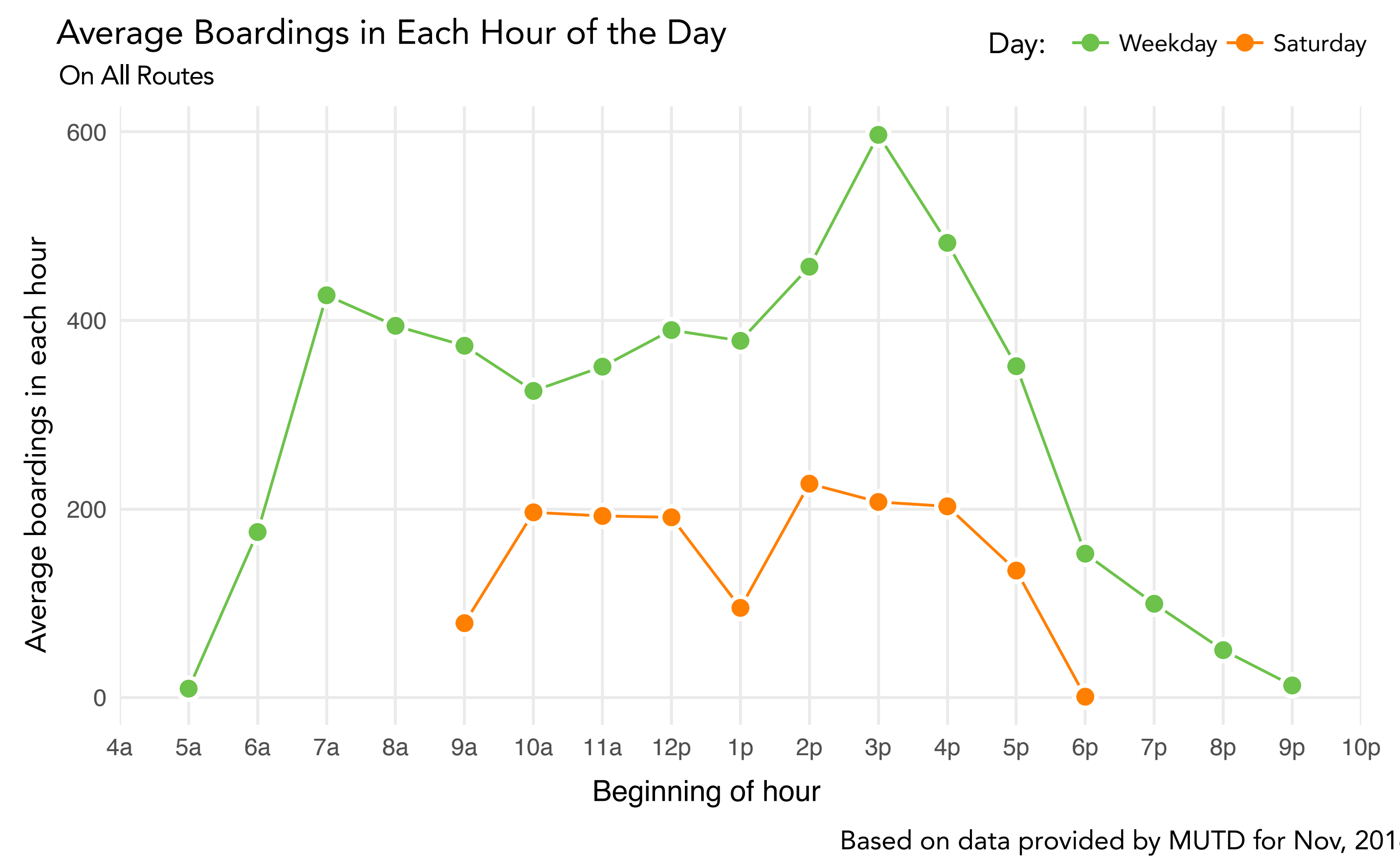


Figure 25: Graph of Total Ridership By Hour, for Weekdays and Saturdays

Buses running late at night, and very early in the morning, will always be much emptier than those running during the day. Yet the presence of those late buses is, in many transit systems, supporting higher productivity during the day.

This sometimes becomes clear when an agency cuts the last bus trip of the day, because few people ride it. Measured alone, the last trip of the day was the least productive, so it was cut. Very soon, however, the bus trip that is *now* the last of the day (and was the second-to-last, before) becomes equally unproductive.

No responsible person will plan their daily schedule, or their life, around the last bus of the day. The last bus is a sort of insurance policy, there if people need it, and it always looks unproductive when it is evaluated on its own.

Late night trips tend to support afternoon ridership, because people who work or study in the second half of the day head out in the afternoon and come back home at night. If the bus isn't there for them to return home at night, then they have a powerful incentive to get a car or find some other way to make their round-trip commute. For this reason, it is common for transit agencies to find that, when nighttime service is cut, afternoon ridership drops.

It is rarely a good idea to measure the productivity of a route or a network by time of day, with an eye towards cutting trips and thereby increasing productivity. The ridership on a route is almost always arising from the *day-long and week-long* level of service.

This is an area in which MUTD planning in collaboration with the University of Montana is key. The Associated Students of the University of Montana (ASUM) is already running a night shuttle, from 7:30 pm until midnight on weekdays, and 2:30 am on Fridays and Saturdays, along a route that is very similar to Route 1. It may not be strategic for Mountain

7 While transit schedules are written in response to ridership, ridership also responds to schedules. If more frequency is offered during the AM peak, then ridership during the AM peak is probably a little higher than it otherwise would be. If more frequency is offered in the afternoon when schools let out, then more students probably ride the bus in the afternoon than otherwise would. Thus we should read existing ridership patterns as arising partly in response to the service provided.

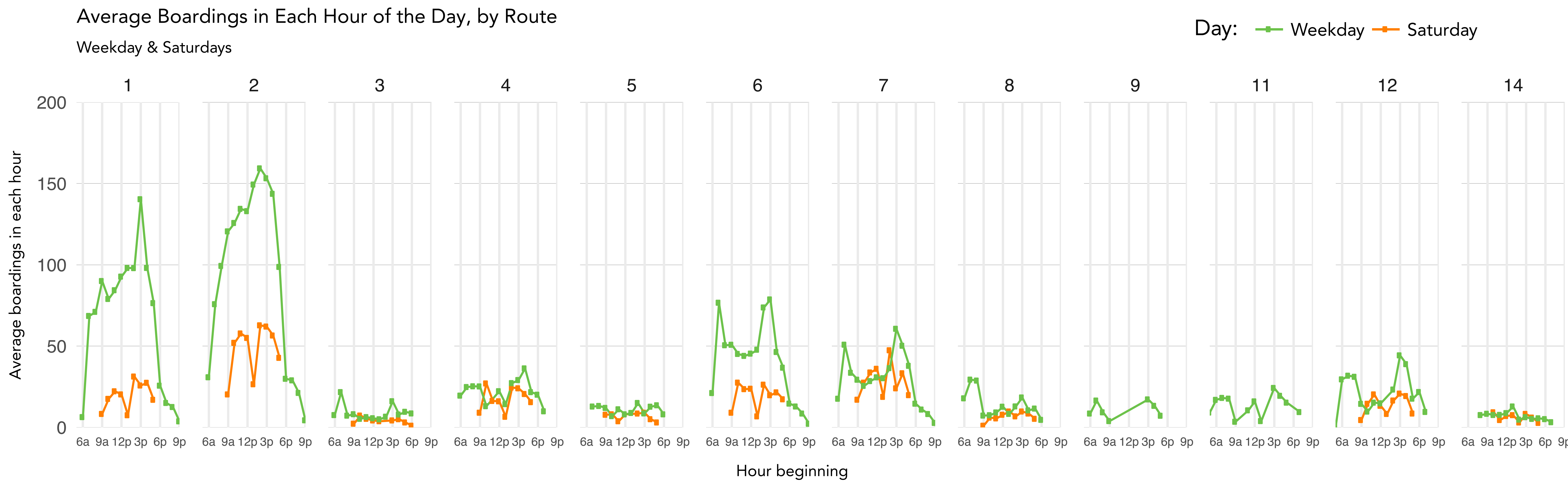


Figure 26: Graph of Ridership by Route, Hour and Day

Line to try and lengthen its span of service on Route 1, if doing so would only compete with (or duplicate) the service investment made by ASUM.

On the other hand, if the U-Dash night shuttle isn't thoroughly integrated into the Mountain Line network (in terms of public information, marketing, scheduling, fares and bus stops) then many people might not think to use the services as a single network, throughout the day.

Saturdays

Total ridership on Saturdays is lower than on weekdays (as shown in the graph in Figure 25, on the previous page). However, *ridership relative to service levels* is actually slightly higher on Saturdays than on weekdays! In November 2016, Mountain Line attracted an average of 27 boardings per service hour on weekdays. On Saturdays, the system got 28 boardings per service hour.[8]

On Saturdays, Mountain Line routes come once per hour, for 7-8 hours of the day. (Routes 9 and 11 don't operate at all on Saturdays.) This is enough time for someone to run errands on Saturday, but clearly not enough time for someone to commute to a service job. Of course, anyone in a service job is likely to work Sunday as well, and so is probably not relying on transit for their regular commute.

Many routes have similar Saturday and weekday productivities. Route 7 was somewhat more productive on Saturdays than weekdays. Route 2 was vastly more productive, doing 53 boardings per hour on Saturdays compared to 31 boardings per hour on weekdays. Given how many retail and recreation destinations Routes 2 serves, its high performance on Saturdays (compared to other routes) is not surprising.

The midday dip in the Saturday ridership line on the previous page (and on this page) is caused by a gap in service around 1:00 pm. Instead of one hour between buses, there are 1.5 hours between buses at that time, on every route.

Ridership by Route, by Hour

The graph in Figure 26 shows ridership by hour of the day, for weekdays and Saturdays, for each Mountain Line route separately.

The high ridership on Routes 1 and 2 is immediately apparent, on both weekdays and weekends. Their daily demand curve is also distinctive: rather than an AM and PM peak, we see a slow build in ridership throughout the morning, with a peak at or before 3:00 pm.

Other routes (6, 7, 12) show distinct AM and PM peaks in ridership. (Other routes may have similar patterns, but their ridership is so low that the data sample size from November is too small to make any conclusions about a daily pattern.)

In this chart, we can see that ridership on weekdays and Saturdays is very

8 These numbers are higher than the Fiscal Year 2015 average annual productivity of the entire Mountain Line network, as reported on page 35. This is partly because these numbers come from November 2016, when the University is in session. At other times of year, ridership and productivity will be much lower. Saturday ridership may also be lower, relative to weekdays, when there are fewer University students in the city. In addition, Fiscal Year 2015 average annual productivity included only six months of Zero Fare-caused ridership, whereas ridership in November 2016 was responding to Zero Fare.

different for Routes 1 and 2; somewhat different for Route 6; and fairly similar on all other routes. This demonstrates how responsive ridership is to frequency:

- On Routes 1, 2 and 6, Saturday frequency is hourly, compared to every 15 or 30 minutes on weekdays. Ridership is much lower on Saturdays.
- In contrast, on all other routes, weekday and Saturday frequencies are similar. Ridership across the two day types is much more similar.
- Thus we can clearly see the effect of frequency on ridership and productivity.

Ridership by stop

The map at right shows the average daily total boardings at each bus stop in the network on weekdays in November 2016.[9]

A small dot on a very low-frequency route may simply be a reflection of the low level of service. A small dot on a frequent route, on the other hand, suggests other problems. Conversely, a large dot on an infrequent route means that ridership is high *despite a low level of service,* which suggests that underlying transit demand may be high.

From this map, we can observe that:

- The high-demand destinations served by the frequent network account for most of the stops with 100+ average daily boardings: Downtown, the University, Southgate Mall and North Reserve.
- Nearly all segments of Routes 1 and 2 show large boardings dots.
  - The exception is the segment of Route 2 on Johnson, between Southgate Mall and 3rd Street. Boardings are only slightly higher on frequent Route 2, here, than they are on the nearby (infrequent) Route 8.
- High-demand destinations like the Walmart at the south end of Brooks Street, or the Community Medical Center, also show substantial ridership despite being served by lower-frequency routes.[10]
- Outside of the core area of Missoula (approximately bounded by I-90, Reserve, and the eastern edge of the city) no stops saw more than 25 average daily boardings.

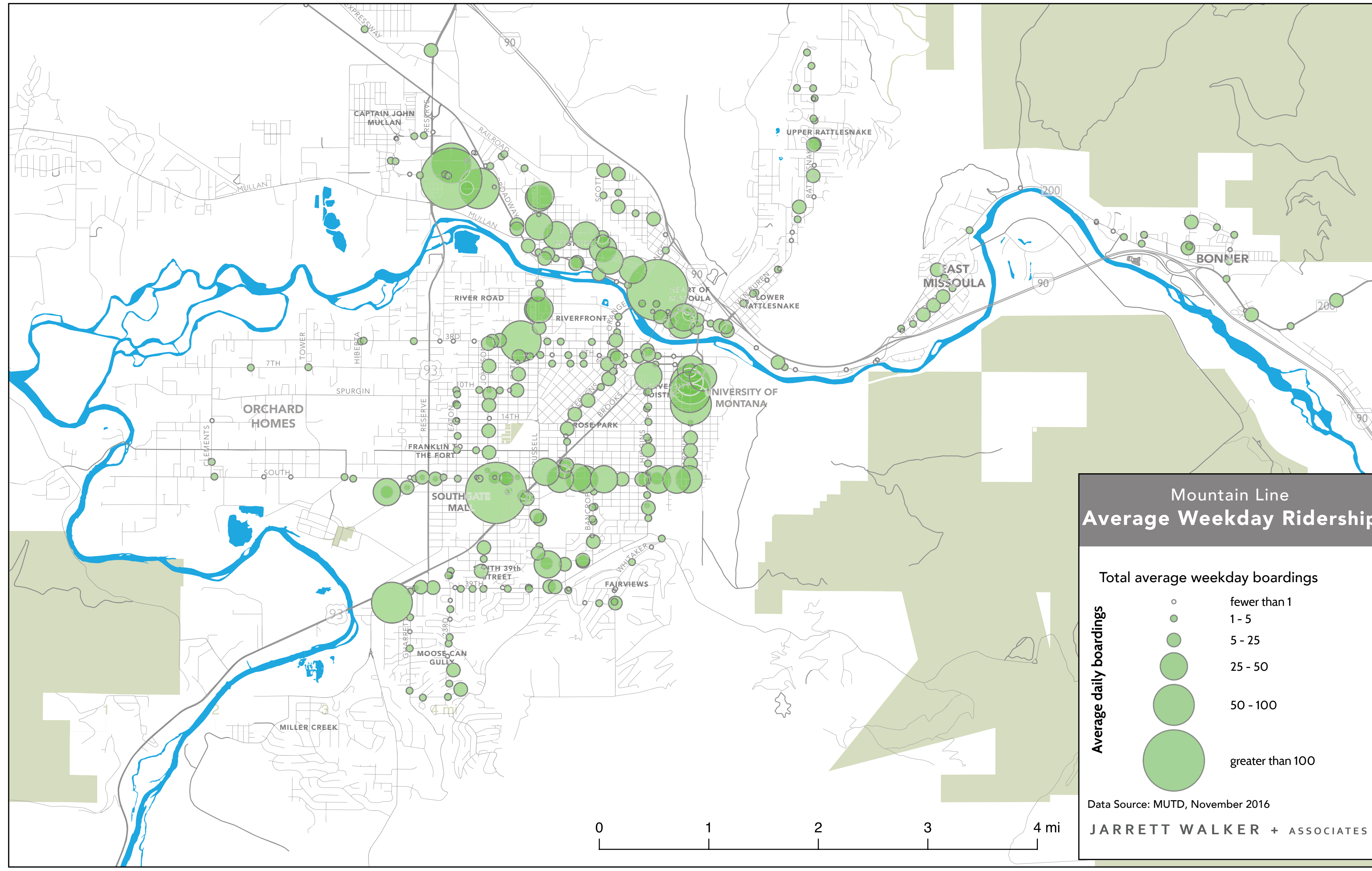


Figure 27: Map of Average Weekday Boardings by Stop

9 Stops where no boardings occurred in November 2016 are omitted.

10 In nearly any transit network, the Walmart always shows high ridership, though in many cities it is so far away that the cost to reach each Walmart rider is very high.

Productivity

Systemwide productivity

Some of the goals Mountain Line adopted in its last Long Range Plan (in 2012) arise from high ridership, such as:

- Providing efficient service
- Meeting regional sustainability goals
- Improving air quality
- Reducing vehicle miles travelled

Implicit in any goal to increase ridership, or to achieve other outcomes that depend on increased ridership, is a constraint: there is a limited amount of funding available in any year. Mountain Line cannot spend infinite amounts of money in pursuit of each additional rider to achieve efficiency and lower VMT.

Any goal that relates to higher ridership, then, actually arises from higher ridership *relative to cost.* If a transit agency wants to increase ridership within a fixed budget, it will examine where (or when) in its network ridership relative to cost is already high, and consider reallocating service to those routes or those times.[11]

Because no transit agency has a limitless budget, someone who cares about maximizing ridership would not be satisfied simply by a large dot on the boardings map on the previous page until they knew what it cost the transit agency to achieve that large dot.

In this report, productivity is measured as boardings per service hour.[12]

Productivity = Ridership / Cost = Boardings / Service hour

Productivity is strictly a measure of achievement towards a ridership goal. Services that are designed for coverage goals will likely have low productivity. This does not mean that these services are failing or that the transit agency should cut them. It just means that the budget dedicated to those services is not being spent to maximize ridership.

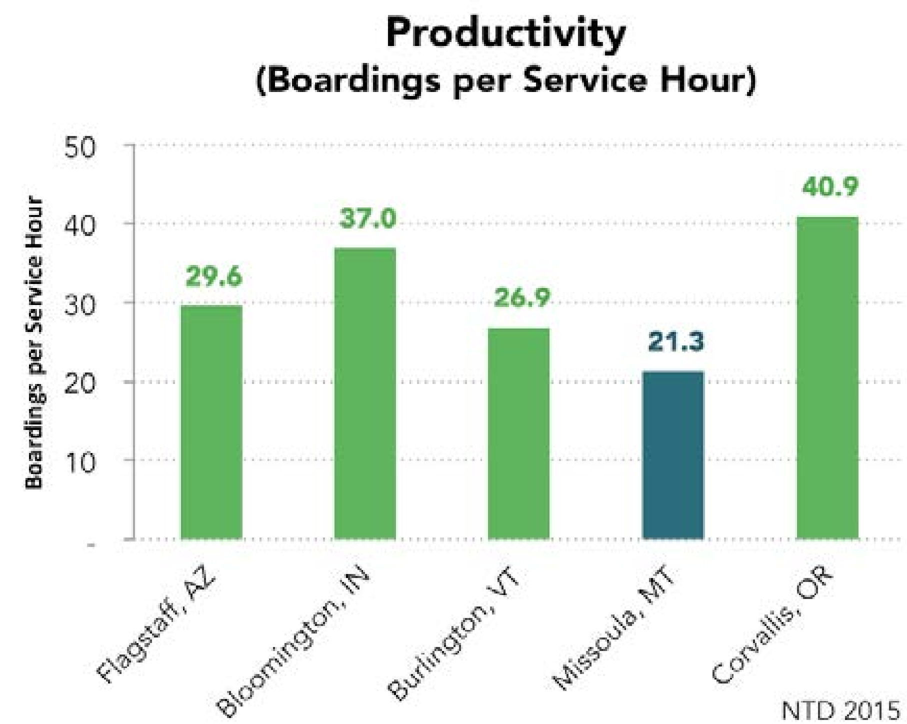


Figure 28: Graph of Fixed-Route Productivities of Peer Cities

The graph above shows that in fiscal year 2015 the Mountain Line fixed route network was less productive than all of the peer agencies we selected for this study. For each hour of service Mountain Line supplied, an average of 21.3 people boarded the bus.

Note that Mountain Line instituted the Zero Fare program halfway through fiscal year 2015, in January 2015. Some of the ridership and productivity gains that have resulted from Zero Fare accrued in fiscal year 2016, for which data will be released by the National Transit Database, our source for this analysis, in early 2018.

11 There are other ways to increase ridership within a fixed budget, one of which Mountain Line has already enacted: lowering fares. Agencies can also increase ridership by improving the design of their routes or the network as a whole, so that trips become faster and easier for a large number of people; by shifting service to days and times when it attracts more riders; or by working with partner agencies to create disincentives to driving.

12 The technical term is "revenue hour of service," which represents one hour of a bus and driver in operation, open to the public, accepting revenue. Revenue hours do not include the time drivers spend getting to the start of a route, which is known as deadhead. In this report we will use the more intuitive term "service hour" instead of "revenue hour."

One way to visualize the productivities of individual routes is to flip back and forth between the map showing the frequency of each Mountain Line route (on page 30) and the map of boardings at each stop (on page 34).

The scatterplot below presents an easier way to visualize productivity by route. As in the scatterplot on the previous page, each route is a dot, and it is plotted based on its midday frequency (on the horizontal axis) and its productivity (on the vertical axis).

In this scatterplot, Mountain Line routes are shown alone. Each dot is scaled based on the total amount of service provided to the route.

The most frequent routes (1 and 2) are also the most productive. This means not only that they are getting more ridership, but that they are getting more ridership *relative to their cost.*

The wide range of productivities of hourly routes is striking, from 30 boardings per hour on Route 14 to 9 boardings per hour on Route 8. This range suggests that, if Mountain Line wishes to increase the productivity of its network, increasing the frequency on some of their routes may help achieve that goal.

The weekday and Saturday productivities of all Mountain Line routes are reported in the table in Figure 30, below. A few routes get more boardings per hour on Saturdays than they do on weekdays, as shown by the ratios in the column at the far right, in particular Routes 2 and 7.

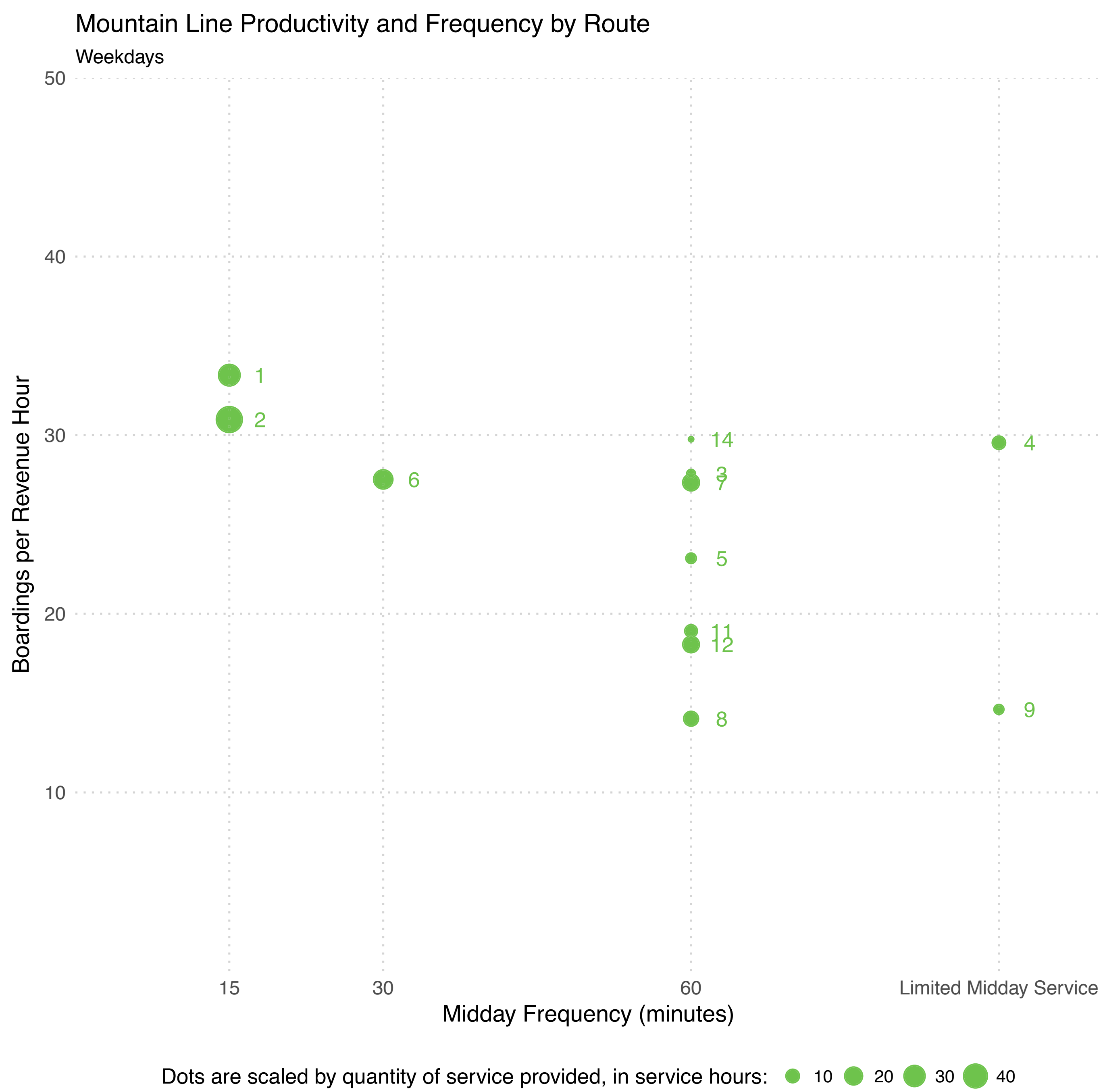


Figure 29: Scatterplot of Productivity of Mountain Line Routes

Route	Weekdays: Frequencies AM	Midday	PM	Evening	Span (hours)	Boardings	Service hours	Weekday Productivity	Saturdays: Frequency	Span (hours)	Saturday Productivity	Ratio of Saturday to weekday productivity
1	15	15	15	60	15.0	1,059	32	33.4	60	8.5	32.5	98%
2	15	15	15	60	15.0	1,508	49	30.9	60	8.5	52.9	171%
3	45	60	30	30	12.5	115	4	27.8	60	6.8	21.9	79%
4	60		60	60	12.3	288	10	29.6	60	7.5	24.2	82%
5	60	60	60		11.5	131	6	23.1	60	8.0	15.3	66%
6	30	30	30	60	15.0	655	24	27.5	60	8.4	25.8	94%
7	30	60	30	60	15.0	468	17	27.4	60	8.5	37.1	136%
8	30	60	60	60	11.5	178	13	14.1	60	8.5	8.5	60%
9	60		60		5.5	76	5	14.6				
11	60		60	120	14.7	164	9	19.0				
12	30	60	30	60	12.8	302	17	18.3	60	7.5	18.2	100%
14	60	60	60	60	11.3	83	3	29.8	60	7.8	29.9	101%

Data provided by MUTD for November 2016

Figure 30: Table Reporting Routes' Weekday and Weekend Productivities

One of the biggest components of operating cost is frequency. (It is not the only component – route length and span of service also matter.)

