Paving the Way to Accessibility

Assessing Salt Lake City's Bicycle Network

Daniel Ritter
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This report satisfies a graduation requirement for the Master of City & Metropolitan Planning program at the University of Utah. It was completed under the supervision of Dr. Alessandro Rigolon. Sweet Streets SLC provided guidance on its direction, solicited participants for a workshop and interviews, and reviewed the report for factual accuracy. The report represents the opinions of its author and local bicyclists and does not necessarily represent the opinions of Sweet Streets.

Department of
CITY & METROPOLITAN PLANNING
THE UNIVERSITY OF UTAH

SWEET STREETS
SALT LAKE CITY

Executive Summary

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"It's a super outdoorsy city but no one feels safe biking in their own community."

Bicycling plays a critical role in connecting us to opportunities such as employment, healthcare, education, and more. However, bicyclists remain an afterthought in many places and the infrastructure that does exist is often uncomfortable, unsafe, and ineffective at connecting us with the places we want or need to go.

Salt Lake City has an extensive and rapidly growing bicycle network with strong crosstown corridors and a secondary network of neighborhood routes. However, bicyclists must often contend with heavy, fast-moving traffic on wide downtown streets or navigate the east-west divide created by the railroad tracks and Interstate 15. These conditions create barriers for bicycling, making it uncomfortable for all but the most fearless. Salt Lake City's transportation plan, which was adopted in May 2024, calls for an expanded low-stress bicycling network, which would enable residents to move comfortably to reach the places that matter to them.

Paving the Way to Accessibility evaluates Salt Lake City's bicycle network with a focus on comfort and access to opportunity. Its foundation is a routing analysis that assesses how comfortably residents can access different amenities by bicycle depending on where they live. This summary briefly describes the analysis before focusing on its key findings and recommendations.

This report was produced in collaboration with **Sweet Streets SLC**, who were instrumental in providing guidance on its direction and structure and recruiting local bicyclists for the community engagement phase.

Methodology

A routing analysis uses an algorithm to identify the best route between an origin and a destination using a network and a set of preferences and restrictions. The origins for this analysis were the center points of almost 2,500 census blocks in Salt Lake City, which represent where a typical resident may live. The destinations were the locations of amenities that someone may want or need to go on a regular basis, such as workplaces, schools, grocery stores, parks, healthcare facilities, government buildings, or places of worship.

The network consisted of streets, trails, and paths that can be used by local bicyclists. Each segment was assigned comfort and preference values, which were critical for instructing the algorithm and determining the access to opportunity score.

The comfort values were automatically assigned based on the presence and type of bicycle facilities and the speed limit. The preference values were manually assigned the account for the difference in perceived comfort while bicycling on a particular road and its actual infrastructure. For example, 700 East has a conventional bike lane in Sugar House but few people would feel comfortable using it given the speed and volume of traffic. These values were primarily based on input from local bicyclists during the community engagement phase of the report's creation, which included a workshop and interviews.

Next, the routing algorithm took these inputs and sought to find routes that maximized comfort and minimized distance traveled, essentially modeling the decisions that urban bicyclists make every time they decide to ride. It generated a route from every origin to every type of destination, resulting in almost 50,000 unique routes.