In examining transit systems in cities around the U.S., we have found a statistically significant correlation between transit route frequency and productivity (as have scores of academic researchers).

The scatterplot at right shows the individual routes from 24 U.S. transit networks, each plotted according to their midday frequency (on the horizontal axis) and their productivity (on the vertical axis).[13] Mountain Line routes are shown as black circles.

Among all of the dots in this chart, there is a clear curve detectable, up and to the left. More frequent services tend to have higher productivity (ridership per service hour), even though providing high frequency requires spending *more* service hours.

While a higher frequency increases the denominator of the productivity ratio, the higher ridership more than makes up for it.

This is how we know that high frequency contributes to high ridership, rather than simply representing a responsive transit agency that raises frequency where ridership is high. If higher frequencies were not causing higher ridership, then the dots on this chart would be a flat horizontal cloud, instead of a curve upward to the left. When a transit agency increased the frequency on a route, its ridership would increase proportionally, and *its productivity would remain unchanged.* Instead, higher frequencies are associated with *higher* productivities.

This happens because frequent service is the most useful and convenient service for riders; thus, transit agencies typically target this most expensive service towards their strongest markets. When frequent service is available to people in a suitably dense, walkable environment, high ridership is a common result.

Mountain Line's low-frequency routes show a very wide band of productivities, which is unusual. On some of these routes, service may be under supplied relative to demand. On others, interlining (in which multiple routes are served by a single bus) may be distorting the productivity measurement. These route-by-route observations follow in the next section.

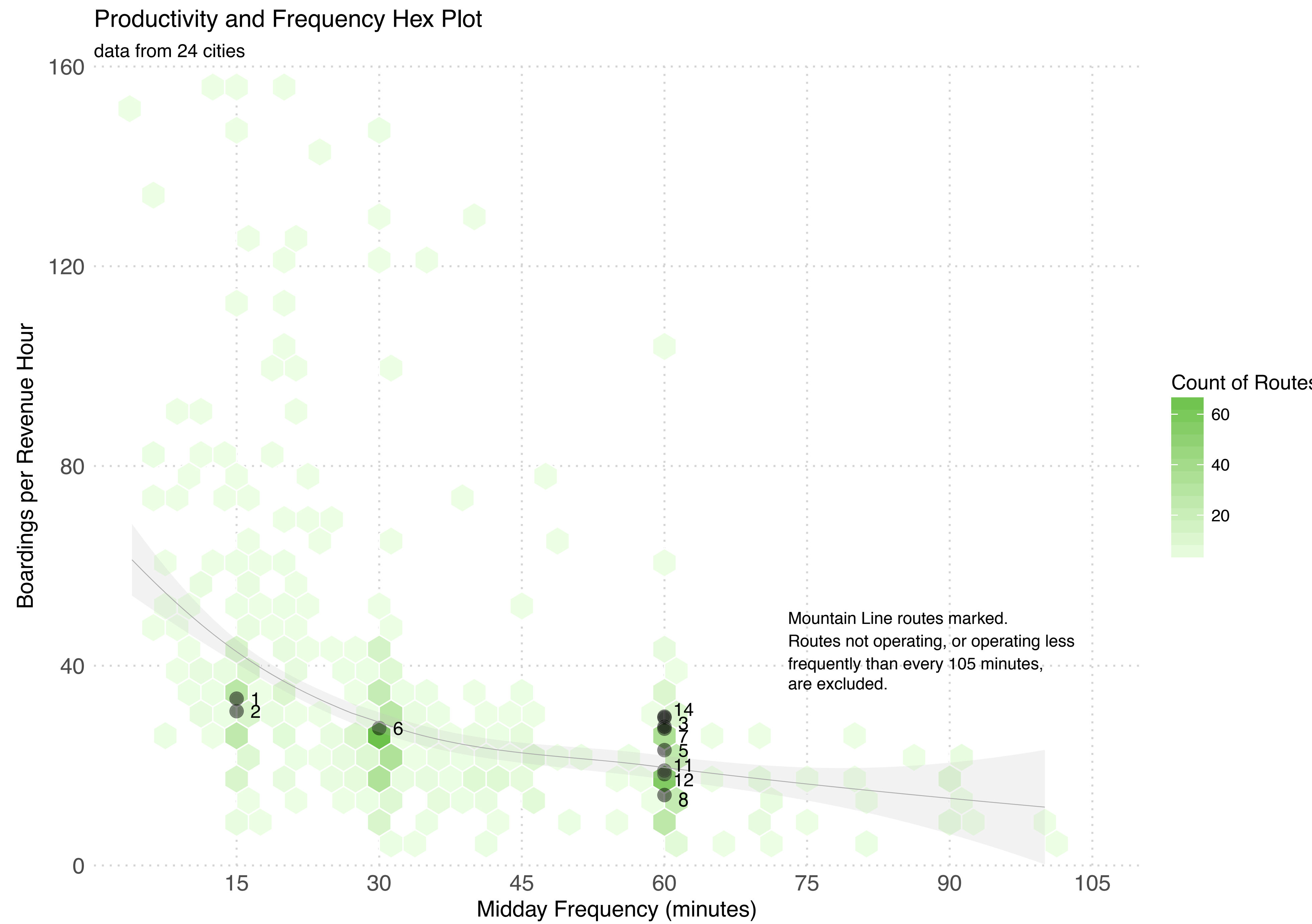


Figure 31: Scatterplot of Productivity of Routes from 24 U.S. Agencies

13 Where multiple routes occupy the same space, they are "binned" together into hexagons, which are then shaded based on how many routes they contain.

Route-by-Route Observations

Routes 3, 5, 11 and 14

There is a very important caveat to make about the productivities of Routes 3, 5, 11 and 14: these routes are thoroughly and intricately "interlined," meaning a bus and driver will do them in series, in a complex and varying pattern through the day. Without this interlining, they would not be nearly as productive, because buses would have to spend more time (and therefore cost) on each of them. Interlining is a way to operate short routes efficiently.

However, the way these routes are interlined is efficient but delicate. Intricately and thoroughly interlined routes can, in some systems, lead to cascading reliability problems (as a breakdown or major delay on one route leads to delays on multiple other routes through the day).

Such interlining also makes it hard to make changes to one route without changing one or more other routes simultaneously. Three interlined routes cannot, by definition, all be at a downtown pulse simultaneously, so transfers between them will sometimes involve long waits (and for such short routes as these, it may be faster to simply walk to one's final destination from the downtown transit center).

Thus the interlining of Routes 3, 5, 11 and 14, and the resulting efficiencies, may not withstand needed changes in the network without breaking apart and therefore reducing the productivity of each route in the interline.

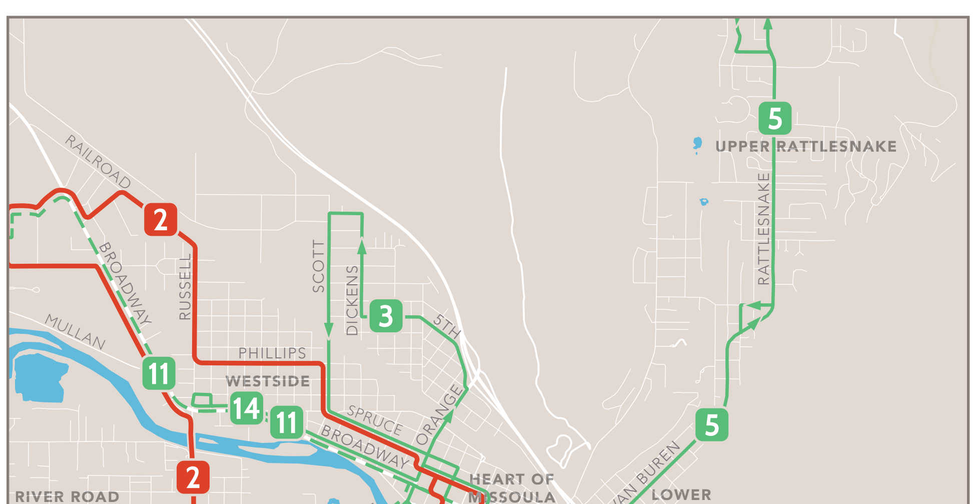


Figure 32: Inset Map of Routes 3, 5 and 14

Route 7

The relatively high productivity of Route 7 (shown below in Figure 33) is not surprising, given that it is the only north-south route in the city that is not competing for ridership with any other route. It runs on Stephens Street, through a dense and walkable area with a mix of activities (a shown in the Activity Density map on page 14), the type of place that would naturally generate all-day two-direction travel demand.

For the neighborhoods around Route 7, between South and 3rd, Route 7 is the most direct way to get downtown or to the Southgate Mall. In contrast, Routes 1, 6 and 12 share a market, and Routes 2, 8 and 9 share a market.

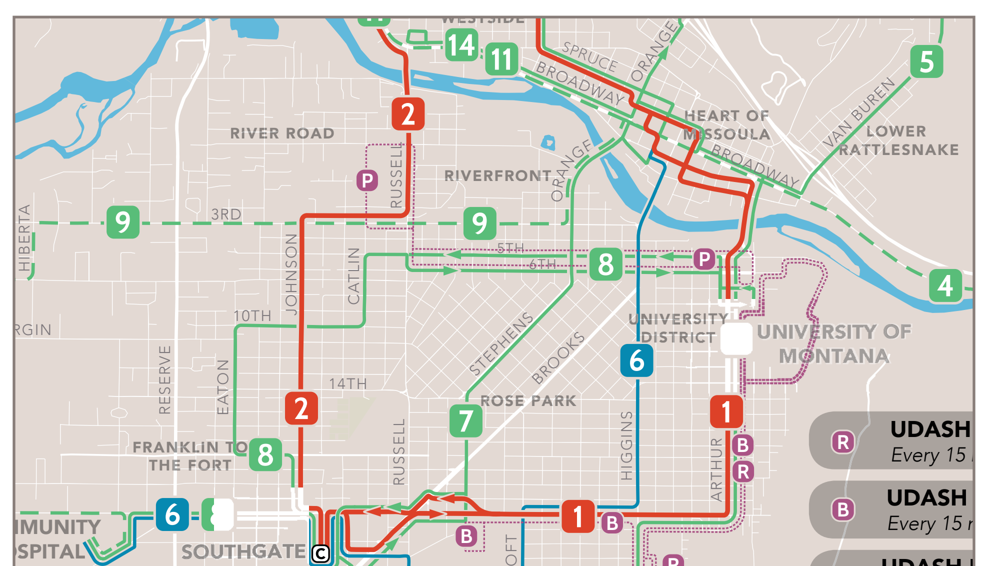
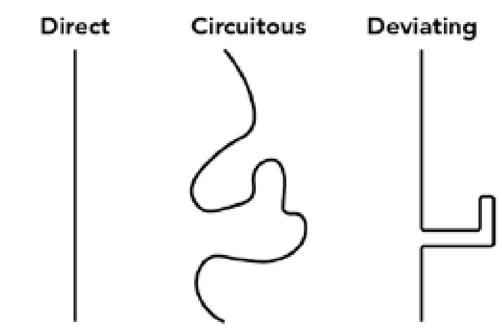


Figure 33: Inset Map of Routes 7 and 8

Route 8

Similarly, the low productivity of Route 8 (also shown in Figure 33) is not surprising, because there is no segment of the route on which it is uniquely useful to the neighborhoods around it. At its north end, along 5th and 6th, it is completely duplicated for east-west travel by the university's U-Dash route.

On its north-south segment, between 3rd and South, it parallels Route 2 but in a very circuitous pattern. Anyone who is in hurry, but is willing to walk a few blocks, likely walks to Route 2, which offers much shorter waits and a more direct ride to Southgate Mall.



Finally, it reaches Community Medical Center only after a major deviation to Southgate Mall. (In fact, all routes that serve the Community Medical Center are fairly circuitous or deviating.)

Route 4

Route 4 (shown below in Figure 34) is quite productive, considering its low frequency, and despite serving low-density, unwalkable areas. However, it covers a long distance, and therefore offers people an alternative to a long drive.[14] It is the only Mountain Line route than can be thought of as an "express" or "intercity" service.

Route 4 is also quite direct, only deviating in Bonner where it the bus is near the end of the route and therefore mostly empty anyway. Income may also be a factor in its high ridership relative to cost. Routes 4 and 5 offer a similar level of service, but Route 4 serves areas with lower median incomes, and higher densities of low income people living near bus stops. Route 4 is considerably more productive than Route 5.

Route 9

Route 9 (shown below in Figure 35) serves Orchard Homes, a very low-density but high-poverty area. This means that the people within walking distance of any Route 9 stop may have a severe need for transit, but there are very few of them, and therefore few riders on Route 9. In addition, because Orchard Homes is a sort of "peninsula" off of the city, any route serving it will naturally be circuitous, and therefore offers indirect rides to one of its endpoints or the other.

Finally, Route 9 offers minimal rush hour service – three trips in the morning, three trips in the evening – which would be mostly useful for people working an 8-to-5 work schedule. The number of people who are willing to rely on Route 9, despite its low frequency and its circuitousness, and who work an 8-to-5 job (or are willing to spend the entire day out, running their errands) must be very low.

By looking at the boardings map for Route 9 alone (on page 60) we can observe that the route is nearly unused on its Clements and 7th Street segments. What little ridership it gets near its southern terminus is likely related to the hospital, or represents people riding to the hospital to transfer to another route.

14 People's tolerance of low frequency improves as their trips get longer. Many people will happily plan their trip to another city around a bus that only leaves four times a day, but hardly anyone will plan a trip across town on a bus that leaves four times per day.

Figure 34: Inset Map of Route 4

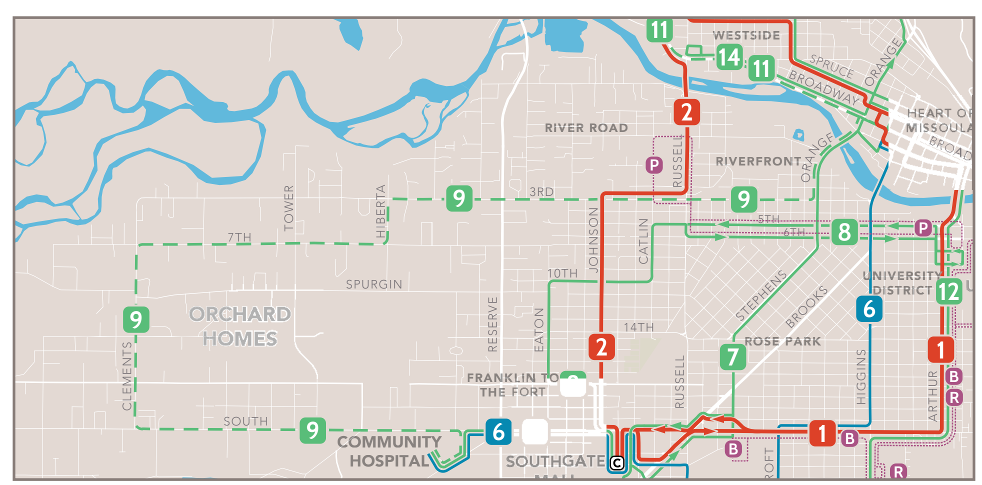


Figure 35: Inset Map of Route 9

Routes 11 and 12

Routes 11 and 12 (shown in Figure 36 at right) run every hour during the midday, with some longer gaps between buses (especially on Route 11). They run parallel to or on top of more frequent routes.

Their low productivity is not surprising. The segments of Route 12 where there are the most people (near the University) also have the most overlapping and competing transit services. Anyone standing at a Mountain Line bus stop on Arthur Street has only a 1 in 5 chance of getting on Route 12 (because 4 out of 5 buses each hour are for the frequent Route 1). (For University students and staff, the U-Dash Red Line is also coming by every 15 minutes.)

The segments of Route 12 on which it is not competing with other, more frequent, routes are serving low-density areas. Naturally, few people are travelling to the areas walking distance from any bus stop.

The segments of Route 11 on which there are the most people and activities are also served by frequent Route 2, and while the two routes are not on the same street, anyone who is willing to walk a few blocks will most often get a faster trip by walking to Route 2.

It is only on their more distant segments that Routes 11 and 12 offer unique coverage, but around these segments densities are lower, walkability is poor, and the routes themselves have become circuitous and indirect. (Close-up maps of boardings on Routes 11 and 12 are, respectively, on page 61 and page 62.)

Route 2

Route 2 (shown in Figure 36 at right) is one of the most circuitous in the Mountain Line network, doubling back on itself at North Broadway. It presents a completely roundabout way for someone to get from the south side of Missoula to downtown.

Based on November 2016 ridership data, almost no one uses Route 2 to travel between the south side of town and downtown. In the map on page 53, the boardings and alightings dots on Great Northern are equal in size, and on top of one another. In the bar charts on that page, boardings and alightings at the northwest corner of the route are nearly equal, indicating that the bus mostly empties out and refills as it passes through the area.

It may be better to think of Route 2 as *two* frequent routes: one between downtown and North Reserve, the other between North Reserve and Southgate Mall. For the convenience of a few riders and for Mountain Line's operational efficiency, they are through-routed into one route.

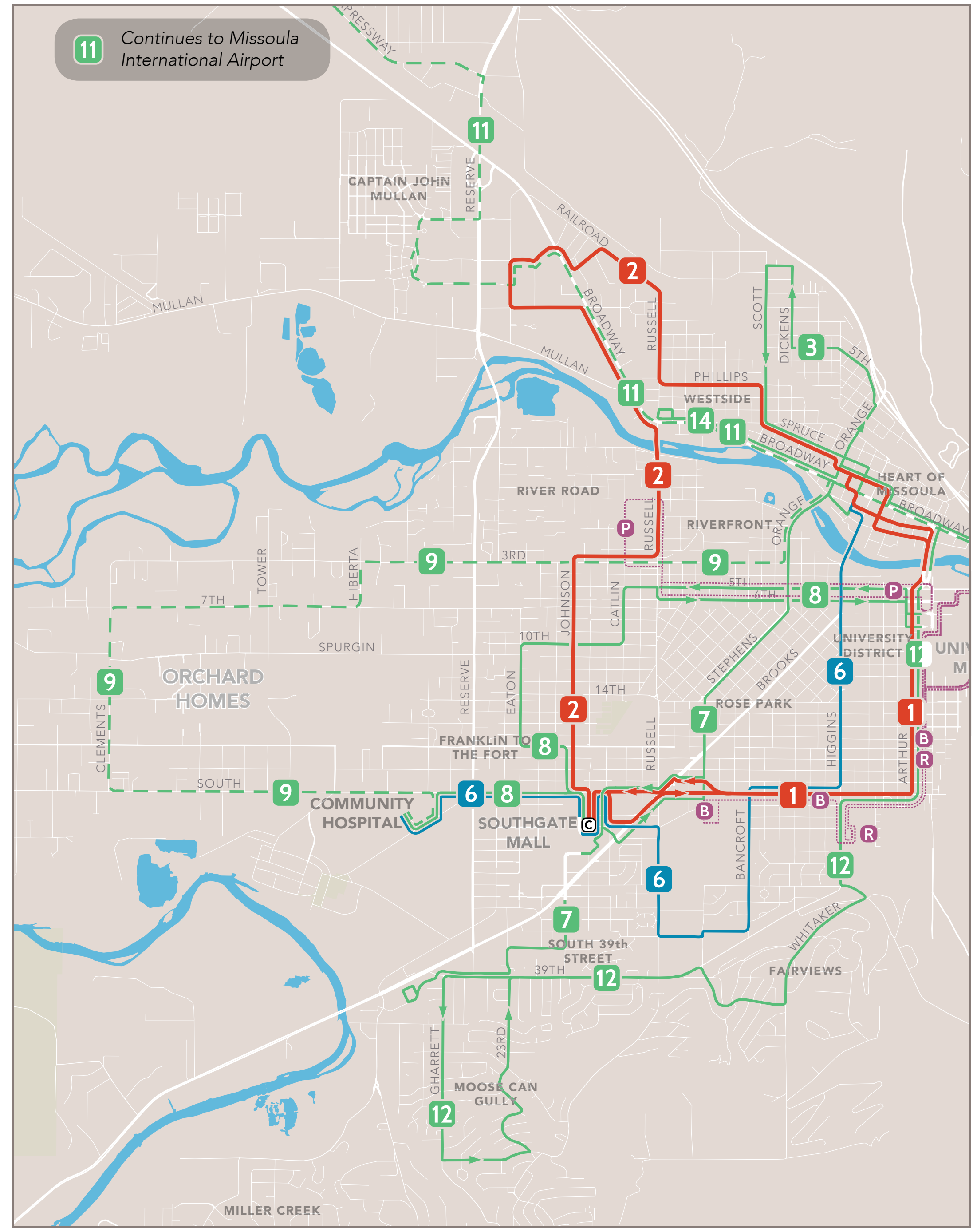


Figure 36: Inset Map of Routes 2, 11 and 12

However, it may not be necessary to always operate Route 2 as a single route. Splitting Route 2 into two routes would allow Mountain Line to set the frequencies and spans service differently on the two sides of the river. It would also allow Mountain Line to branch more frequent service into less frequent service as potential transit ridership gets lower west of Reserve.

Network Characteristics

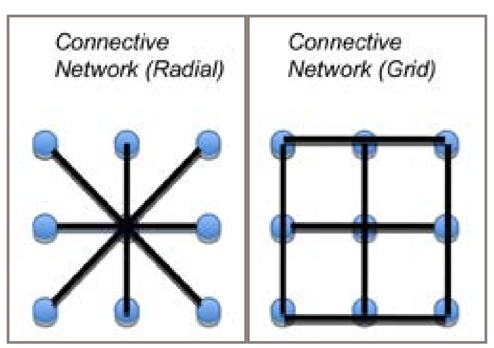
This section describes some characteristics of the Mountain Line network that may not be immediately apparent to the reader. Some of these characteristics are deliberate techniques used to turn a collection of lines into a network covering an area. Which of these techniques are suitable for Mountain Line in the future will depend on the frequency of routes in the network and the geography of the city.

One of the Key Choices we are presenting to Missoula in this report is between higher frequencies and higher geographic coverage. The outcome of this choice in particular will influence which of these techniques we recommend for Missoula's transit network.

For example, a "pulse" is essential for a low-frequency, high coverage network, but becomes less important as routes' frequencies get better. In another example, a "grid" network only works well if most routes are frequent, allowing easy transfers at every grid intersection.

Some of the characteristics of the Mountain Line network described below are not intentional techniques, but rather side-effects of other network design decisions, or artifacts of history.

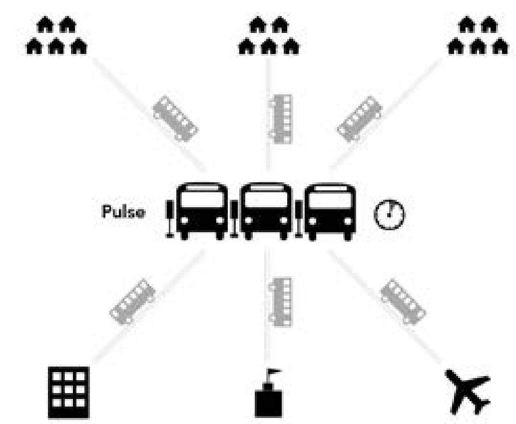
Radial networks



If a city has only one area where jobs and other activities are concentrated, then all routes can simply go from outlying neighborhoods into that center. This is a "radial" network.

In small cities, there is often only one activity center, and a radial network can easily provide one-seat-rides for most people to their activities. Few trips require a connection at all, but for those that do, all connections happen downtown.

Most larger cities, however, do not have only one center of activity. Some very large metropolitan areas – such as Los Angeles – are so dense across such a large area that they truly have everywhere-to-everywhere travel demand. Missoula is not such an extreme case, but has at least four obvious areas of concentration: downtown, the university, the areas around N. Reserve and the areas around Southgate Mall. (In the future, some of the lower-density areas between these centers are expected to fill-in with development, as shown in the map of projected change in residential density on page 15.)



In a "perfect" grid or a "perfect" radial network (neither of which, of course, exists) every place in the city is at most one transfer away from every other place in the city. These two shapes have naturally developed in cities because they allow a set of lines to function together as a network, on which people can travel from anywhere to anywhere.

Pulsing

Small-city radial networks, including Mountain Line's network, are often operated with a "pulse" downtown.

To offer a pulse, an agency must design its routes to be a certain length so that buses can all arrive downtown at the same time, each 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 small cities.)

Anyone who has been at or near the Downtown Transfer Center may have noticed many buses arriving and departing at once, and this is the pulse.

A pulse is an excellent way to create a network out of a set of routes, because it makes transfers less onerous and risky than they would be if they happened at random. This is especially important for low-frequency routes. If two 60-minute routes cross someplace in the city, and someone wants to transfer between them, their average wait will be 1/2 of the frequency, i.e. 30 minutes. (Sometimes they will get lucky, and wait 1 minute; sometimes they will get unlucky, and just miss their connection, and wait 59 minutes. On average, they will wait 30 minutes.) This amount of waiting time, and degree of variability in trip time, is intolerable to most people, so hardly anyone will rely on such a connection.

Instead, if the transit agency designs the network so that those two 60-minute routes pulse together at a Transfer Center, people's wait at the connection point will be reliably just a few minutes long. Many more people will be willing to transfer between low-frequency routes if the connection is quick and reliable.

There is a cost to pulsing, however. 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 for Mountain Line to lengthen a route just a tiny bit in response to requests. It 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.

Second, the routes must be given enough spare time to protect them against all of the predictable or unpredictable delays that happen on the roads. If two 60-minute routes are meant to pulse together, and one of them is often late and misses the rendezvous, then the transferring passengers face waits even worse than if the routes were connecting at random – they may often be waiting 55 minutes! The spare time added to schedules to protect against delays is called "recovery time," and it is essential for the reliability of a pulse.

Radial networks are well-suited to pulsing, and vice versa. Mountain Line currently operates a pulse downtown: a set of low-frequency routes come together downtown once every hour, wait for one another and for passengers to transfer among them, and then depart outbound. (There is also a smaller pulse with just a few routes at the Southgate Mall.)

There are a few characteristics of Missoula that make it less necessary and less beneficial to operate an *entirely* radial network:

- There are multiple activity centers and they are across the river from one another, so they cannot all be near the center of a radial network.
- A few high-density corridors do not point towards downtown, in particular Russell and Reserve.
- Because the City and Mountain Line have chosen to "Focus Inward," rather than spread service and development widely, Mountain Line is offering some high-frequency routes through the densest areas. This makes it possible for people to transfer, outside of downtown, with a reliably short wait.

For these reasons, Mountain Line does not offer a purely radial network. Instead, it combines a radial network with a very simple two-route frequent grid: Routes 1 and 2 form a square across the city, offering the highest frequencies in places with high ridership potential. The two routes connect with one another downtown and at Southgate Mall.[1] In the background of this simple frequent grid is a low-frequency radial network, on which quick connections can be made downtown.

Consistent route spacing and walking distances

One of the difficulties in the design of radial networks is how to manage route spacing. When routes are far from the center of the network, they are naturally far apart from one another. They can branch into lower-frequencies as they get farther from town, to reduce walking distances to service, but in doing so they double the wait times for that service.

As radial routes approach the center of the network, they come closer and closer to one another. At some point they come so close that they either run on the same streets, and therefore offer higher frequencies on those inner-corridors, or they run on nearby parallel streets and compete with one another.

When routes heading into downtown (or to any other major center) run on nearby parallel streets, they present potential riders with a more complicated and risky trip-planning task. For someone wishing to travel to downtown, and able to walk a few blocks, they must do a complicated survey of schedules (or use a transit planning app) to figure out which street to walk to. Once they are walking to that street, if they miss that bus, they have to start again, and likely walk to a different street to catch the next bus to downtown.

Dividing transit service among more streets inevitably leads to lower frequencies on each street, and therefore longer waits. If parallel routes can be consolidated onto a few main streets, service frequency to many destinations is better and waits are shorter. The network also becomes simpler and easier for people to remember. However, the average walking distance to a bus stop gets longer. (At least, until new development focused around transit corridors delivers very short walks and brings the average down again.)

Examples of this dilemma can be seen in the map inset in Figure 37 at right:

- Parallel service on Spruce and Broadway, northwest of downtown.

1 In practice, Routes 1 and 2 operate as a big loop, with Route 1 buses continuing as Route 2 buses and vice versa. However, that depends on operational details that may not be permanent, so they are described to customers as individual routes.

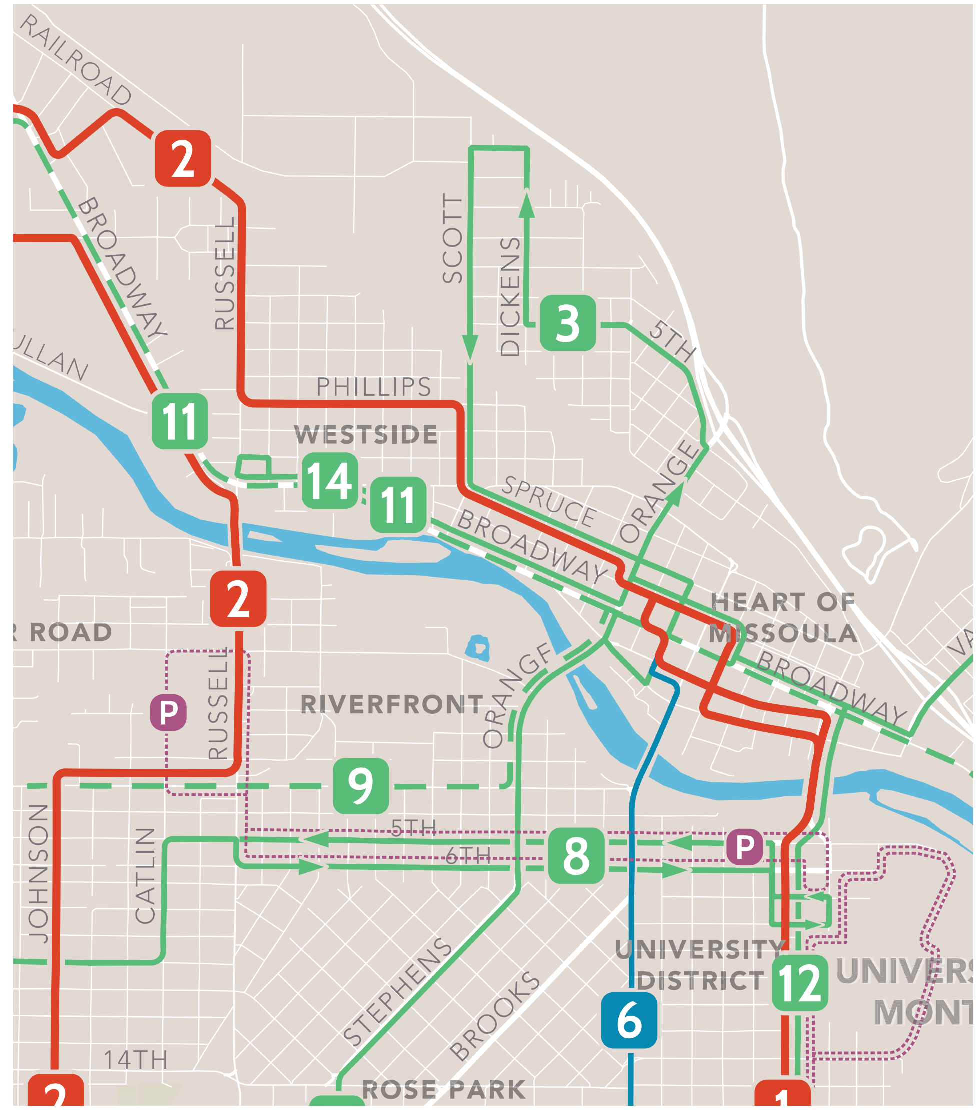


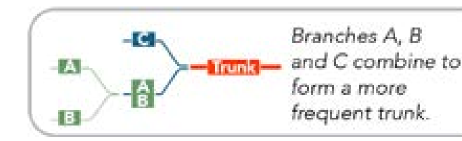
Figure 37: Inset Map Showing the Central City

- Parallel service on S. Orange, Higgins and Arthur. Numerous people and places between Orange and Arthur are within a short walk of two, if not all three, corridors, all with the same destination to the north.
- Parallel service on Broadway and Russell. However, barriers to walking mean that these streets are farther apart (on foot) than they appear on a map.

"Branches" and the downtown pulse

If every low-frequency bus route is scheduled to get downtown at the same time, to facilitate a pulse there, that means that every low-frequency bus route is heading into and out of downtown *at the same time*. As a result, there may be two buses per hour on that shared corridor... but they come just 3 minutes apart. In effect, the combined services are still offering just hourly frequency. This is currently how Routes 7 and 9 work on their shared segment of S. Orange Street. This is also how Routes 11 and 14 work on Broadway.

The existing Mountain Line network does not make any use of a technique called "branching," in which a higher frequency route splits into lower-frequency branches once it is farther away from a center. Branching is common in radial networks. It allows people to use higher-frequency service along inner-city, denser corridors, but still provides lower-frequency coverage to more distant outlying areas.



However, for branching to deliver higher-frequency corridors (such as on Orange, or on any major road leading to downtown), the two branches *cannot be at the same pulse at the same time*:

- Either the bus arrivals on the shared "Trunk" corridor are *staggered*, and people get reliably short waits there...
- Or the bus arrivals on the shared corridor are *timed together*, so that the arriving buses pulse together downtown.

This means that, with a radial network that has a major pulse downtown, it will be difficult for Mountain Line to offer higher frequencies on corridors approaching downtown.

Designing a pulsed, radial network like Missoula's requires working through all of these technical considerations:

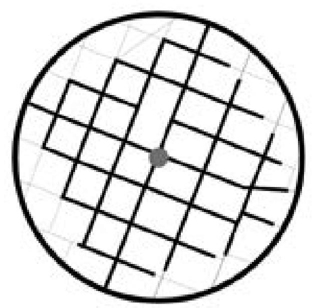
- Which combinations of low-frequency routes are most important to pulse with one another?
- What is a reasonable maximum walking distance to service, in close-in areas where routes come together as they approach downtown?
- Are there opportunities to offer higher frequencies on shared corridors, and then branch into lower-frequency routes reaching farther into lower-ridership areas?
- Given the numerous bridges over the river in Missoula, should all of them have transit routes over them? Or should service be concentrated into fewer, more frequent corridors from the south side of town?

- Should high-frequency routes wait downtown for the pulse? Or should they simply flow through, given that the next bus on those routes is always coming soon?

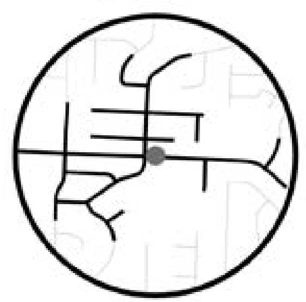
Walkability and deviations

In thinking about walkability, we are almost always focused on the existence and quality of sidewalks and safe crossings, and these are certainly necessary minimal features of a walkable place. In Missoula, maintaining sidewalks in winter is a known challenge, especially sidewalks that are directly adjacent to large roadways and become covered in snow and ice.

However, even when there are sidewalks and safe crossings, the design of the street network itself can severely limit walking, and in doing so can limit the ridership potential of a transit stop or route.



To understand how, compare the two street networks at right, each with a single bus stop in the middle:



- The street network at top has very high connectivity. This means that of the places around a transit stop, most of them will be within walking distance, because the street network offers such direct paths. This means that a single stop can serve a fairly large area.
- The looping streets and cul-de-sacs in the network at bottom have low connectivity. This means that of the homes around the transit stop in that neighborhood, only a few are within a short walk. The street network requires people to walk far out of their way. A single stop in a disconnected street network, like this one, is actually serving a much *smaller* area.
- A secondary effect of disconnected street networks is that they require those roads that *do* go through to be even larger, in order to handle all the traffic that is forced to use them. This means that neighborhoods like the one at bottom are surrounded by wider roads and bigger intersections, which makes walking or accessing transit on those main roads less safe and less pleasant.

If a transit stop is only within walking distance of a small set of places, then a transit agency needs to run more circuitous and looping routes in order to get close to everyone. This effect is visible in the South Hills, where there are pockets of high density housing (as seen in the map of residential density, on page 12). Unfortunately, the poorly connected street grid forces Mountain Line to run circuitous service in the area, contributing to low ridership and high costs.

Walkability around major intersections may become a bigger challenge for Missoula if Mountain Line ever adds frequent routes that connect outside of downtown, the Mall or another off-street transit center.

In cities with frequent transit networks, frequent routes cross at major intersections and people simply transfer at bus stops at the intersection. This is very efficient, because buses (and passengers) don't waste time circling in and out of transit centers or parking lots. It requires, however, that the major intersections be safe and comfortable enough for walking, crossing and waiting at bus stops.

Most intersections in central Missoula would work as transfer locations, but roads like Reserve, Broadway and Brooks present serious challenges to transfers at intersections.

Collaborating with the University

The Associated Students of the University of Montana (ASUM) charge themselves a fee to fund four "U-Dash" routes in and around campus (as shown on the network map on page 30). This student-led service was born of a frustration with the public transit network, which wasn't at the time meeting the needs or ambitions of the student body.

It is clear from ridership patterns that university students and staff rely enormously on the Mountain Line network, and contribute to its productivity and relevance in the city. However, universities generate such tremendously high ridership when classes are in session that it is natural for there to be specialized routes focused on that peak demand. They are often provided by the university itself, as they are in Missoula.

A city's transit agency, meanwhile, is responsive to year-round demands and ridership, as well as university ridership. Thus Mountain Line and ASUM have a set of different, though often overlapping, interests.

Nationwide, it is becoming more and more common for agencies in this situation to collaborate on network planning. Especially now, when third-party trip planning tools (like Google Transit) have made it clear that potential riders don't care what agency's name is on the bus. They just want to get where they are going, soon.

There is a wide range of ways that neighboring but different transit providers, like Mountain Line and ASUM, can collaborate and present an integrated, useful network to the public:

- Some partners simply integrate their marketing and trip planning functions.
- Some go further and integrate fares (unnecessary in Missoula, where all transit is currently free).
- Some split up the network, with one agency running one set of routes and the other running the rest. (Seasonality is an important consideration here, since most routes are needed all year long, while a few may only be needed when school is in session.)
- Some go even further and "share" routes, running a mix of the two agency's buses on a single route.

While the most extreme version of integration is to become a single agency, there are improvements that Mountain Line and ASUM can make soon, that do not require combining agencies.

6 Financial Analysis

Summary

Despite its growing ridership and the recent increase in local property tax assessments for transit, Mountain Line is facing some financial uncertainty in the future. This uncertainty is attributable to a few factors:

- Mountain Line had been planning to replace and renew its aging fleet of buses using about $20 million of regional surface transportation funds. In 2016, Mountain Line was informed that those funds would be used to complete the Russell Street project instead. This came as a surprise to Mountain Line. As a result, the agency must find another source of funding – or set aside existing revenues – for urgent fleet replacements. The fleet is currently maxed-out, which means that no peak service can be added (in the form of new routes or higher frequencies) until the fleet is renewed and expanded.
- Ridership on Mountain Line has grown fast over the past two years. This may improve the agency's chances of getting competitive federal funds. Any additional award would be relatively small, and would be announced in February 2018.
- The three-year pilot Zero Fare program, funded by community partners, will come to the end at the end of this year.
- Some small federal funding streams are vulnerable to Federal policy-making and congressional action in any year. The federal transportation bill that is responsible for one quarter of Mountain Line's operating revenues will be revisited by Congress in 2020.

Stability

Approximately 90% of Mountain Line's operating revenues come from two relatively stable sources: local property taxes and Federal 5307 grants. (All of Mountain Line's revenues and expenses for the current fiscal year, FY 2017, are summarized in the tables at right.)

The current local property tax rate does not sunset, though the amount of tax revenue generated each year fluctuates with the value of property. A robust economy with increasing property values and/or development will increase revenues from this source, while an economic downturn could decrease revenues. It is impossible to predict future economic trends, but small communities like Missoula with major public universities tend to have fairly stable property markets, compared to major metropolitan areas, suburbs or small economies based on single industries.

It may seem counterintuitive to claim that Federal 5307 funding is stable given the current uncertainty about the entire federal budget. However, 5307 is funded from the Highway Trust Fund, and as a result is somewhat insulated from budget cuts that can be made more easily with general fund expenditures.

The remaining 10% of Mountain Line's operating revenues are less stable. Revenue to support Zero-Fare comes from 15 partners and is subject to renegotiation this year. Federal CMAQ funding is vulnerable in the existing national political environment.

Long term commitments from Zero Fare partners would improve the stability of local funding. Small savings might be achievable through a deeper partnership with the University and ASUM. In the long run, if reductions in other revenue streams threaten Mountain Line's service levels, an increase in the property tax rate might become thinkable.

Mountain Line anticipates that its operating expenses will increase by an average of 3% per year, which is reasonable and consistent with the inflation rates at other similar-sized agencies nationwide. However, it is impossible to predict future inflation with certainty. The most variable cost elements in recent history relate to fuel and healthcare, and are likely to remain variable in the future.

The biggest financial challenge currently before Mountain Line relates to buses: there is not enough capital to replace aging buses, acquire additional buses, or for needed expansions to the maintenance and storage facility. Neither additional frequency nor new routes could be added at peak times, until capital funding is secured to acquire more buses and more bus storage space.

FTA 5307 formula funds are intended to support capital expenditures. However, small systems can use them for operations and, like other small systems, Mountain Line uses all of its 5307 revenues for operations. Another FTA funding program meant for buses and bus facilities (5339) was reduced by over 50% in 2012, and, despite recent increases, the program is still unable to meet Mountain Line's and other agencies' bus replacement needs.

Mountain Line is setting aside both operating and capital reserves (as shown in the table at right), to fund fleet replacement and to stabilize service levels in the future. Under its current budgeting practices, Mountain Line's operating budget is forecast to balance until 2038. However, this forecast does not include funding the later phases of investment in frequency, span and coverage that were foreseen in the 2012 Short and Long Range Plans. (Earlier phases were implemented in 2013 and 2015.) These planned investments in the fixed route network have become untenable under the new fiscal constraints.

Sources of Operating Revenue in FY 2017	Amount	Percent of Total
Federal: 5307 (including STIC)	$1,824,975	25%
Federal: CMAQ	$292,000	4%
Local: Property Tax	$4,848,810	66%
Local: Zero Fare and Other Programs	$421,900	6%
Total Operating Revenue	**$7,387,685**	

Types of Operating Cost in FY 2017	Amount	Percent of Total
Operations	$4,113,155	65%
Maintenance	$796,130	11%
Administration	$1,243,975	17%
Contribution to Capital Reserve Fund	$175,000	2%
Contribution of Operating Reserve Fund	$1,059,425	14%
Total Operating Expenses	**$7,387,685**	

Figure 38: Tables Summarizing Mountain Line's Budget in Fiscal Year 2017

Local Property Taxes

Local property tax accounts for the largest source of operating revenue, at about 60%. This is also the most stable source of revenue as it is not dependent on future voter or legislative action. The property tax rate was increased by voters in 2013, allowing Mountain Line to increase service levels. The rate does not sunset.

However, future revenues property tax revenues are dependent on the health of the real estate market. A major economic downturn could depress real estate values and property tax revenue. A booming economy could increase revenues at a rate greater than inflation.

Property values, and therefore property tax receipts, respond to economic conditions slowly, so there can be a delay of multiple years between an economic recovery and an increase in property tax collections for transit service. To be conservative, it is best to look at historical trends (which would include the Great Recession) to project future revenues.

Federal Grants

5307: Urbanized Areas Program

After local funding, the next largest proportion of Mountain Line's operating revenue comes from the Federal 5307 program, which is designated for urbanized areas. The 5307 program is funded by the Highway Trust Fund and is immune to annual appropriations legislation in Congress. The appropriations bill that funded it (the FAST ACT, passed in 2015) expires in FY 2020.

When Congress was writing and debating the FAST ACT in 2015, there was an attempt to prevent the use of the Highway Trust Fund as a source of funding for transit. This proposal was immediately shot down by members of both parties. There will surely be new attempts to strip transit from the Highway Trust Fund in the future, but there is no reason to expect a different result. Although there is a great deal of uncertainty regarding the President's discretionary budget, and no one can accurately predict what will likely occur in the future, the odds are favorable that this source of funding will be stable until 2020, and possibly beyond.

Small Transit-Intensive Cities (STIC) Program

Mountain Line also receives "bonus" 5307 funds as part of the competitive STIC program, which rewards small agencies that exceed annual thresholds for six different measures of transit performance.[1] The thresholds are based on the average performance, for that year, of larger urban areas. Because the thresholds move from year to year, and because a different number of small cities transit systems qualify for the pool of funds from year to year, the amount of funding that might be available to Mountain Line varies every year.

For its fiscal year 2018 budget, Mountain Line received about $215,000 of Small Transit Intensive Cities (STIC) funding because it excelled on two measures: revenue hours of service per capita and boardings per capita.[2] The grant award, however, is always three years behind the performance measurement. The grant that was announced in February 2017, and will be used in Mountain Line's FY 2018 budget, is a result of FY 2015 performance.[3]

Congestion Mitigation Air Quality (CMAQ) Program

The same can't be said about CMAQ grants. This program is meant to fund pilot projects and new services for three years – not ongoing operations. Somehow, the state of Montana received an exemption, allowing CMAQ recipients to use grants for continual operations. Even aside from this special dispensation, CMAQ funding is more susceptible to political forces than are 5307 funds. Thus it would not be prudent for Mountain Line to count on CMAQ revenues in future years.

5339: Bus and Bus Facilities Program

Another small potential source of funding is the Federal 5339 Bus and Bus Facilities program. This program can only be used for vehicle and facility capital expenditures. Unfortunately this program is underfunded, and will not be able to provide significant revenues in the next few years. It could, however, be a source for small grants, if a local funding match for bus purchases were found.

Zero Fare and Bulk Pass Programs

Another source of local revenue is the Zero Fare program, which began in January 2015. The program is funded by 15 local partners, and has considerably increased ridership and productivity on Mountain Line (as shown in the graph in Figure 19 on page 27).

The original goal of the program was to increase ridership on Mountain Line by at least 45%, in three years, but that goal was already met by the end of 2016, just two years into the program.

However, Zero Fare was a three-year demonstration program that is now in its third year. If the program continues beyond December 2017, it will be a result of renewed commitments by the 15 partners (or new partners). An end to the program would mean the restoration of fares, and a drop in ridership and productivity in future years.

Zero Fare Program Partners (as of 2017)	
University of Montana	City of Missoula
Associated Students of the University of Montana	Missoula Metropolitan Planning Organization
County of Missoula	St. Patrick Hospital
Community Medical Center	Missoula Aging Services
Missoula County Public Schools	Missoula Downtown Association
Missoula Parking Commission	Missoulian
Southgate Mall	Destination Missoula
Homeward, Inc.	

Figure 39: Table of Zero Fare Program Funding Partners

Mountain Line will soon need to shift from delivering the Zero Fare program to re-negotiating its continuance. In future years, in terms of efficient use of Mountain Line's resources, it will be beneficial if funders can make multi-year commitments (as they did at the start of the program) so that Mountain Line does not have to dedicate scarce staff time to continual fundraising.

If the Zero Fare program ends in the future, Mountain Line could explore an alternative form of fare discounting and bulk purchasing of transit passes. As an example, in a bulk pass program a university, large employer, business improvement district or housing manager can purchase annual transit passes at a large discount for all students, employees or residents. Because the purchasers are required to buy passes for all of their members, they can be offered a very attractive discount.

Unlike Zero Fare, a bulk pass program involves hurdles to riding the bus (for the purchaser, and even still for the recipient worker or student, who must find and carry their pass in order to ride the bus). For that reason alone, a bulk pass program would not maintain the ridership increases caused by Zero Fare.

In addition, eliminating fares entirely allows Mountain Line to spend fewer resources on fare processing and handling, and less running time waiting for people to pay their fares on the bus. These benefits would not accrue to the same degree from a bulk pass program.

Finally, a bulk pass program is generally much less successful at

1 The STIC program takes 2% of the total available 5307 funds to make additional grants to small transit systems that exceed the thresholds.

2 These are the same measures that we report for Mountain Line and peers, as Investment and Relevance, in the bar charts on page 29.

3 Of the remaining four measures, Mountain Line is close to exceeding the threshold on one additional measure, related to the amount of service provided per capita. There is a slight possibility that Mountain Line has already exceeded that measure, because of the increases in service supplied in January 2015 (halfway through FY 2015). If the FTA finds that Mountain Line exceeded this third threshold in FY 2016, that could increase Mountain Line's STIC/5307 award. However, there are three variables that would have to line up for this to happen: Mountain Line's supply of service in FY 2016, that of other small systems, and that of larger systems whose average sets the threshold for each measure. If all of these variables aligned in Mountain Line's favor, then additional STIC funding could show up in Mountain Line's budget for FY 2019.

distributing the benefits of free transit to people who work for small businesses, service workers, and people who do not work, than it is at delivering those benefits to higher-income professionals and university students.

University Funding Sources

Even though Mountain Line and ASUM run separate services, their success is linked today and will be long into the future. If the organizations develop a deeper partnership in the future (in planning the city's transit network, designing individual services, or even delivering services) their funding fates may become more intertwined than they are today.

Today the University contributes to the Zero Fare program by forgoing its potential STIC revenues, and students assess themselves a fee to pay for U-Dash operations.

Some other funding models that the University, ASUM and their partners may wish to consider in the future include:

Parking fees to help support transit. As universities move towards providing unified transportation systems, parking revenues are sometimes used to improve travel by other modes. This is especially true as parking space on campuses becomes more scarce and valuable, and harder to justify subsidizing. People who can no longer afford to park on campus benefit from other, more affordable modes, and thus parking fees are sometimes used to provide transit service. Campus transit service sometimes functions as a parking shuttle, which offers further justification for this revenue arrangement.

Development fees. Developers of off campus student housing sometimes fund transit service that connects the housing with the university. This typically occurs as a condition on the construction of new development, enforced by a city. This can also be bundled with relaxed off street parking requirements.

General fund contributions. Universities sometimes make contributions to transit service operating budgets (either university-run transit or public agency-run) from their general funds.

As described earlier in this report, there may be opportunities for the University, ASUM, the City and Mountain Line to do more with less, by collaborating on the design of the city's transit network if not the operations of individual routes. If someday there is more intensive collaboration in planning and service delivery, then more intense and strategic collaboration over funding might also need to take place.

Tax Increment Financing (TIF) Districts and Special Improvement Districts (SID)

While Mountain Line is a regional agency, with a service area that extends beyond the boundaries of individual cities, its funding and service levels need not be set entirely at the regional scale. A few regional agencies raise or accept revenue from specific sub-areas. Rather than raising new funds across the entire transit district, funds are raised directly from areas where higher levels of transit service or certain capital investments are appropriate. (Aspen and Boulder, Colorado, and Seattle, Washington, provide examples of such funding arrangements.)

In the Missoula area, additional funds for higher levels of service in a sub-section of the MUTD service area could possibly be achieved through the existing property tax structure. However, two other funding tools may be available – Tax Increment Financing (TIF) or a Special Improvement District (SID). Mountain Line has never pursued either of these sources of funds for transit capital projects or service.

TIF is a form of "value capture." TIFs are established to capture the increased property tax receipts that result from major public investments, and use those increased receipts to pay off the investments. For example, say a city wishes to build a new park and believes that it will increase nearby property values and therefore property tax receipts. The city can finance the park, establish a TIF district, build the park, and then collect the "increment" in property tax receipts that the park causes over future years. TIFs are also used to finance new housing development, transportation infrastructure, schools, stadiums, and more.

TIFs are mostly used for capital improvements, not for ongoing services, but there is nothing that prevents them from being used for operations, maintenance and service. TIFs always have a sunset date.

Missoula currently has seven TIF districts, each of which are managed by the Missoula Redevelopment Agency (MRA). The MRA already makes significant investments in transportation projects, and has expressed an interest in supporting transit on Brooks St. specifically. Presumably all of the remaining funding generated by these TIF's has already been dedicated for other purposes. However, if a new TIF is established in the city, Mountain Line should evaluate whether development of the district will trigger increased capital needs for Mountain Line, and whether those capital investments would be a reasonable part of a package of improvements that increases nearby property values.

TIFs have major downsides, chief among them that they divert growing property tax revenues away from existing commitments (like schools and other basic government services). Sometimes the nexus between the capital investment and the "increment" in tax receipts is hotly debated before and after the fact. It can be hard to tell whether the initiating project is solely or even significantly responsible for the growth of tax receipts. TIFs sometimes cause conflict between levels of government, as one entity sees its service obligations grow but its property tax receipts remain flat, while another benefits from the collected increment.

A growing trend in public transit is for dense core cities to supplement transit service above the levels that a regional transit agency can justify. This could be simply a contribution to the transit agency from the City's general fund, to pay for a special service, higher frequency or later night service. In some regions (most recently, Seattle) the city has initiated a new tax or fee that pays for increased levels of transit within the city.

7 Key Choices

How to balance ridership and coverage goals?

The most fundamental choice before Missoula concerns ridership: *How important is maximizing ridership within the Municipality's fixed budget for transit?*

A goal of maximizing ridership serves several common intentions for transit, including:

- Low subsidy per ride.
- Vehicle trip reduction and emissions benefits.
- Support for denser urban development, where people can drive less and own fewer cars.

On the other hand, all sorts of other non-ridership transit goals also exist, and are also valid and important uses of transit resources. These include:

- Ensuring that everyone throughout the service area has access to some transit service.
- Providing lifeline access to critical services.
- Providing access for people with severe needs.

No transit agency focuses solely on either of these goals. Most transit agencies have routes that generate a lot of ridership very efficiently, and other which don't draw as much ridership but which have an important social purpose.

In its last round of short- and long-range plans, Mountain Line adopted goals and objectives related to both ridership and coverage.

The strongest statements of ridership goals were:

- "Help meet regional sustainability, growth management, and economic development goals."
- "Improve air quality and reduce vehicle miles travelled."
- "Foster transit-oriented development."
- "Provide efficient…service."
- "Provide greater frequency…"

The strongest statement of coverage goals was:

- "Provide a system of transit services that is responsive to the needs of ***all*** residents" (emphasis added) "particularly those for whom transit is a necessity."
- "Establish bus service within any given five-block area in the… District, thereby extending transit into underserved areas…"

There is a danger, with conflicting goals, that some people will accuse an agency will be accused of failing no matter what they do, because their adopted goals are in conflict. If a high-ridership bus line is crowded, they are scolded for not offering enough frequency there; yet if they remove buses from a low-ridership line to reallocate them to the high-ridership line, they are scolded for cutting access that some people rely on. Only by acknowledging the conflict between these goals, and explicitly deciding how much effort to use pursuing each, can a transit agency succeed at both.

It is often said about public and private organizations alike that if you want to know what really matters, look at their budgets. High-level policies are valuable, but when they are vague or in conflict, the real evidence of what a community values is in the budget.

Thus we suggest that Missoula think about this choice not as black-and-white, but as a sliding scale that the community can help to set:

What percentage of the available budget for transit should be dedicated to generating as much ridership as possible, and what percentage should be spent providing transit where ridership is predictably low, but needs are high?

This is not a technical question, but one that relates to the values and needs of a community.

We estimate that about 70% of the existing Mountain Line transit network is designed as it would be if maximizing ridership were its only goal. The other 30% has predictably low-ridership, suggesting that it is being provided for other, non-ridership purposes. This may be the right balance for Missoula in the future, or the community may wish for a shift in emphasis.

The direction of that shift – either towards higher ridership or towards wider coverage – and how fast Mountain Line should make such a shift are both questions for stakeholders to discuss in this strategic planning process.

One way to manage the perennial conflict between ridership and coverage goals is to define the percentage of a fixed route budget that should be spent in pursuit of each one. Mountain Line could, as a result of this study, establish that it will continue to spend about 70% of its budget maximizing ridership, or it could decide to spend more or less towards that purpose. Mountain Line could also decide to maintain the existing balance in the short term, but devote any new funding to either high ridership or wide coverage, and in that way shift the balance without cutting any existing riders' coverage or frequency.

Missoula's desired balance of ridership and coverage goals will determine how much of a role high-frequency routes play in the Mountain Line network. A high-ridership Mountain Line network would be made of fewer total routes, but with higher frequencies than most routes have today.

The frequencies of Mountain Line routes will, in turn, affect some technical decisions about how the network is and managed:

- *Is there still a major downtown pulse of low-frequency routes?*
- *Can connections between frequent routes be made outside of downtown and the Mall?*
- *Is the network's shape primarily radial, or is it more like a grid?*
- *Do corridors close to downtown benefit from overlapping routes that combine to offer frequent service?*

The usefulness of each of these techniques will depend entirely on the frequency of the Mountain Line network, and therefore on how ridership and coverage goals are traded-off against one another in the future.

Lead or Respond?

There is a basic dilemma in transit planning, which can be summarized as "Lead or respond?"

- Should transit services lead development, meaning operate in places where ridership or need are low *today* but are expected to be high in the near future?
- Or should transit services respond to existing ridership demands, and respond to new developments only once they are producing potential transit riders?

While "leading" always sounds like a more noble and daring path to take, there is a major downside to transit "leading" development. This downside appears as empty buses and low-ridership bus routes in some parts of town, while buses are over-crowded and under-supplied in other parts of town.

Because our ability to accurately predict where and when development will "take off" is imperfect, sometimes the transit service that is meant to lead development ends up attracting low ridership for longer than can be justified, and becomes a failed experiment. It is a much safer bet to respond to existing ridership and existing needs, than to try and get ahead of a development curve that is only somewhat predictable. Thus the choice between "Lead or follow?" does not have an obvious right answer.

Fortunately, the City of Missoula has concurred with Mountain Line's "Focus Inward" policy, and directed more intense development towards the core and major corridors. As a result, the "Lead or respond?" dilemma is made a bit easier than it otherwise would be.

The geographic gap between "Lead" corridors and "Respond" corridors is much smaller than if the City were planning to intensify new corridors far from the existing city core. If the latter were the case, and the City's development policies were to "Spread Outward," then the City would be presenting Mountain Line with a much more excruciating choice between responding to existing ridership and leading new development at the distant edges.

"Leading" development with capital-intensive transit projects (like light rail or streetcars or, more recently, Bus Rapid Transit) is often appealing because the results are so visible: nice stations, special vehicles, special lanes. Developers and people investing in real estate are thought to respond to these visual, capital cues. The federal government has, until recently, been generous in grants to support such "placemaking" projects. Plus, these projects are different, somewhat exotic (in most U.S. cities) and therefore just get people a little excited.[1]

In practice, the service underlying these "placemaking" amenities may not be very useful. In the case of streetcars, many small cities have found that low-frequencies, short spans and short distances keep the service from being relevant to most people's travel, and therefore keep ridership low. In the long run, these "placemaking" transit projects can successfully generate attention and enthusiasm for development, but may not generate high transit ridership. Yet they also represent an ongoing commitment of operating expense for the transit agency.

In addition to a choice about whether to lead development, or respond to it, Mountain Line will face an additional choice about whether to lead with *service improvements* (offering the frequency, night and weekend spans, and city-wide access people find useful) or to lead with *capital amenities* (like nicer stations or special vehicles).

This choice is somewhat subservient to the "Ridership vs. Coverage" choice. If Mountain Line makes a policy decision to devote more resources to maximizing ridership, that suggests the answer to this trade-off is to prioritize high ridership today over leading future development.

1 Many urban transit agencies are starting to "brand" high-frequency, reliable and long-span services, in order to make them visible to the public. They may be called a "Frequent Network," and given unique line colors on maps, symbols on bus stops, and number series. These service elements make transit useful, but can be invisible, or overshadowed by capital amenities that have less impact on usefulness.

How to balance weekday, evening and weekend service?

Very few people cease the activities of their lives on Sundays and holidays. Yet small-town transit networks often close up shop on Sundays and holidays. Some agencies do this because a loss of federal support for transit operations in the 90s and 00s forced them to cut service; others because they never offered Sunday and holiday service to begin with.

There will be a limit to how much any city can reduce reliance on cars and fossil fuels if everyone who wishes to continue their lives on Sundays and holidays must have access to a car for themselves. (Even in an age of car sharing and, soon, driverless taxis, an entire city cannot turn to the same small fleet of shared cars on Sundays!)

Today, the productivity of Mountain Line routes on Saturdays is slightly higher than on weekdays. This suggests that service is under supplied on Saturdays relative to weekdays.

The existing Mountain Line network stops running before most restaurant workers get off their evening shifts. Workers in the service industry tend to make lower wages, and as a group they are a potential source of high ridership. Yet without night service, and service on Saturdays, Sundays and holidays, any service worker in Missoula needs access to a car (or a ride from someone else) at least one day each week, if not once every day. Lengthening the span of service beyond 9:30 pm would make the Mountain Line network more useful for this large group of people.

Within the existing Mountain Line budget, adding Sunday and holiday service, increasing the span of service on Saturdays or adding night service would require cutting weekday frequencies or coverage.

There is no correct answer to how a city should balance weekday frequency and coverage with daily and weekly long spans of service. Within a fixed budget, however, they do trade-off against one another. Whether Mountain Line has struck the right balance for Missoula, and for 2017, is a question that can be explored in this plan.

A choice about weekend service can be considered separately from the choice about how to balance ridership and coverage goals. All-day, all-week transit is key to achieving high total ridership...and yet all-day, all-week transit also serves some important social goals that do not depend on high transit ridership.

Appendix A: Route Profiles

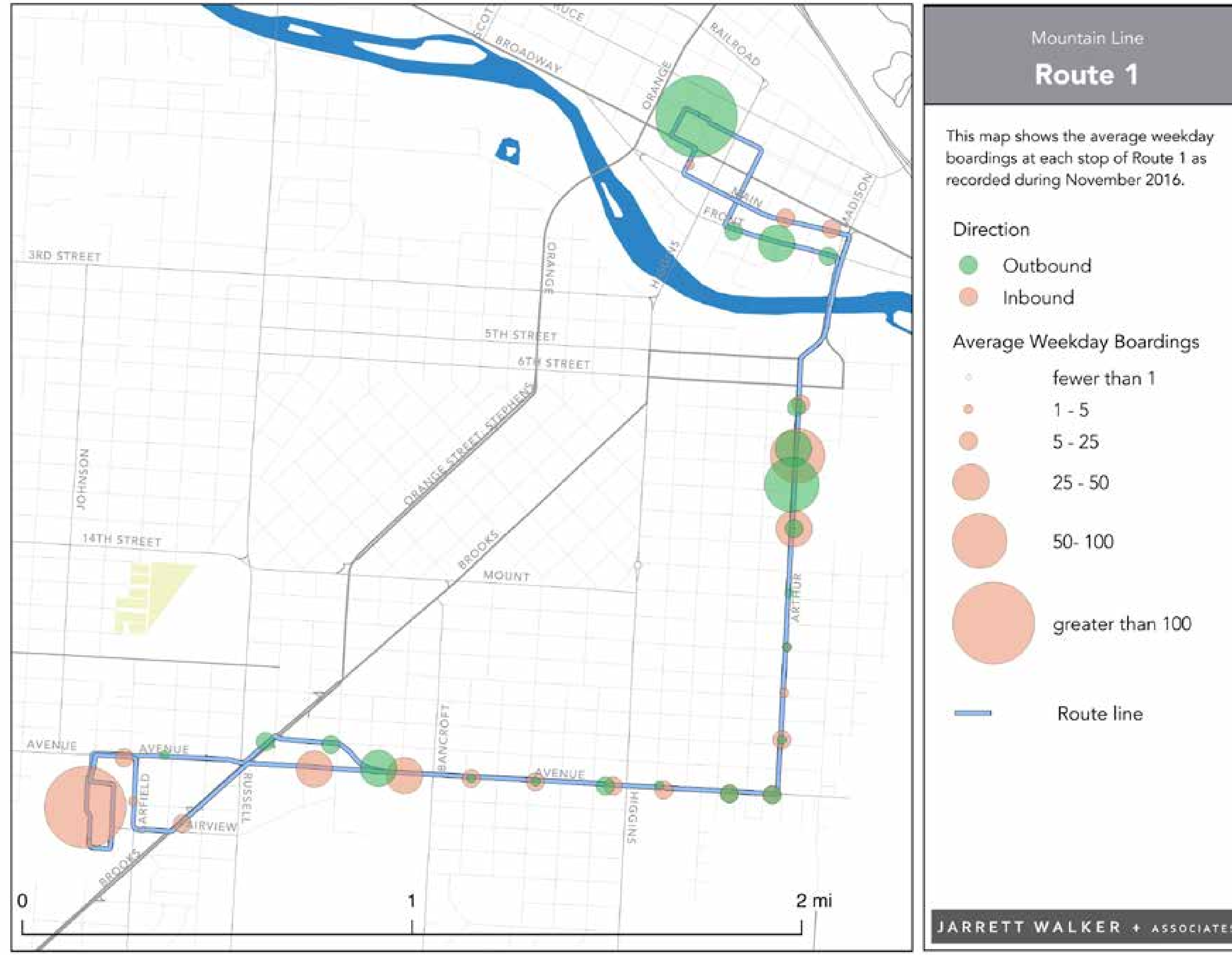
Profile of Route 1

Route Parameters

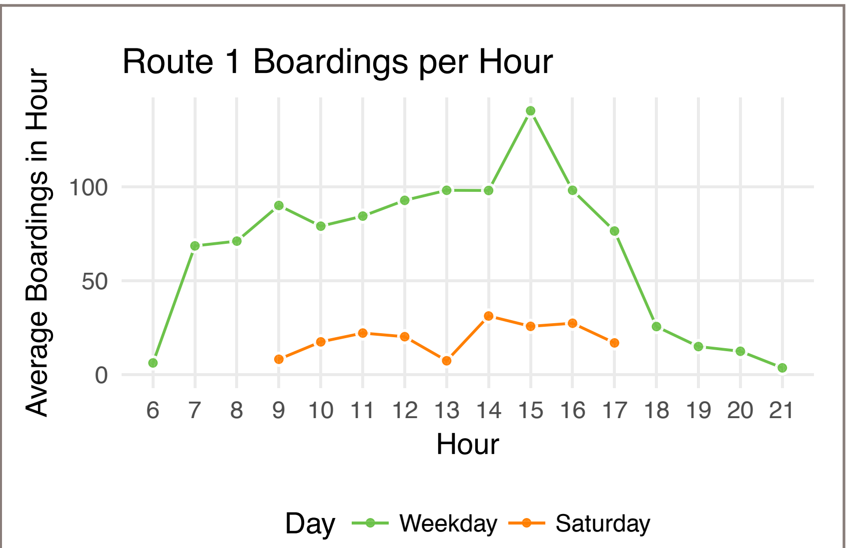
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	15	
Midday Frequency	15	60
PM Frequency (weekday only)	15	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:45 am	9:45 am
End of Service	9:45 pm	6:15 pm
Span (hrs)	15	8.5

Route Performance	Weekday	Saturday
Average Daily Boardings	1,059	177
Ridership Rank	2/12	3/10
Daily Revenue Hours	31.76	5.44
Productivity (Boardings per Revenue Hour)	33	33
Productivity Rank	1/12	3/10
Daily Revenue Miles	409	70
Daily Passenger Miles	1,892	398



Ridership by Hour



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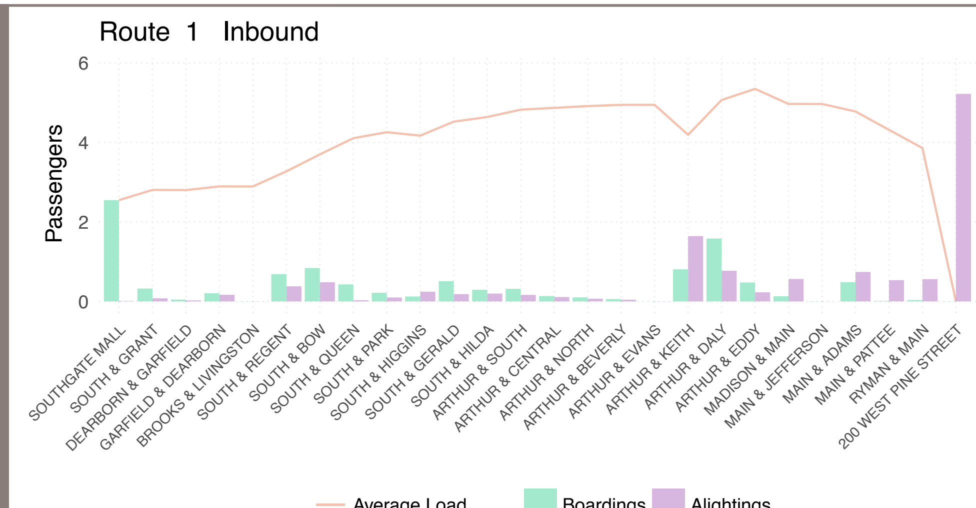
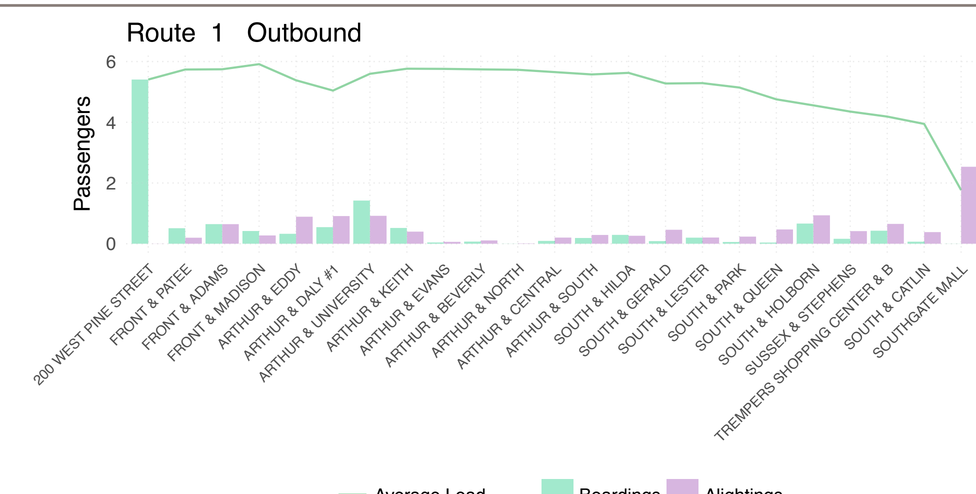




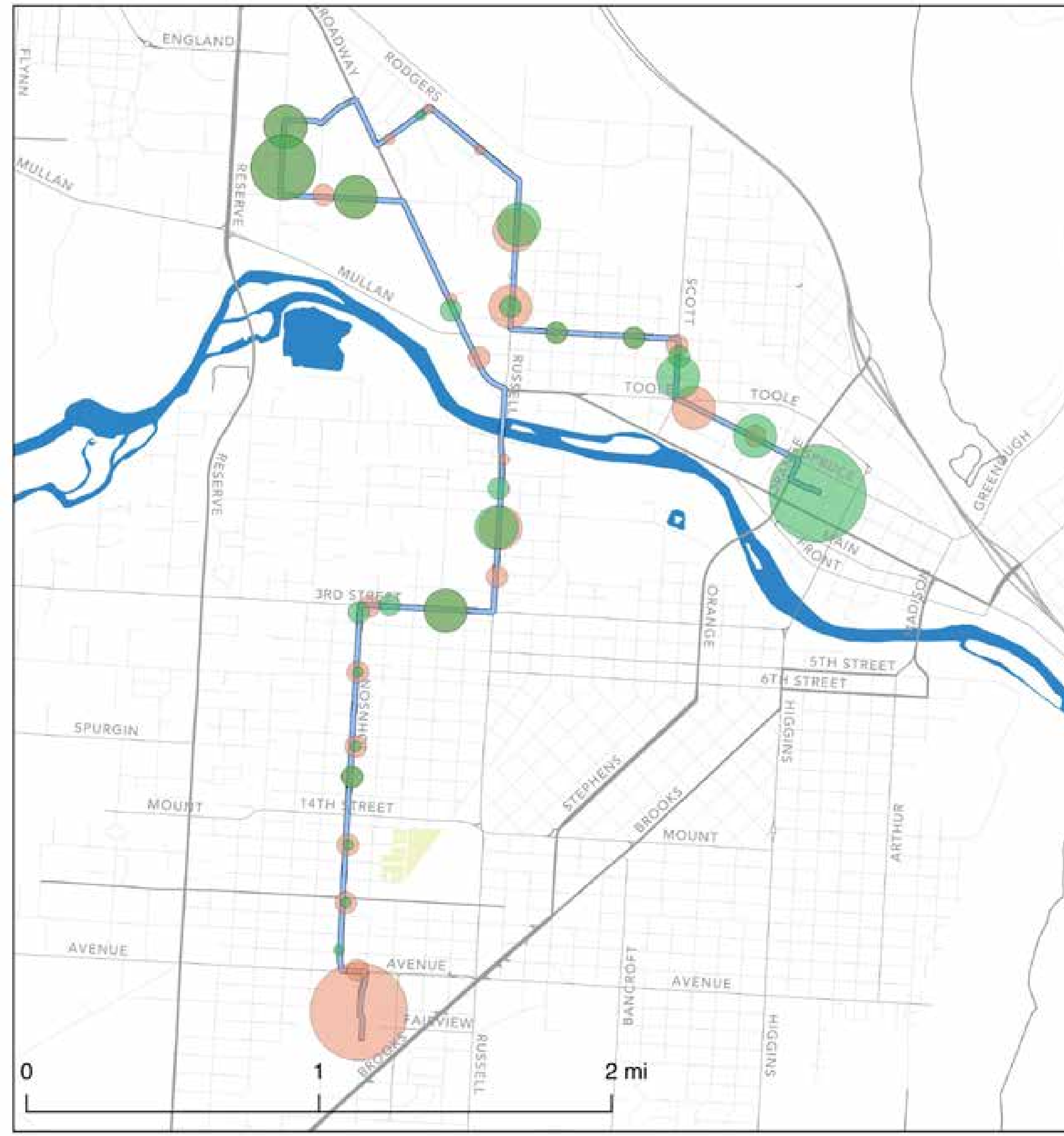
Profile of Route 2

Route Parameters

Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	15	
Midday Frequency	15	60
PM Frequency (weekday only)	15	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:45 am	9:45 am
End of Service	9:45 pm	6:15 pm
Span (hrs)	15	8.5

Route Performance	Weekday	Saturday
Average Daily Boardings	1,508	436
Ridership Rank	1/12	1/10
Daily Revenue Hours	48.83	8.23
Productivity (Boardings per Revenue Hour)	34	56
Productivity Rank	2/12	1/10
Daily Revenue Miles	669	113
Daily Passenger Miles	3,598	1,142



Mountain Line

Route 2

This map shows the average weekday boardings at each stop of Route 2 as recorded during November 2016.

Direction

- Outbound
- Inbound

Average Weekday Boardings

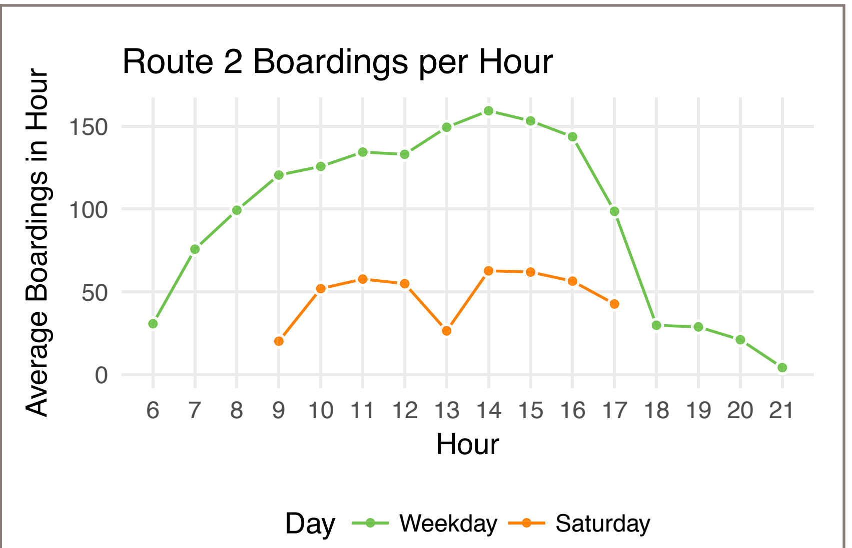
- fewer than 1
- 1 - 5
- 5 - 25
- 25 - 50
- 50- 100
- greater than 100

Route line

JARRETT WALKER + ASSOCIATES

APPENDIX A: ROUTE PROFILES

Ridership by Hour



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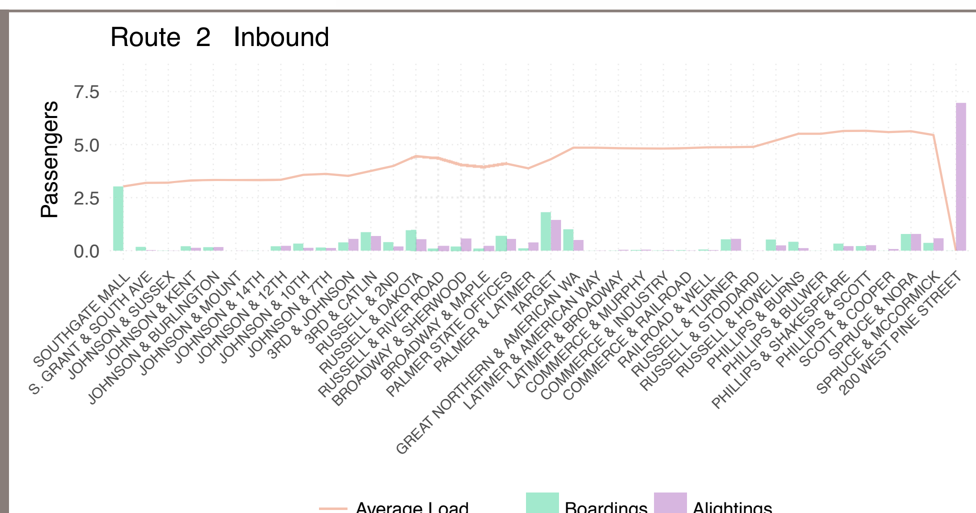
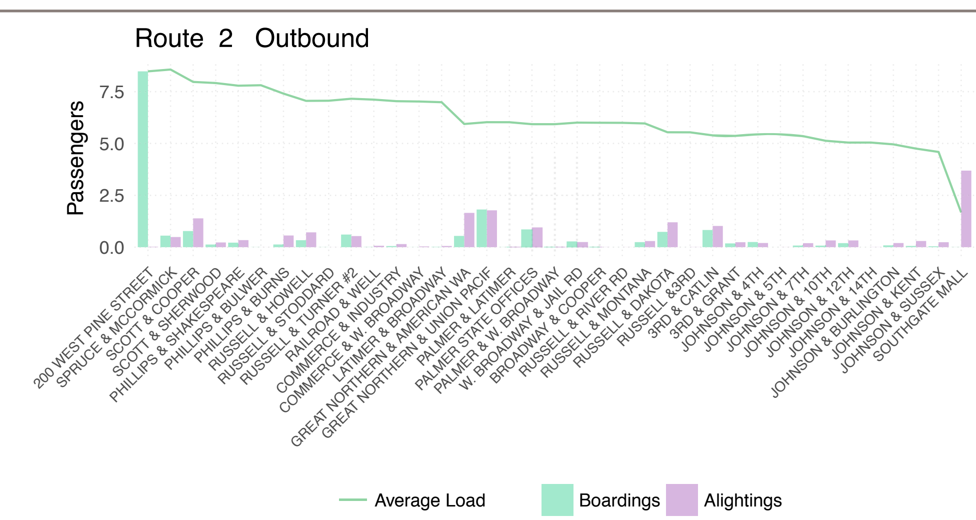
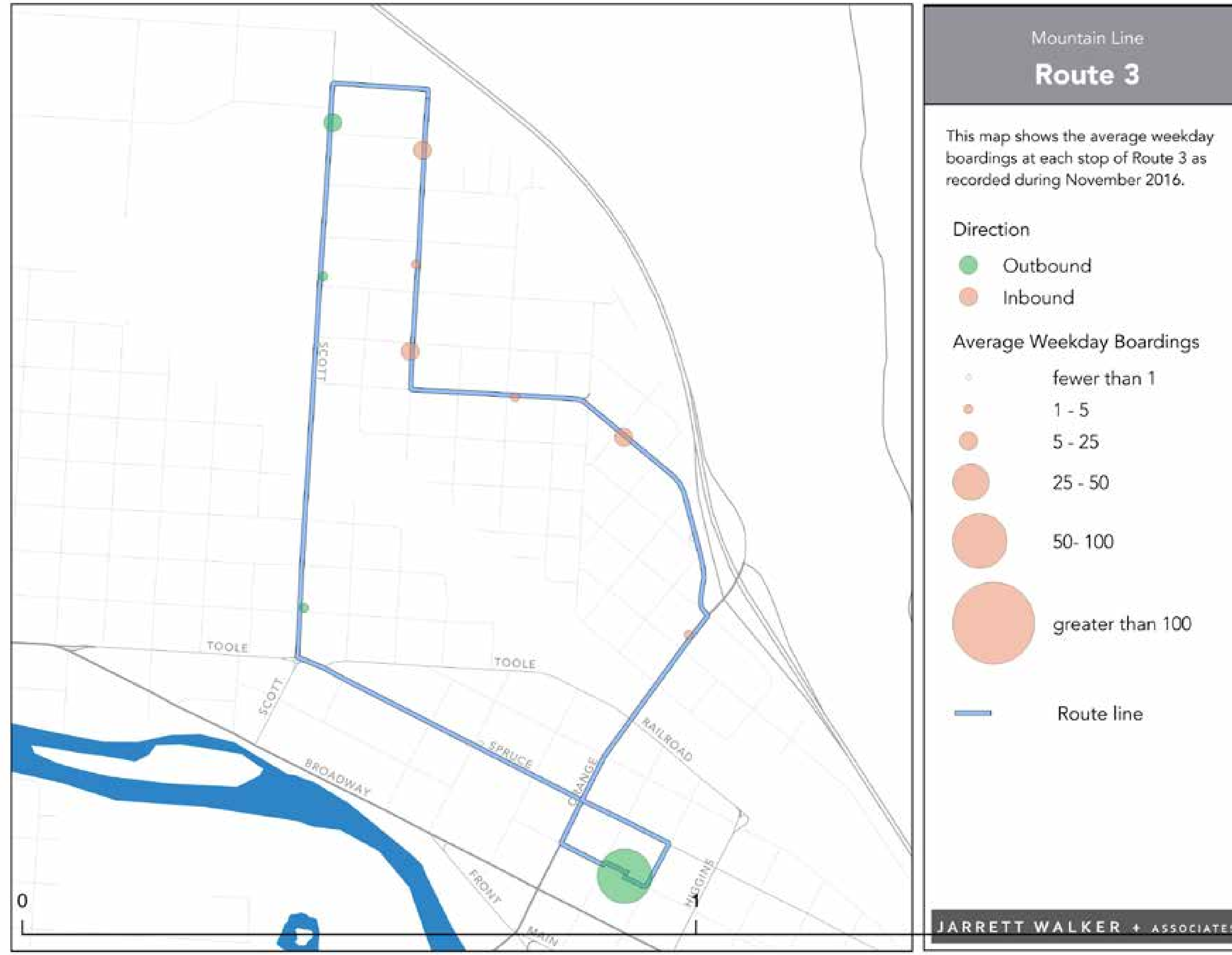




Profile of Route 3



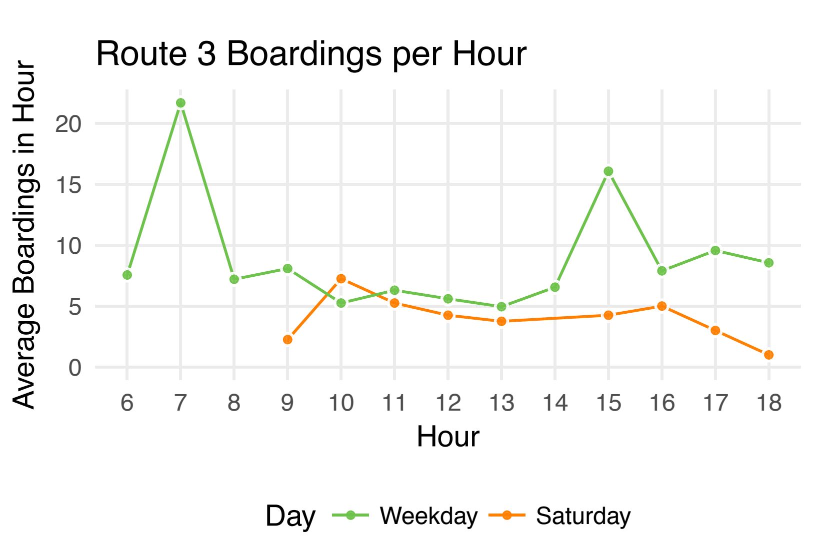
Route Parameters

Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	45	
Midday Frequency	60	60
PM Frequency (weekday only)	45	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:30 am	10:30 am
End of Service	7:00 pm	5:15 pm
Span (hrs)	12.5	6.75

Route Performance	Weekday	Saturday
Average Daily Boardings	115	36
Ridership Rank	10/12	10/10
Daily Revenue Hours	4.14	1.64
Productivity (Boardings per Revenue Hour)	28	22
Productivity Rank	5/12	7/10
Daily Revenue Miles	59	25
Daily Passenger Miles	149	52

Ridership by Hour



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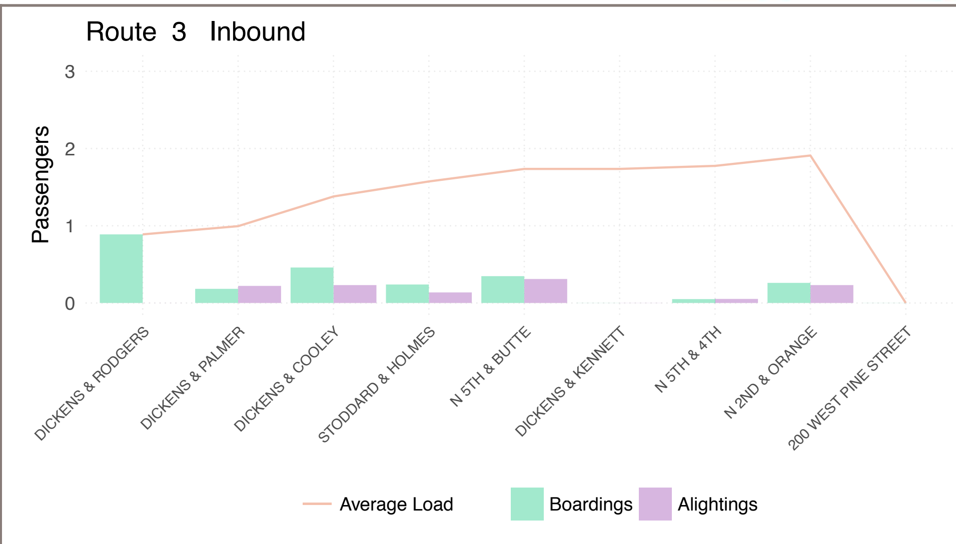
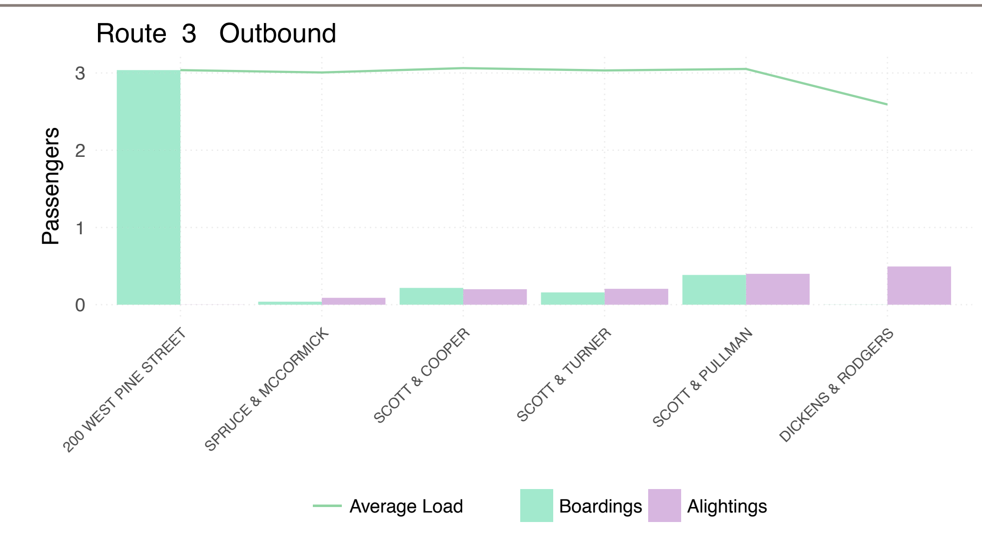




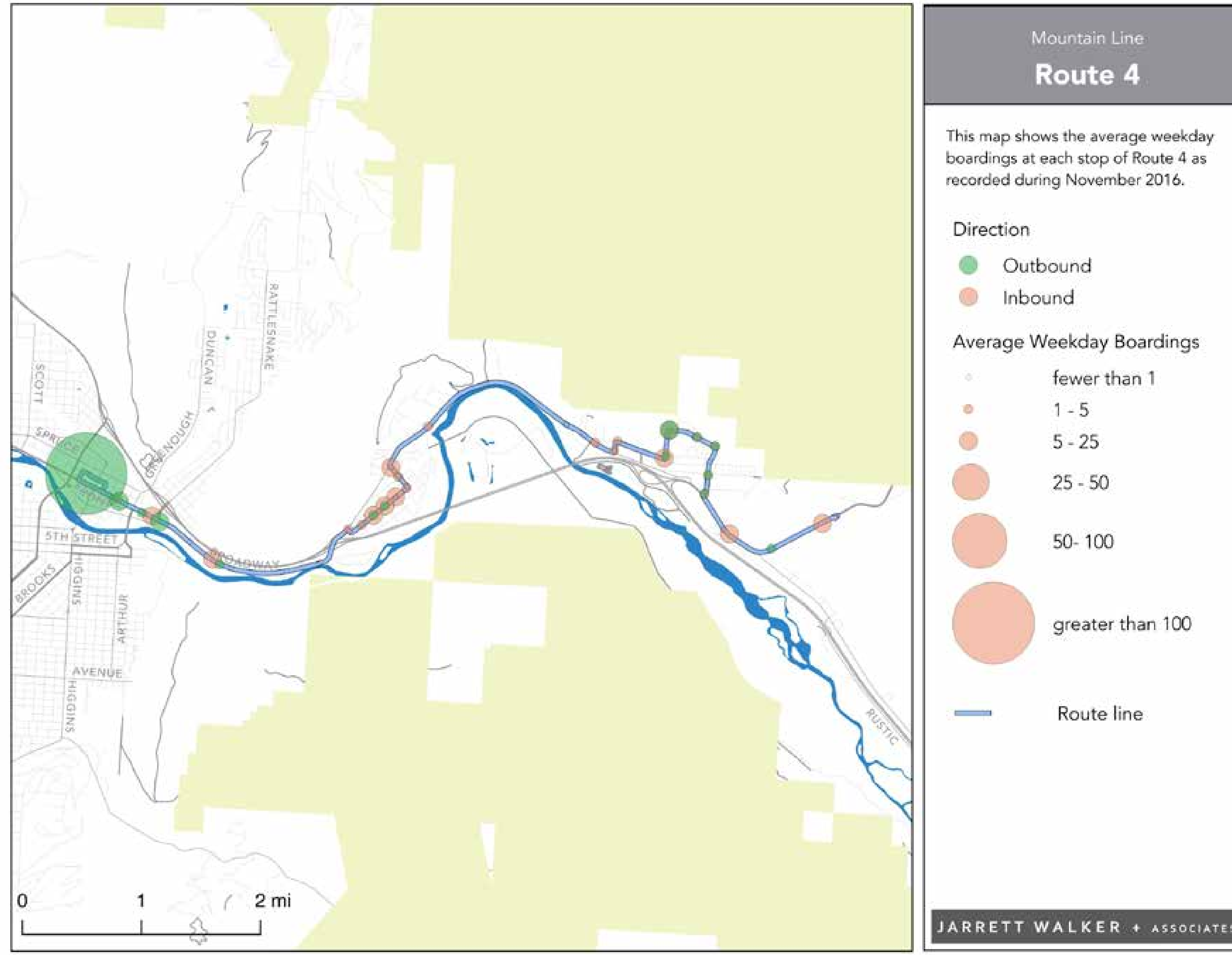
Profile of Route 4

Route Parameters

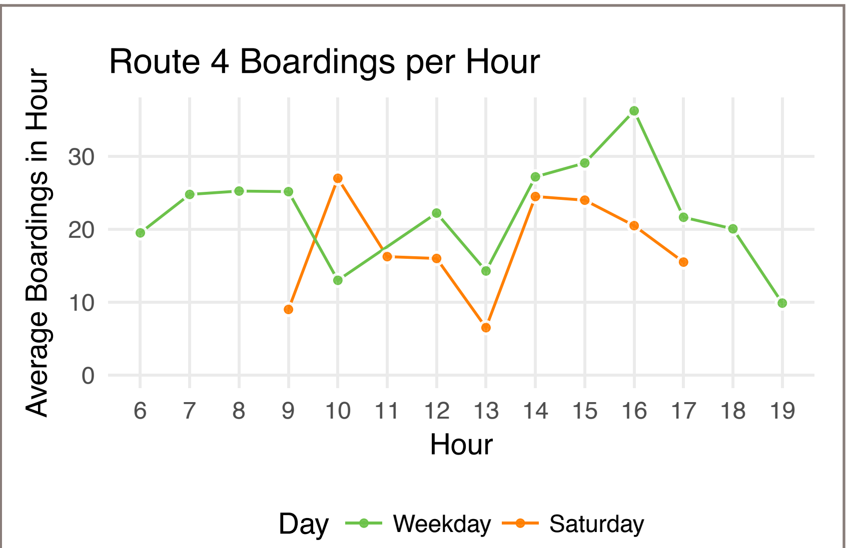
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	60	
Midday Frequency	60	60
PM Frequency (weekday only)	60	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:45 AM	9:45 AM
End of Service	7:00 PM	5:15 PM
Span (hrs)	12.25	7.5

Route Performance	Weekday	Saturday
Average Daily Boardings	288	159
Ridership Rank	6/12	5/10
Daily Revenue Hours	9.75	6.58
Productivity (Boardings per Revenue Hour)	30	24
Productivity Rank	4/12	6/10
Daily Revenue Miles	195	133
Daily Passenger Miles	1,217	675



Ridership by Hour



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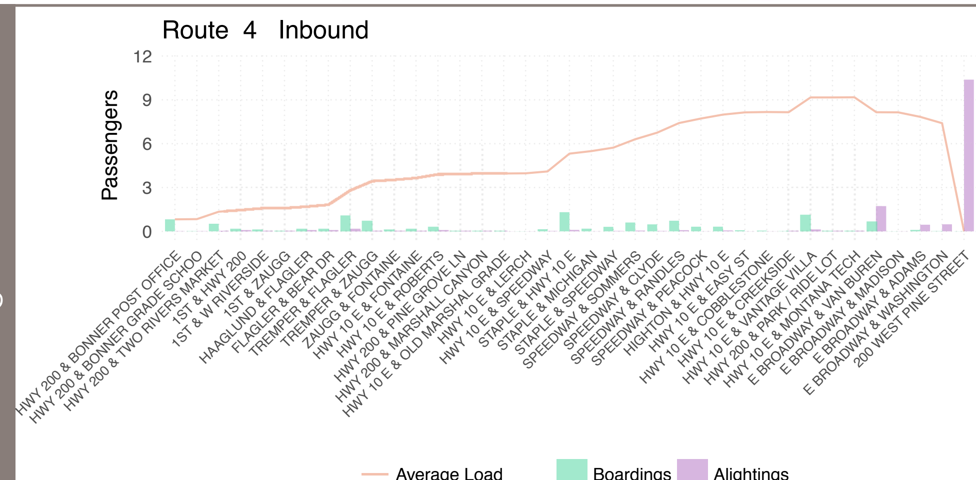
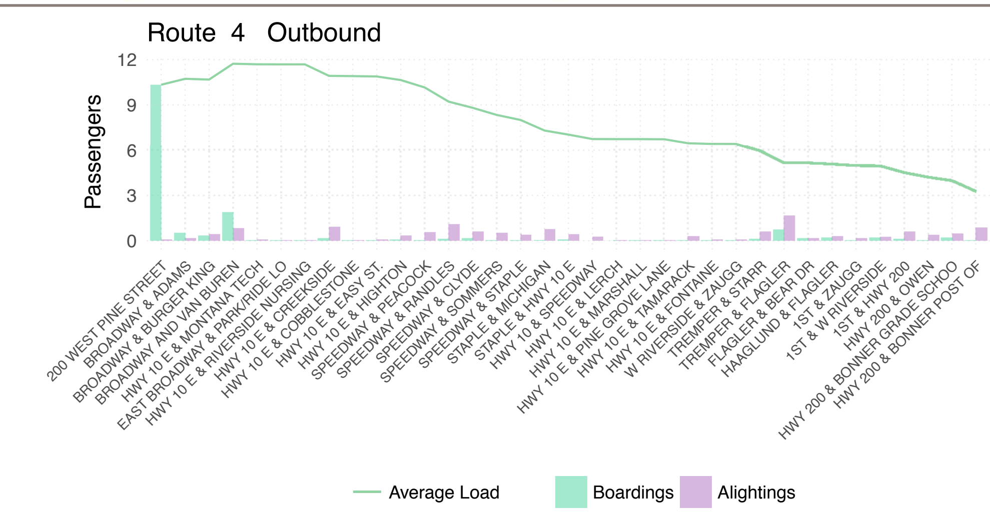




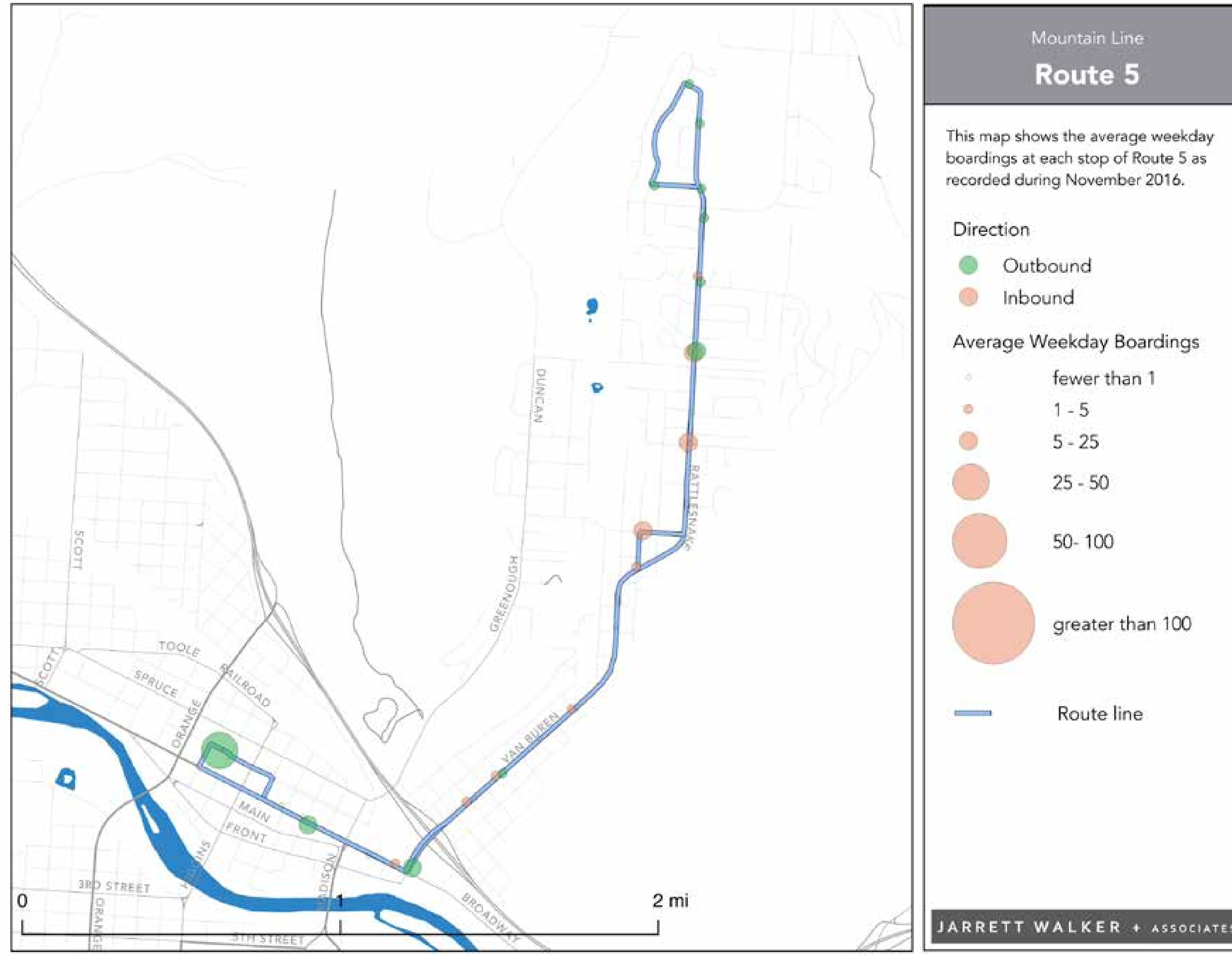
Profile of Route 5

Route Parameters

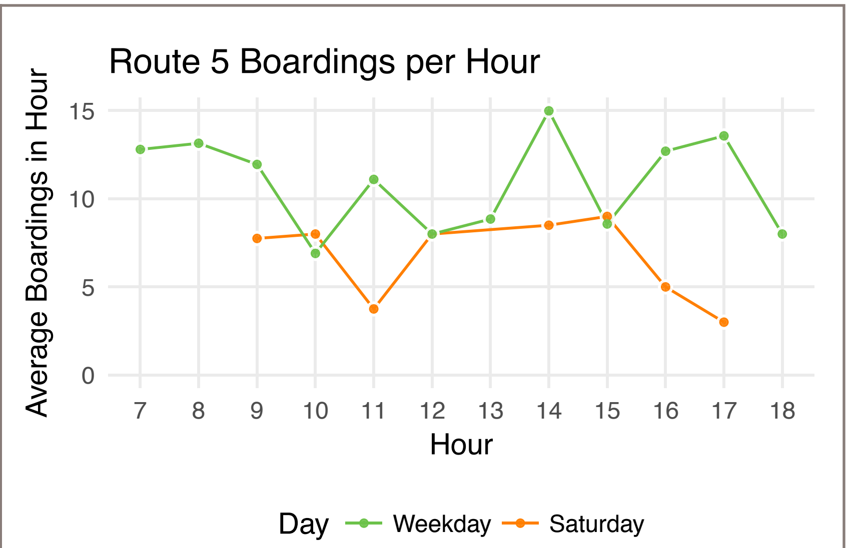
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	60	
Midday Frequency	60	60
PM Frequency (weekday only)	60	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	7:15 AM	9:45 AM
End of Service	6:45 PM	5:45 PM
Span (hrs)	11.5	8

Route Performance	Weekday	Saturday
Average Daily Boardings	131	53
Ridership Rank	9/12	8/10
Daily Revenue Hours	5.65	3.46
Productivity (Boardings per Revenue Hour)	23	15
Productivity Rank	8/12	9/10
Daily Revenue Miles	93	58
Daily Passenger Miles	252	116



Ridership by Hour



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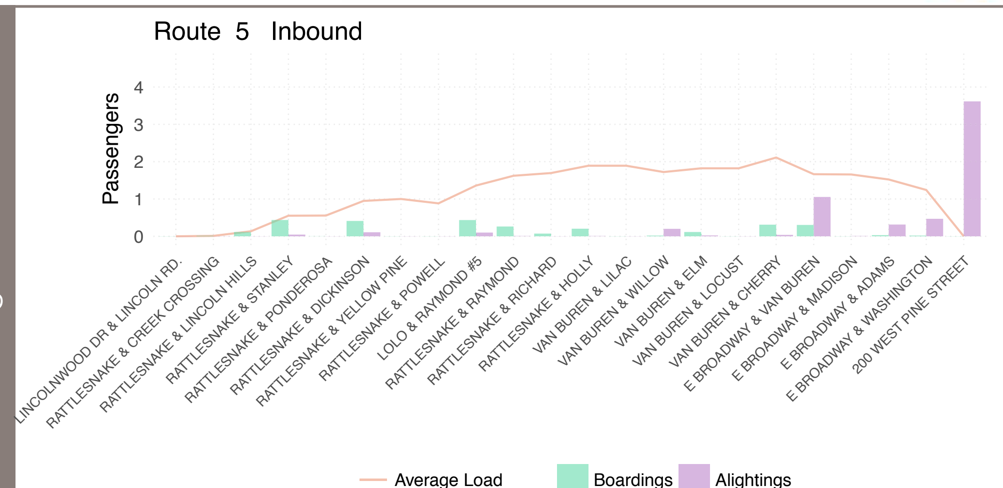
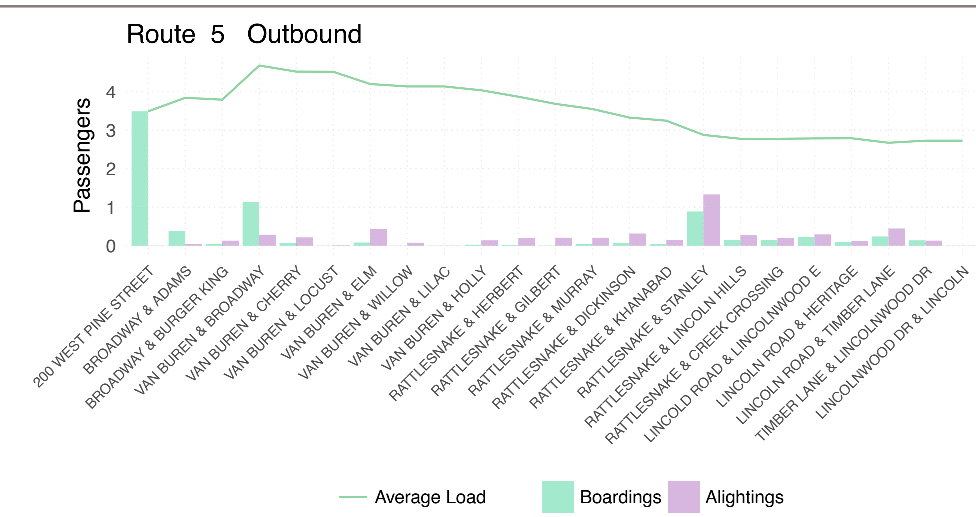
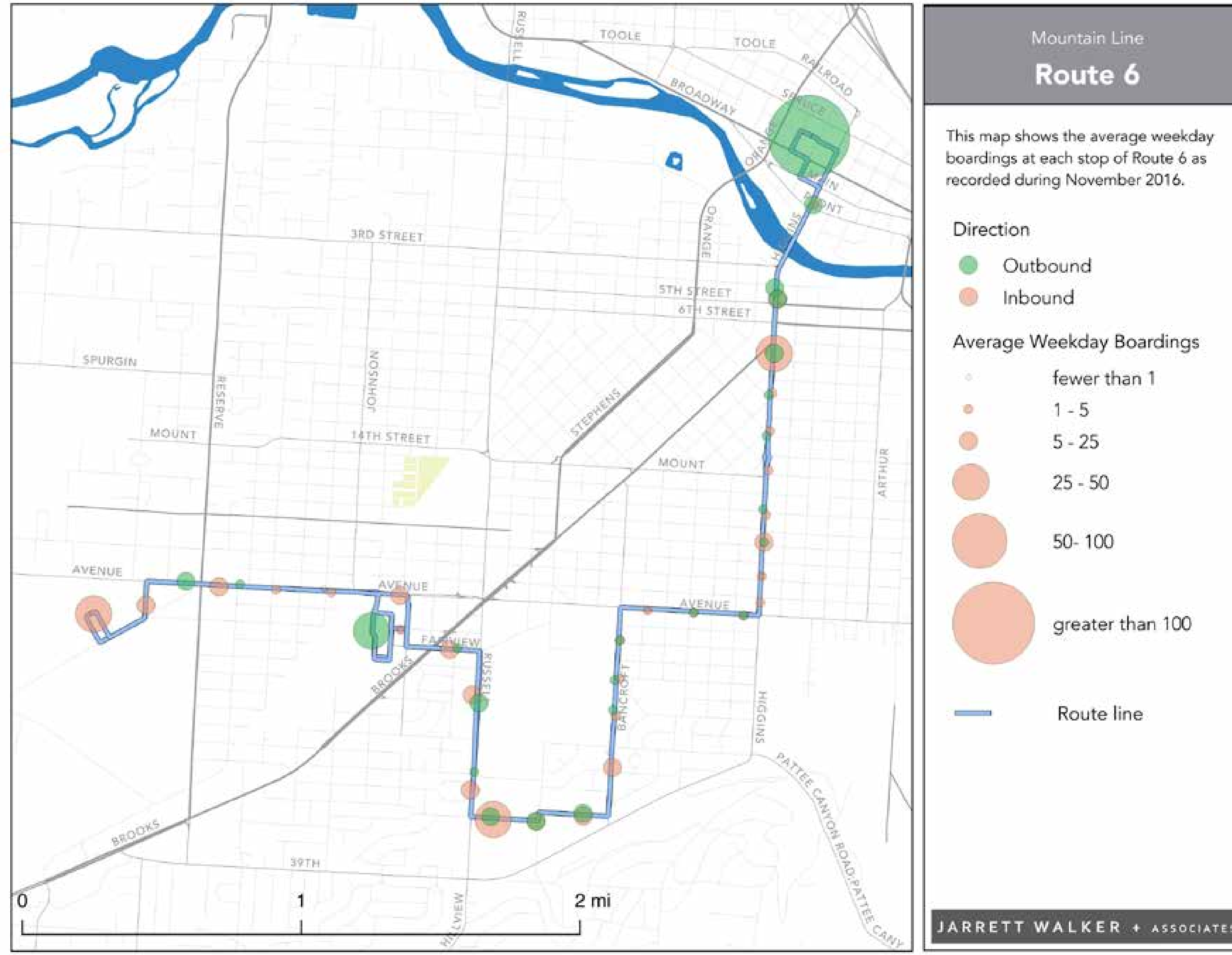




Profile of Route 6



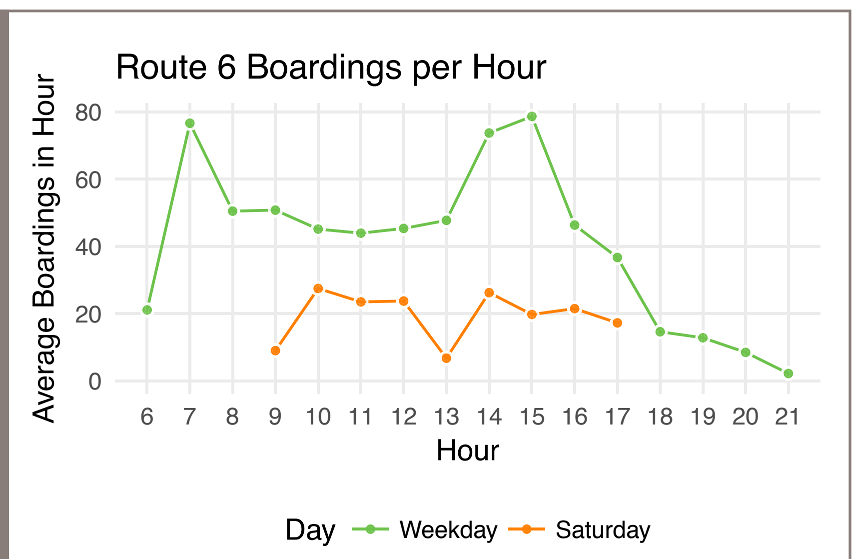
Route Parameters

Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	30	
Midday Frequency	30	60
PM Frequency (weekday only)	30	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:45 AM	9:45 AM
End of Service	9:45 PM	6:10 PM
Span (hrs)	15	8.4

Route Performance	Weekday	Saturday
Average Daily Boardings	655	175
Ridership Rank	3/12	4/10
Daily Revenue Hours	23.79	6.79
Productivity (Boardings per Revenue Hour)	28	26
Productivity Rank	6/12	5/10
Daily Revenue Miles	317	96
Daily Passenger Miles	1,515	487

Ridership by Hour



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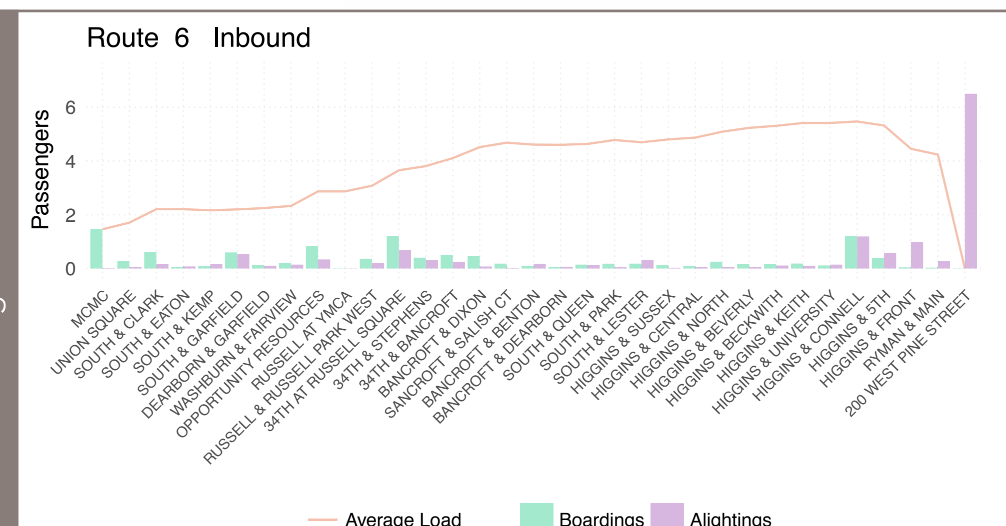
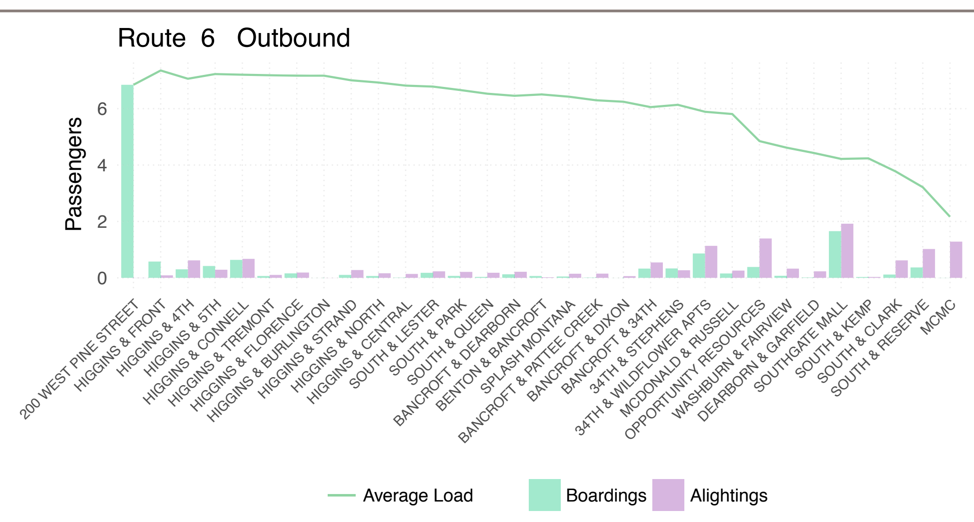




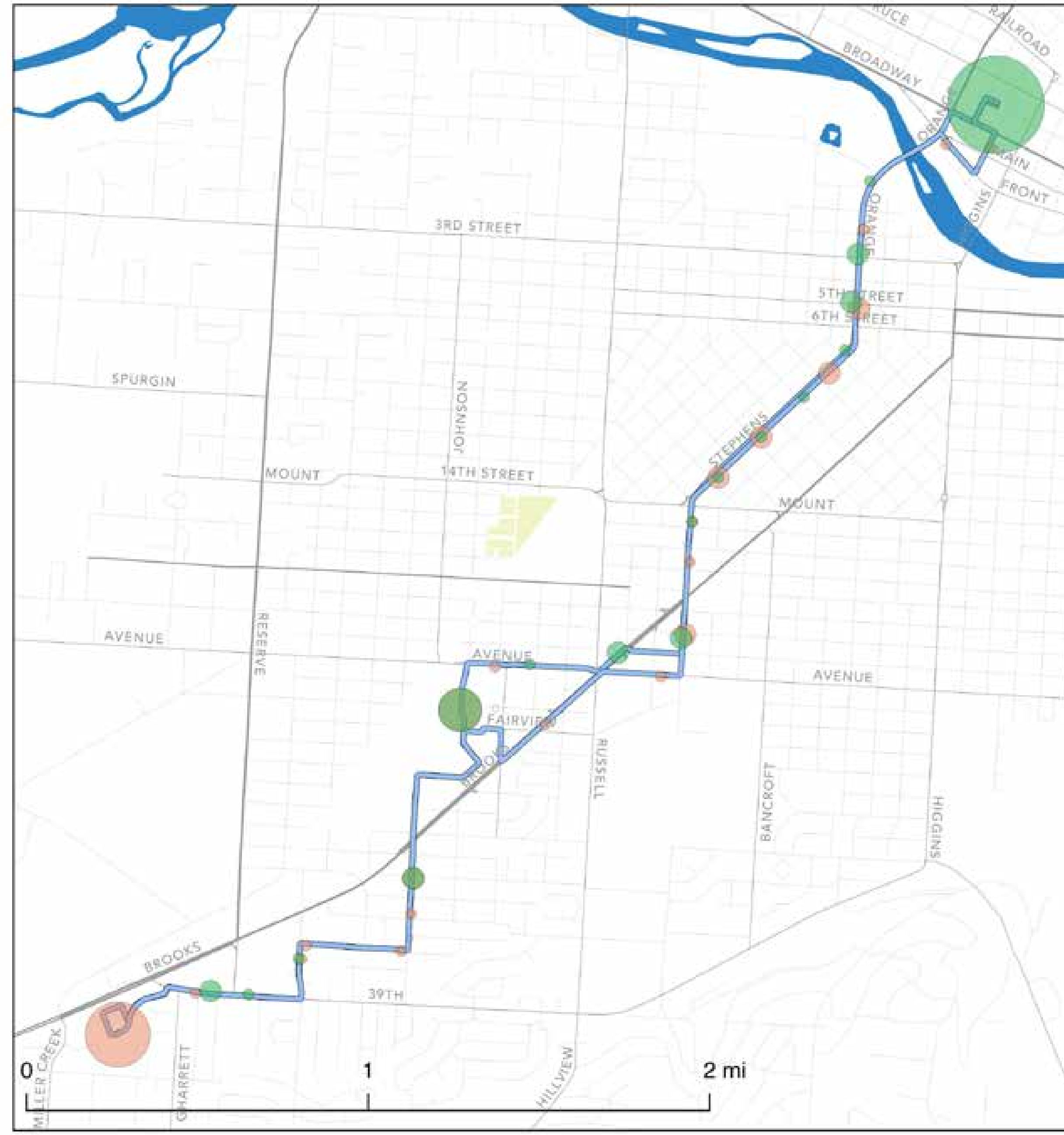
Profile of Route 7

Route Parameters

Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	30	
Midday Frequency	60	60
PM Frequency (weekday only)	30	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:45 AM	9:45 AM
End of Service	9:45 PM	6:15 PM
Span (hrs)	15	8.5

Route Performance	Weekday	Saturday
Average Daily Boardings	468	257
Ridership Rank	4/12	2/10
Daily Revenue Hours	17.10	6.94
Productivity (Boardings per Revenue Hour)	27	37
Productivity Rank	7/12	2/10
Daily Revenue Miles	200.65	81.9
Daily Passenger Miles	1,049	730



Mountain Line

Route 7

This map shows the average weekday boardings at each stop of Route 7 as recorded during November 2016.

Direction

- Outbound
- Inbound

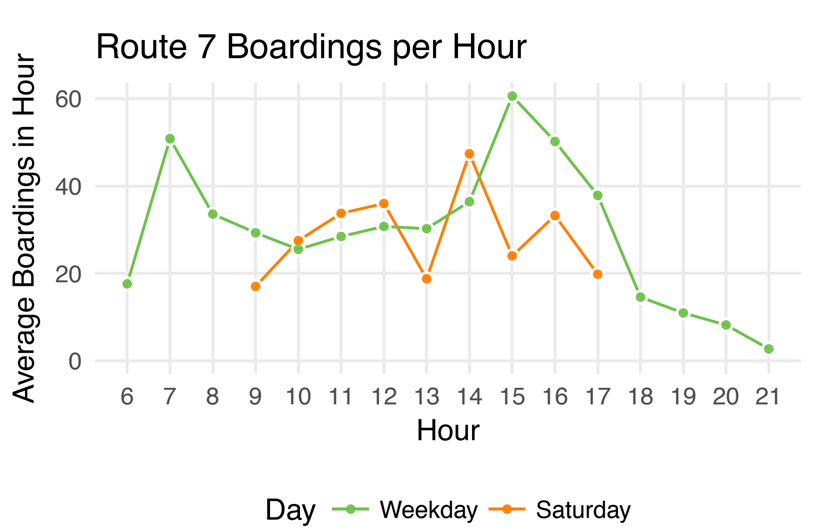
Average Weekday Boardings

- fewer than 1
- 1 - 5
- 5 - 25
- 25 - 50
- 50- 100
- greater than 100

Route line

JARRETT WALKER + ASSOCIATES

Ridership by Hour



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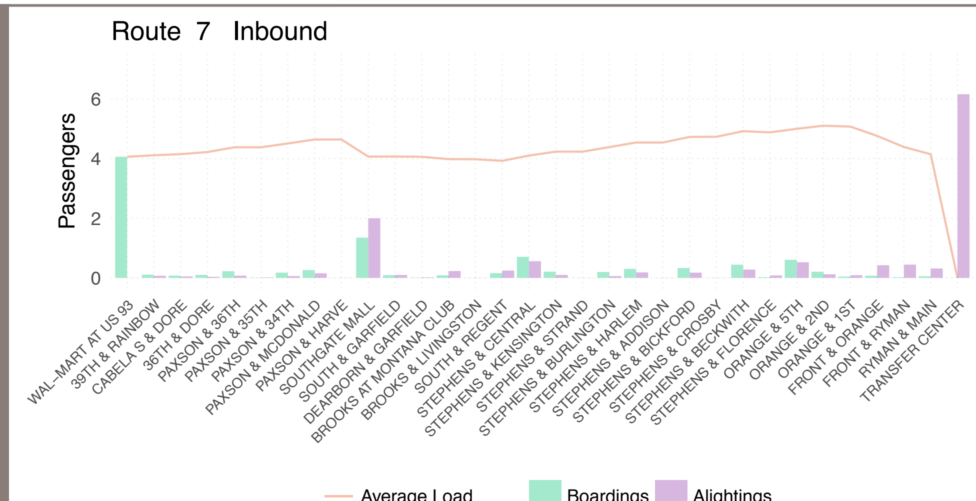
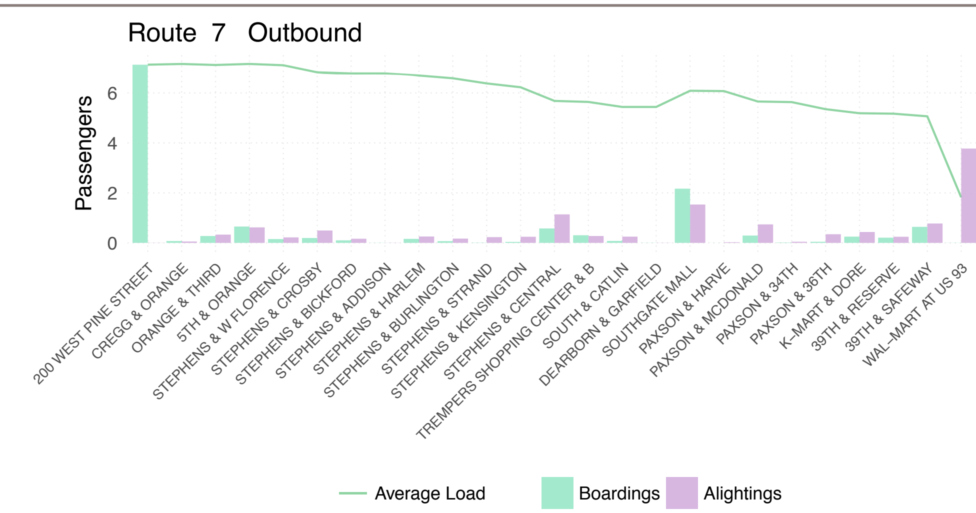




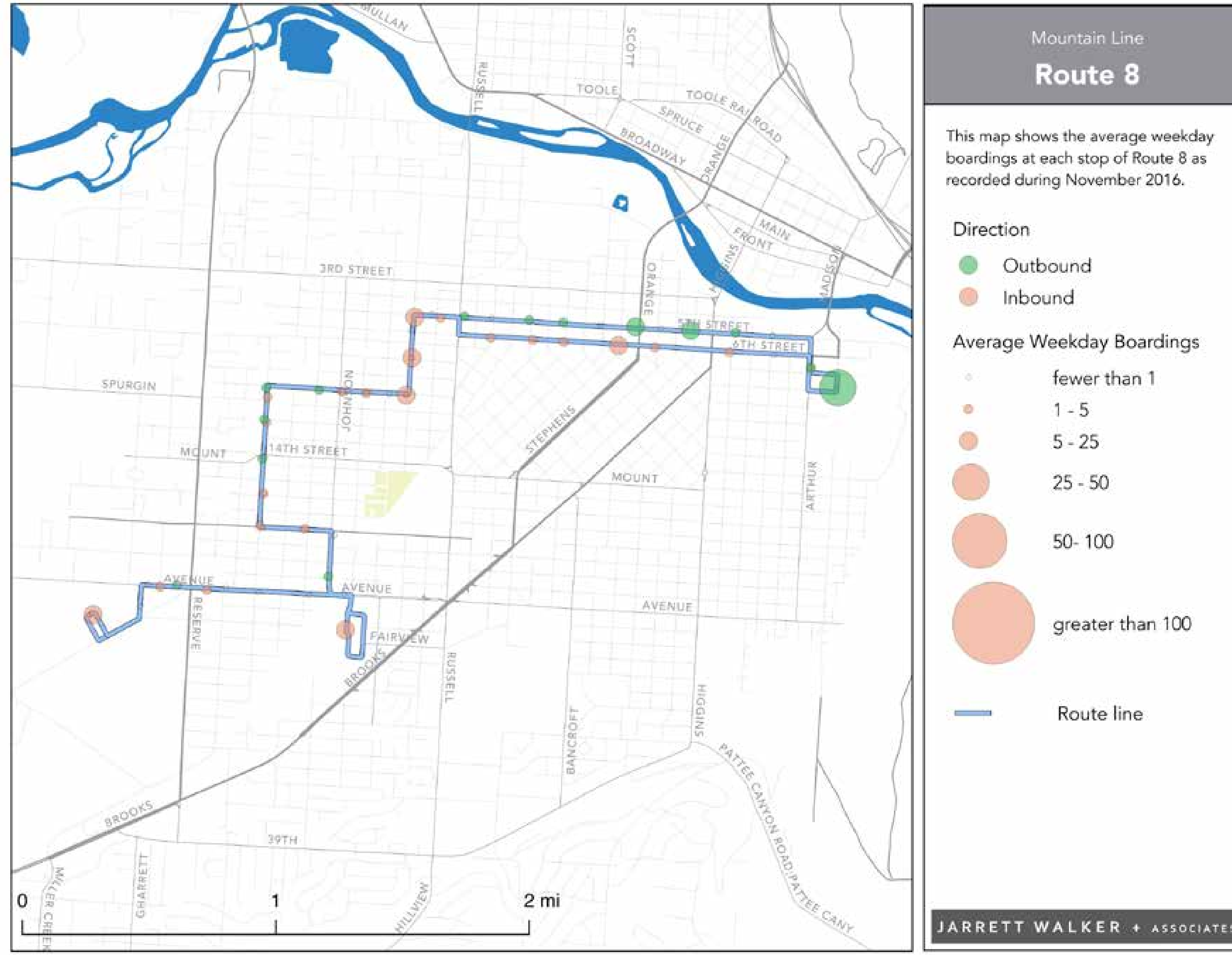
Profile of Route 8

Route Parameters

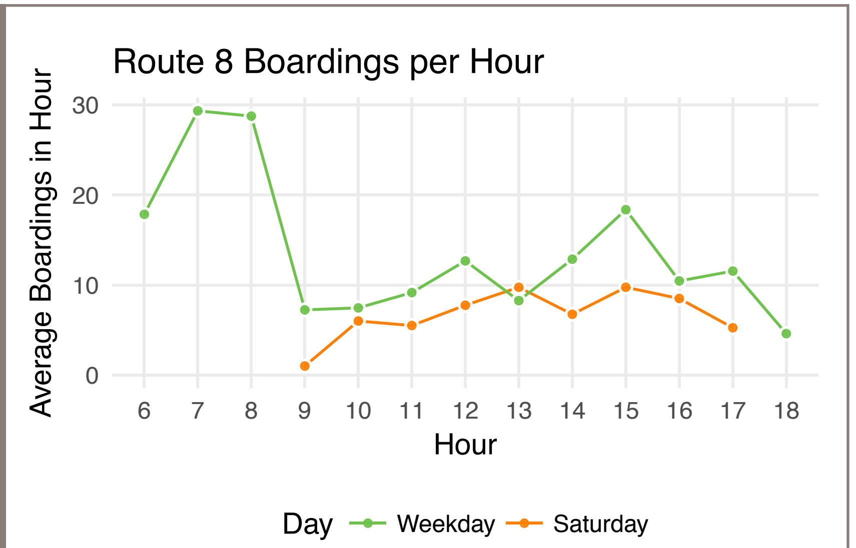
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	30	
Midday Frequency	60	60
PM Frequency (weekday only)	60	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:54 AM	9:54 AM
End of Service	6:22 PM	6:22 PM
Span (hrs)	11:28	8:28

Route Performance	Weekday	Saturday
Average Daily Boardings	178	60
Ridership Rank	7/12	7/10
Daily Revenue Hours	12.62	7.12
Productivity (Boardings per Revenue Hour)	14	8
Productivity Rank	12/12	10/10
Daily Revenue Miles	148.32	84.26
Daily Passenger Miles	402	173



Ridership by Hour



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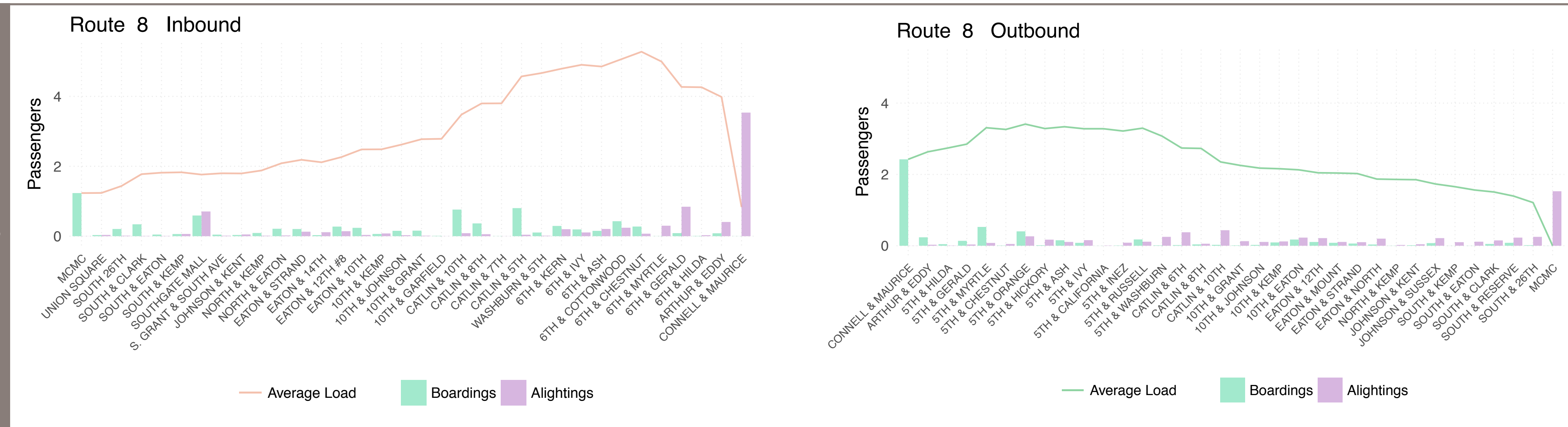


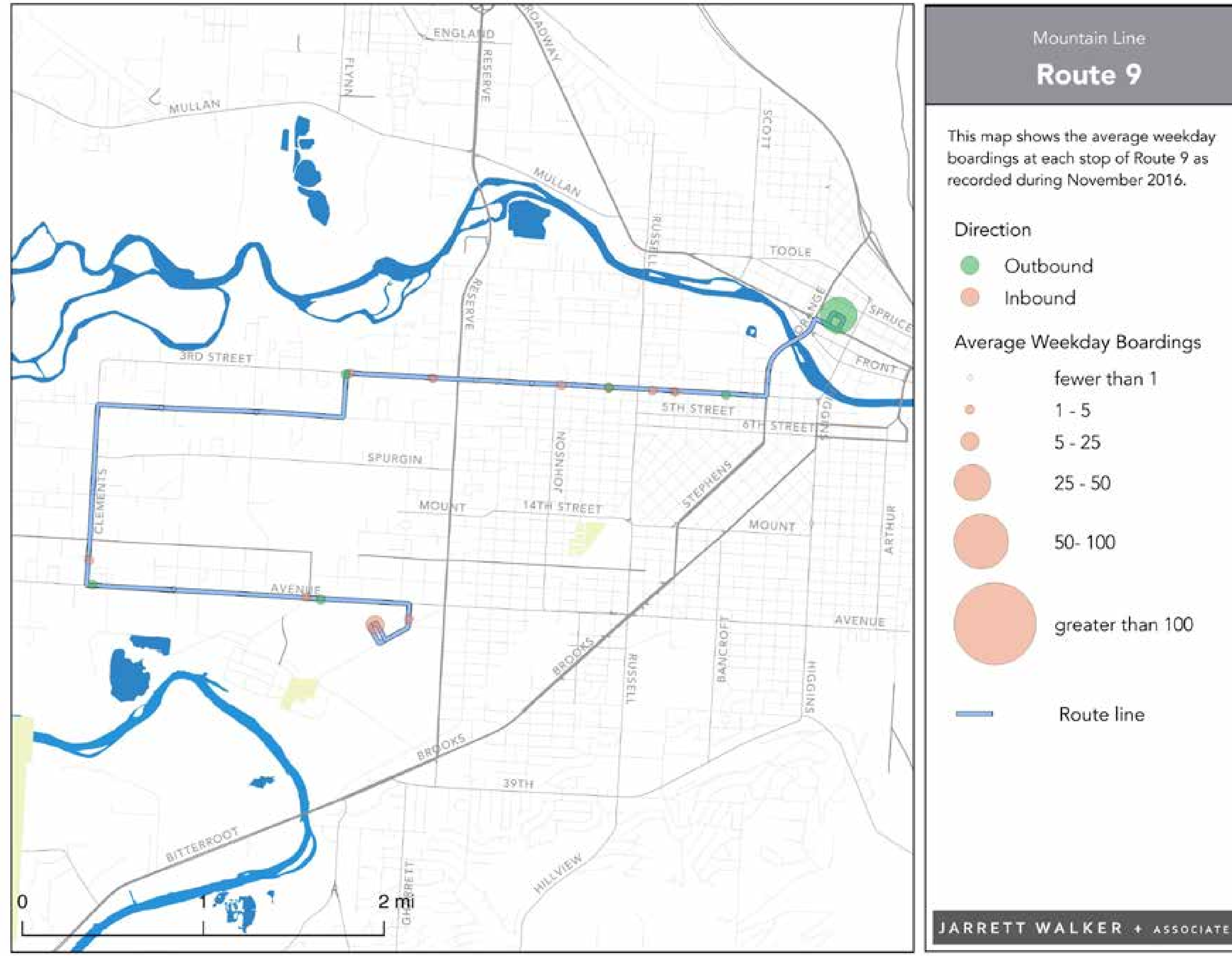
Profile of Route 9

Route Parameters

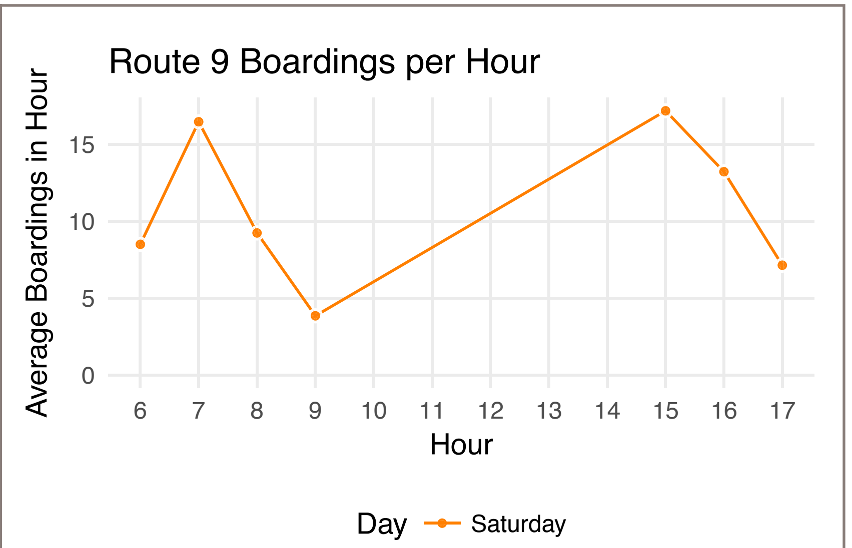
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	60	
Midday Frequency	60	
PM Frequency (weekday only)	60	
Evening Frequency	60	

Span of Service	Weekday	Saturday
Start of Service	6:45 AM	
End of Service	6:15 PM	
Span (hrs)	11:30	

Route Performance	Weekday	Saturday
Average Daily Boardings	76	
Ridership Rank	12/12	
Daily Revenue Hours	5.16	
Productivity (Boardings per Revenue Hour)	15	
Productivity Rank	11/12	
Daily Revenue Miles	95.42	
Daily Passenger Miles	298	



Ridership by Hour



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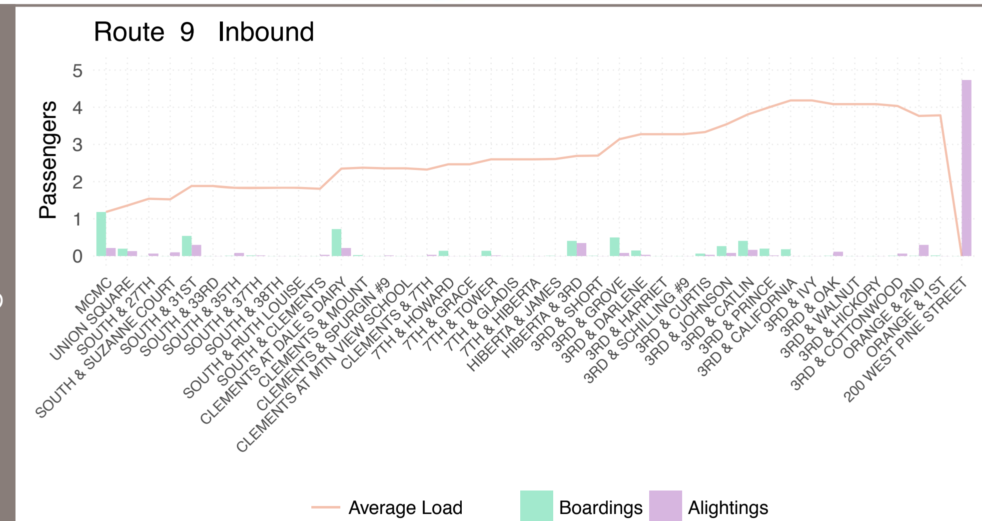
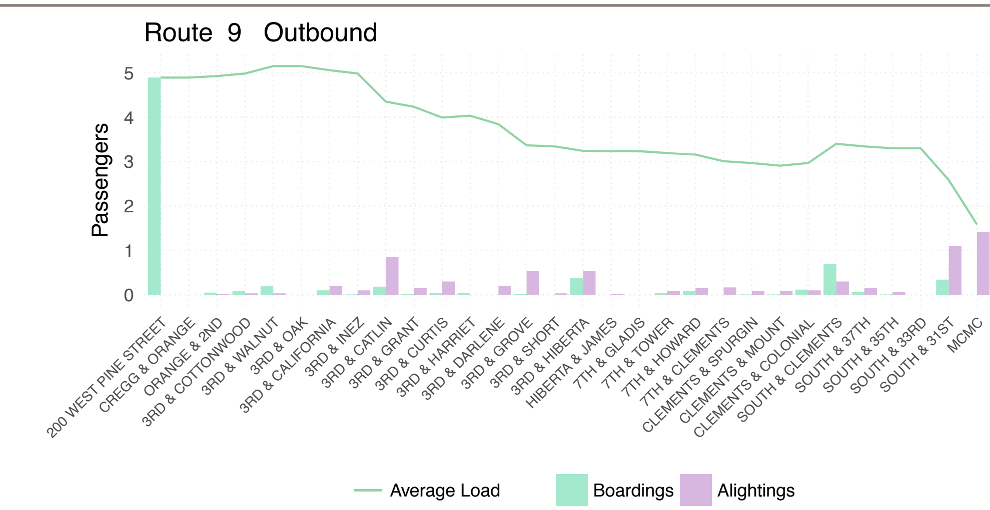




APPENDIX A: ROUTE PROFILES

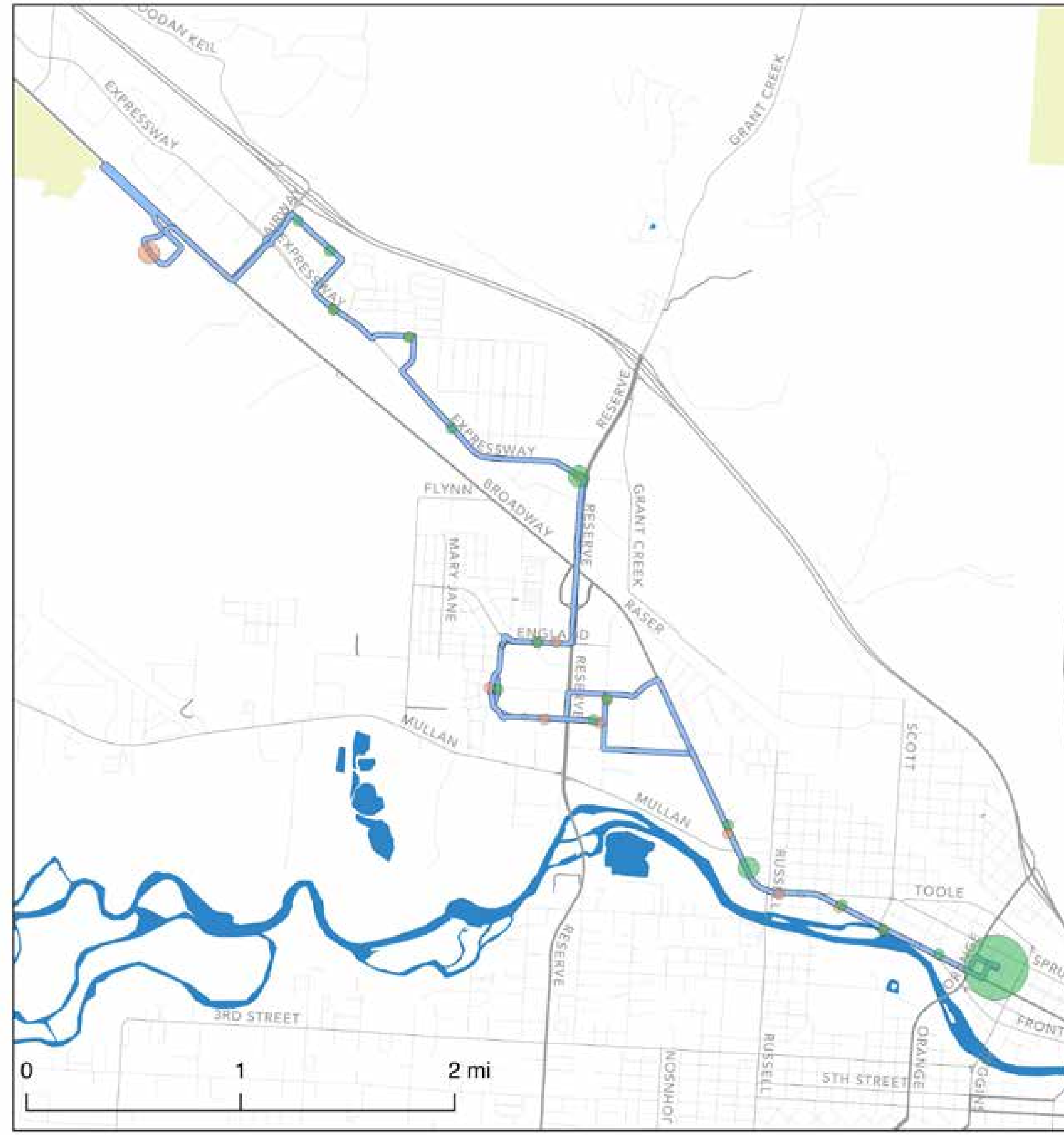
Profile of Route 11

Route Parameters

Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	60	
Midday Frequency	60	
PM Frequency (weekday only)	60	
Evening Frequency	120	

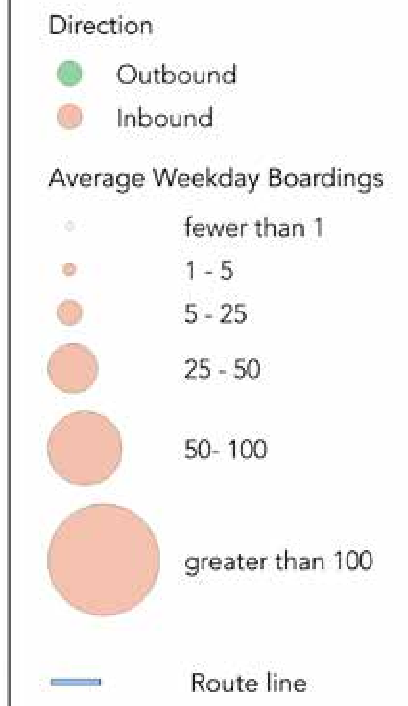
Span of Service	Weekday	Saturday
Start of Service	5:35 AM	
End of Service	8:15 PM	
Span (hrs)	14:40	

Route Performance	Weekday	Saturday
Average Daily Boardings	164	
Ridership Rank	8/12	
Daily Revenue Hours	8.60	
Productivity (Boardings per Revenue Hour)	19	
Productivity Rank	9/12	
Daily Revenue Miles	145.13	
Daily Passenger Miles	578	



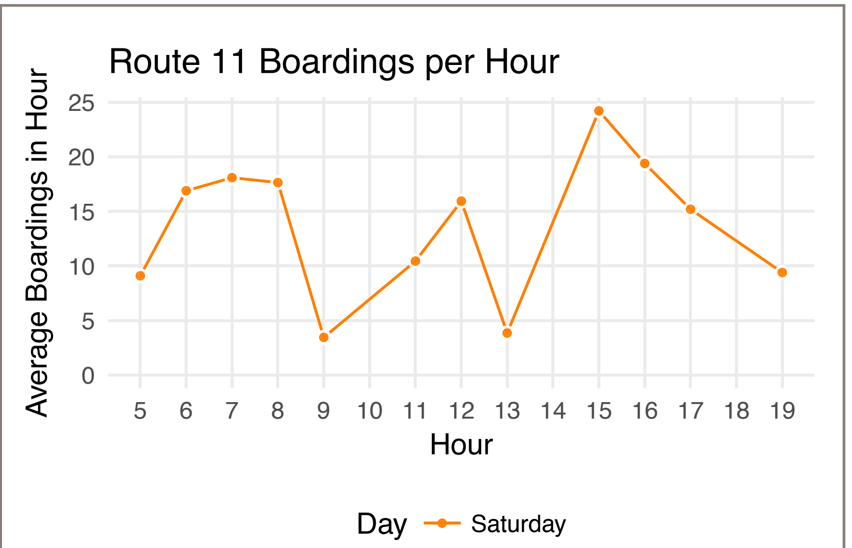
Mountain Line
Route 11

This map shows the average weekday boardings at each stop of Route 11 as recorded during November 2016.



JARRETT WALKER + ASSOCIATES

Ridership by Hour



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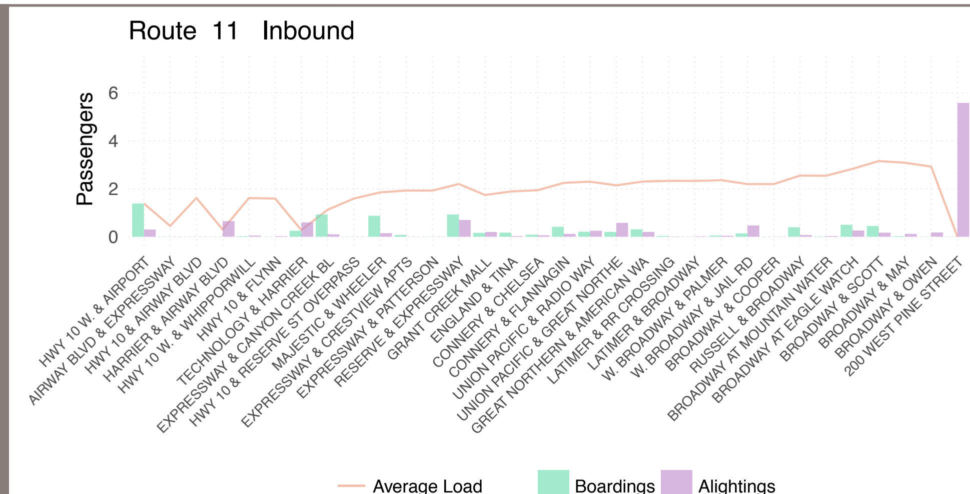
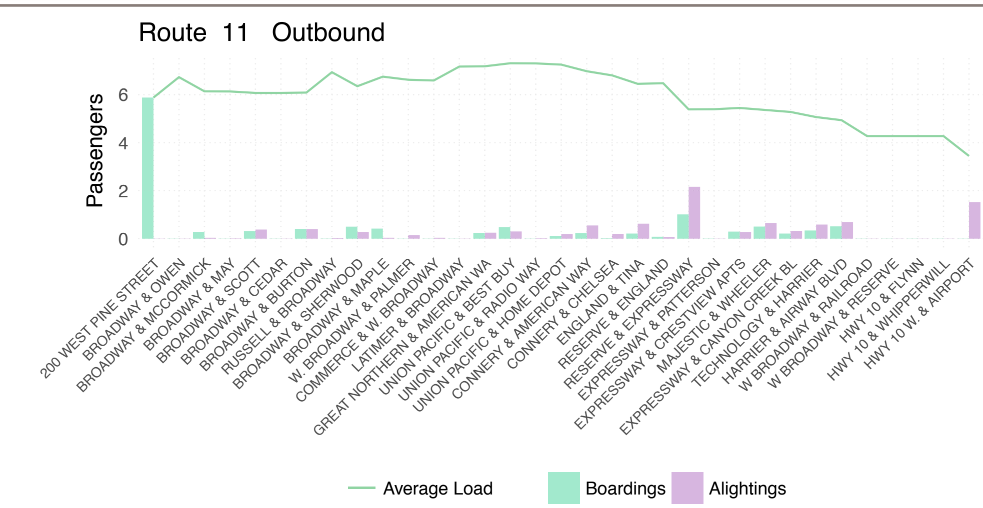




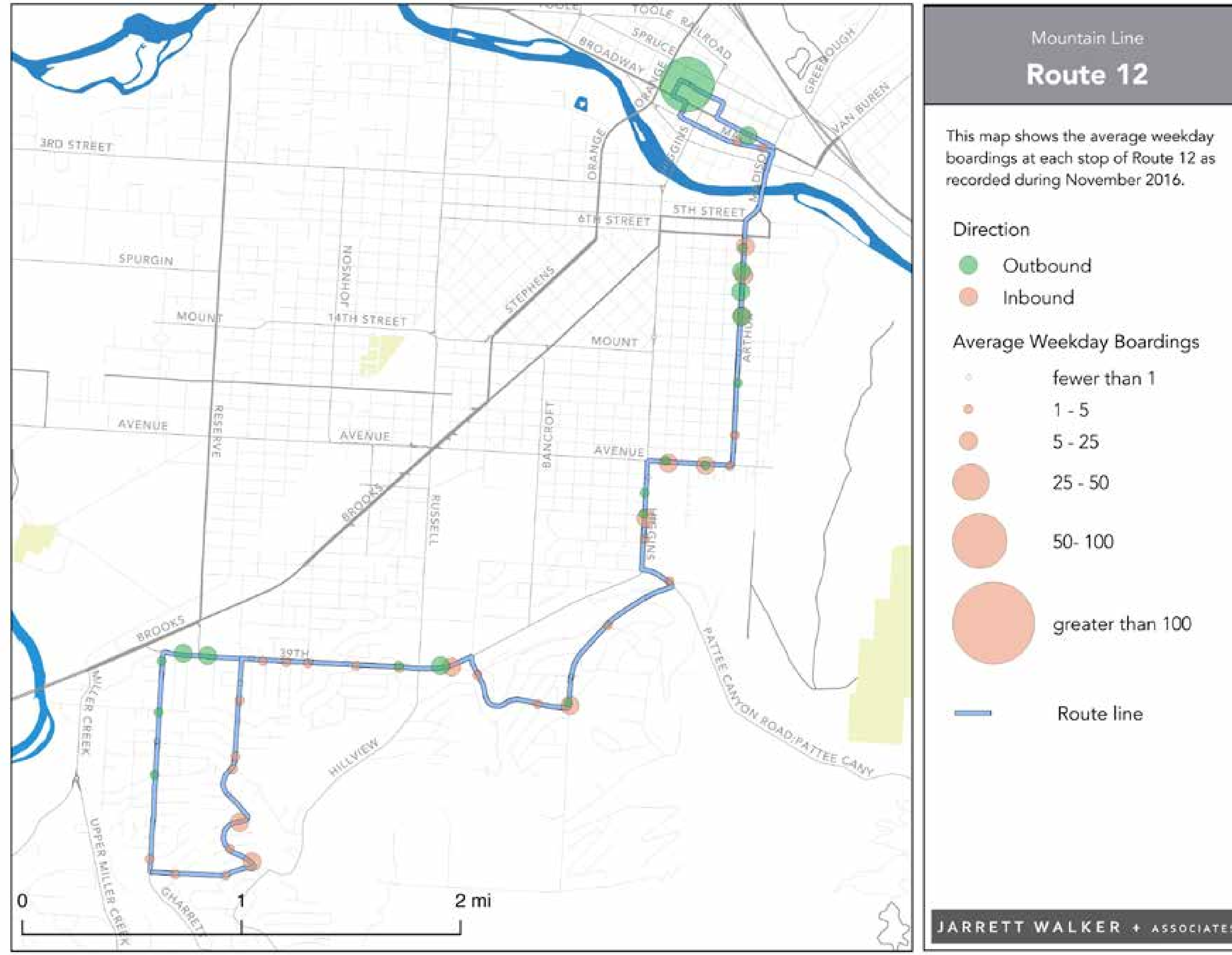
Profile of Route 12

Route Parameters

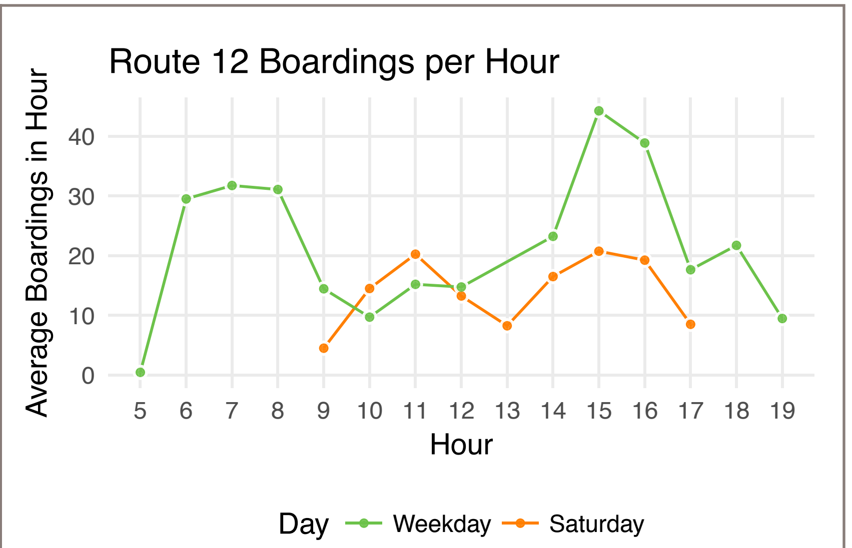
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	30	
Midday Frequency	60	60
PM Frequency (weekday only)	30	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	6:30 AM	9:45 AM
End of Service	7:15 PM	5:15 PM
Span (hrs)	12:45	7:30

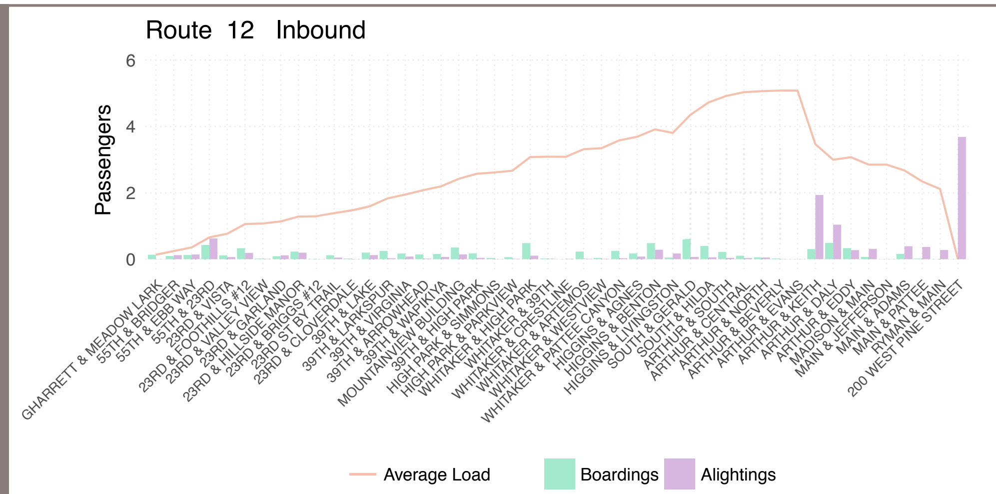
Route Performance	Weekday	Saturday
Average Daily Boardings	302	126
Ridership Rank	5/12	6/10
Daily Revenue Hours	16.52	6.90
Productivity (Boardings per Revenue Hour)	18	18
Productivity Rank	10/12	8/10
Daily Revenue Miles	243.71	103.05
Daily Passenger Miles	864	425

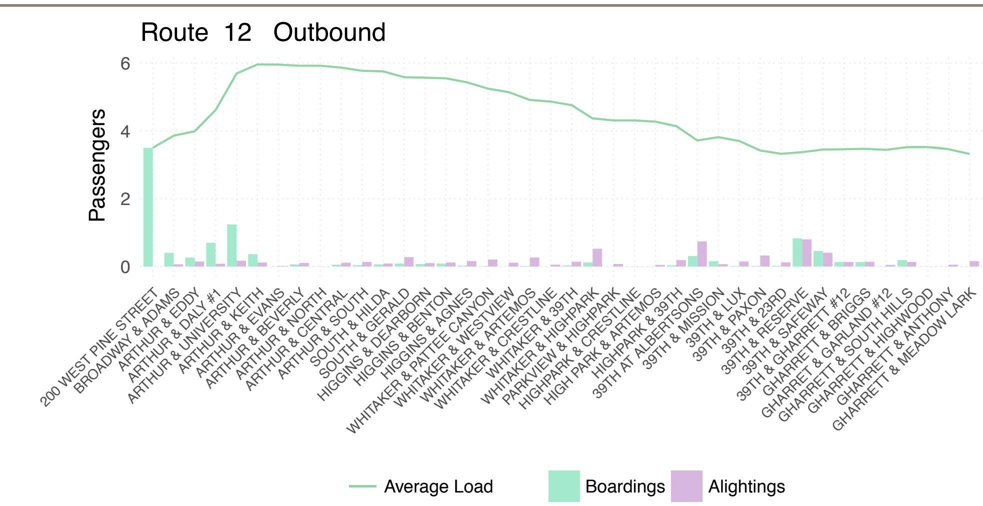


Ridership by Hour



Average Load





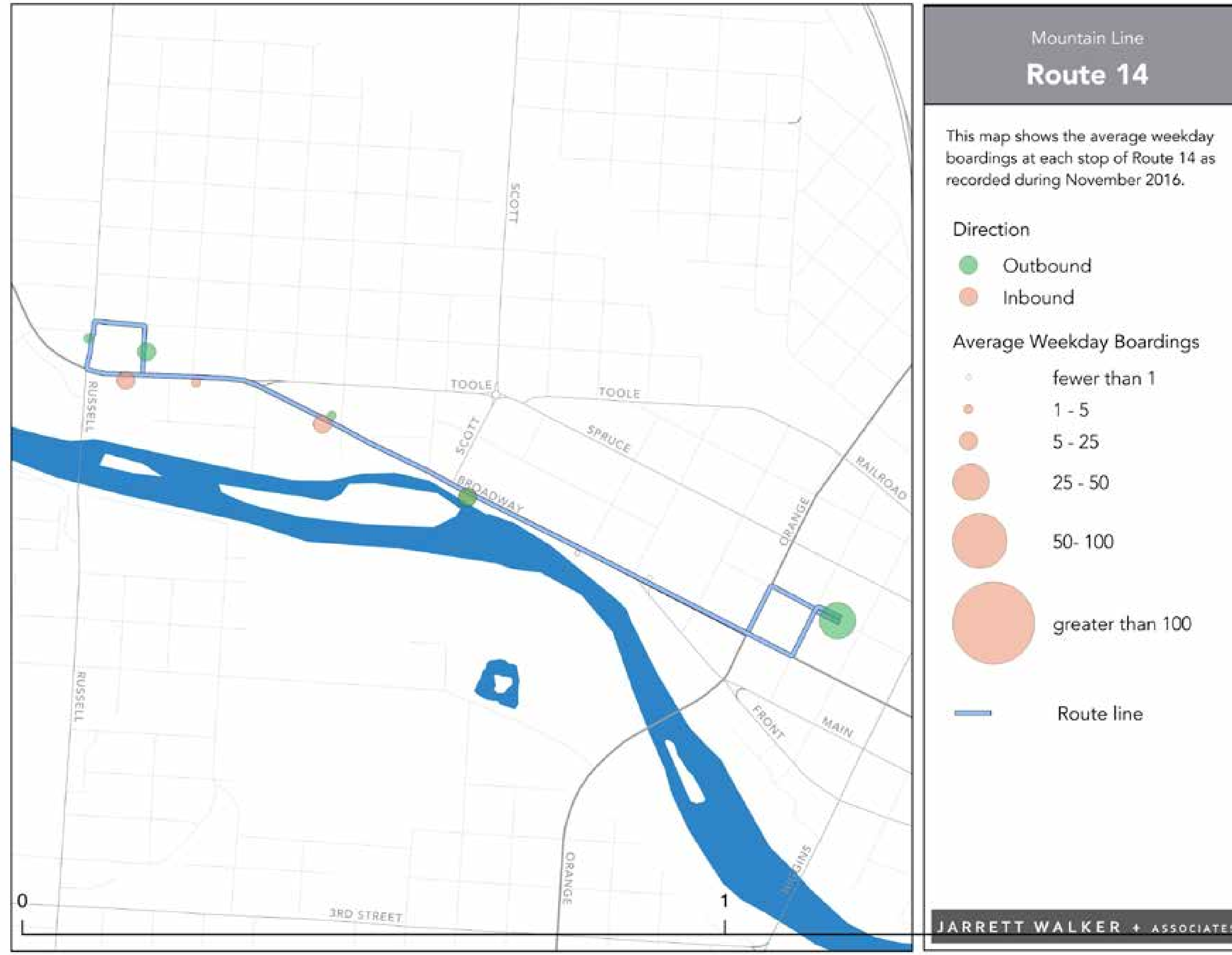
Profile of Route 14

Route Parameters

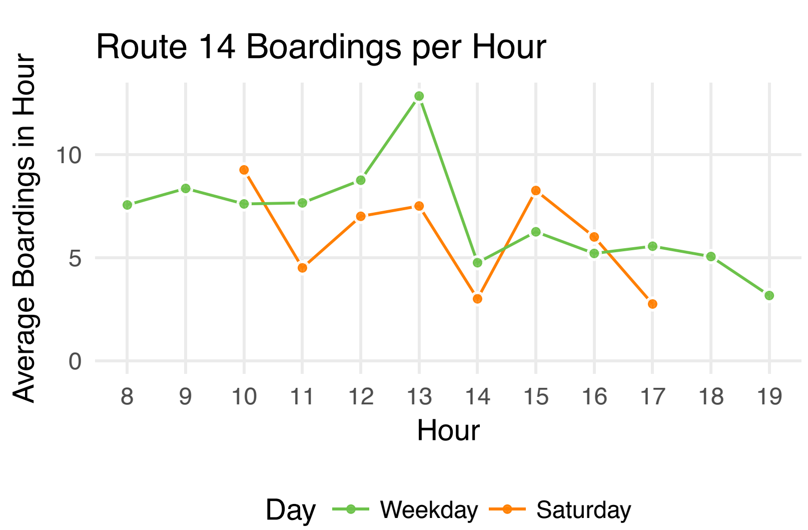
Frequency by Time Period	Weekday	Saturday
AM Frequency (weekday only)	60	
Midday Frequency	60	60
PM Frequency (weekday only)	60	
Evening Frequency	60	60

Span of Service	Weekday	Saturday
Start of Service	8:00 AM	10:15 AM
End of Service	7:15 PM	6:00 PM
Span (hrs)	11:15	7:45

Route Performance	Weekday	Saturday
Average Daily Boardings	83	48
Ridership Rank	11/12	9/10
Daily Revenue Hours	2.78	1.61
Productivity (Boardings per Revenue Hour)	30	30
Productivity Rank	3/12	4/10
Daily Revenue Miles	30.61	18.20
Daily Passenger Miles	68	43



Ridership by Hour



Average Load