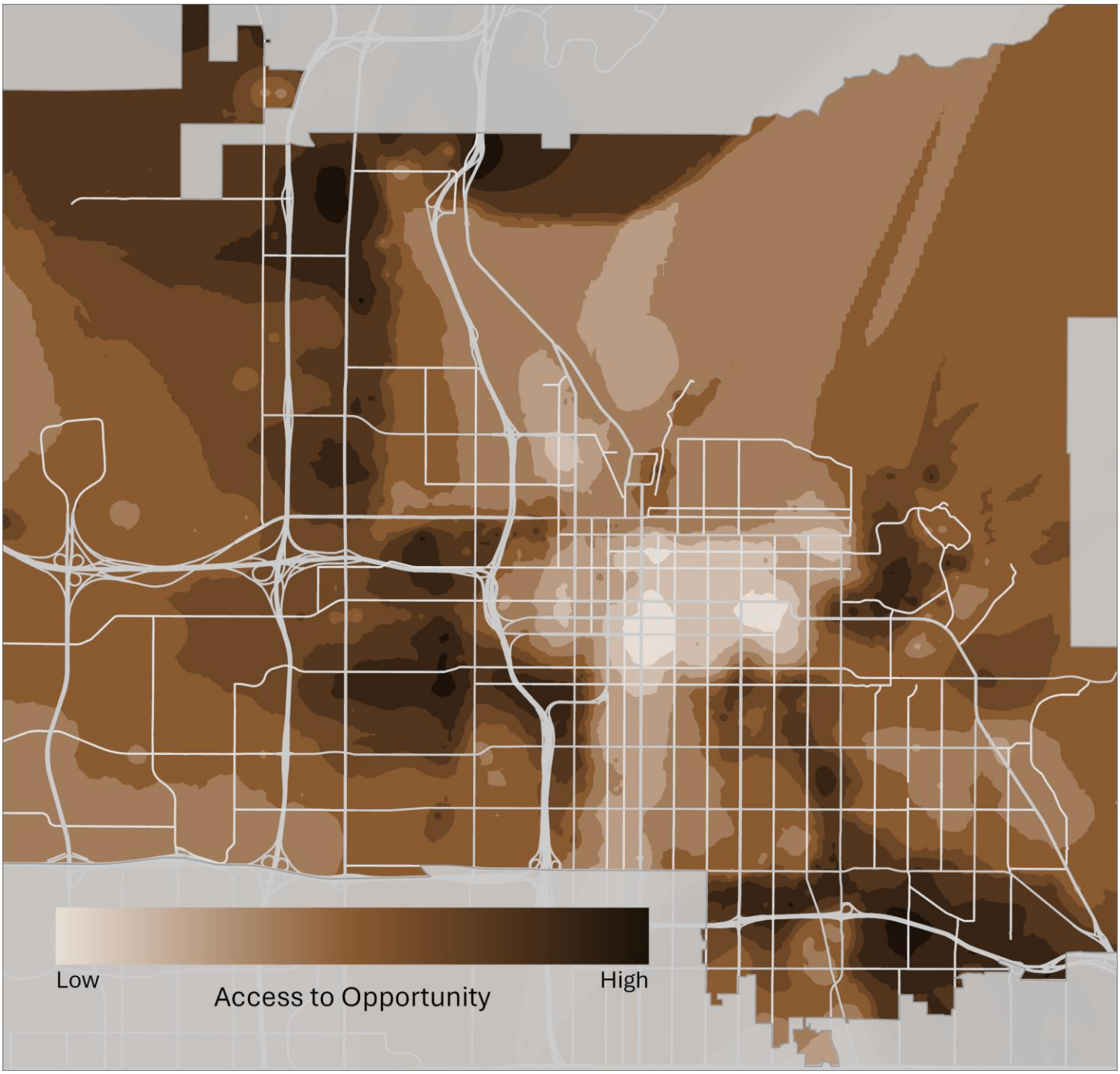
Finally, the routes were used to calculate access to opportunity (ATO) scores across Salt Lake City, which quantify how comfortable it is to bike to a range of destinations depending on where one lives. Each ATO score is a cumulative weighted measure of route comfort from one origin to 20 destinations based on their relative importance for daily life. A negative score means that most routes from a particular origin require bicyclists to use low-comfort streets, while a positive score means that most routes use high-comfort streets. Higher positive scores use more separated paths and protected bike lanes, while lower positive scores use more painted bike lanes and neighborhood streets.

"It feels like the safe routes are a secret that can only be shared by other people who take them."

Findings

There are clear disparities in comfortable access to opportunities by bicycle depending on where one lives in Salt Lake City. In darker places, such as Sugar House and Poplar Grove, residents can combine high-quality facilities like the S-Line Trail, the 9-Line, and the Jordan River Trail with a dense network of residential streets. In lighter places, such as downtown, residents are often forced to use high-speed streets without bicycle infrastructure to reach their destination. The Granary District and Ballpark have the highest variation in score, which indicates that comfort can vary substantially block-by-block.

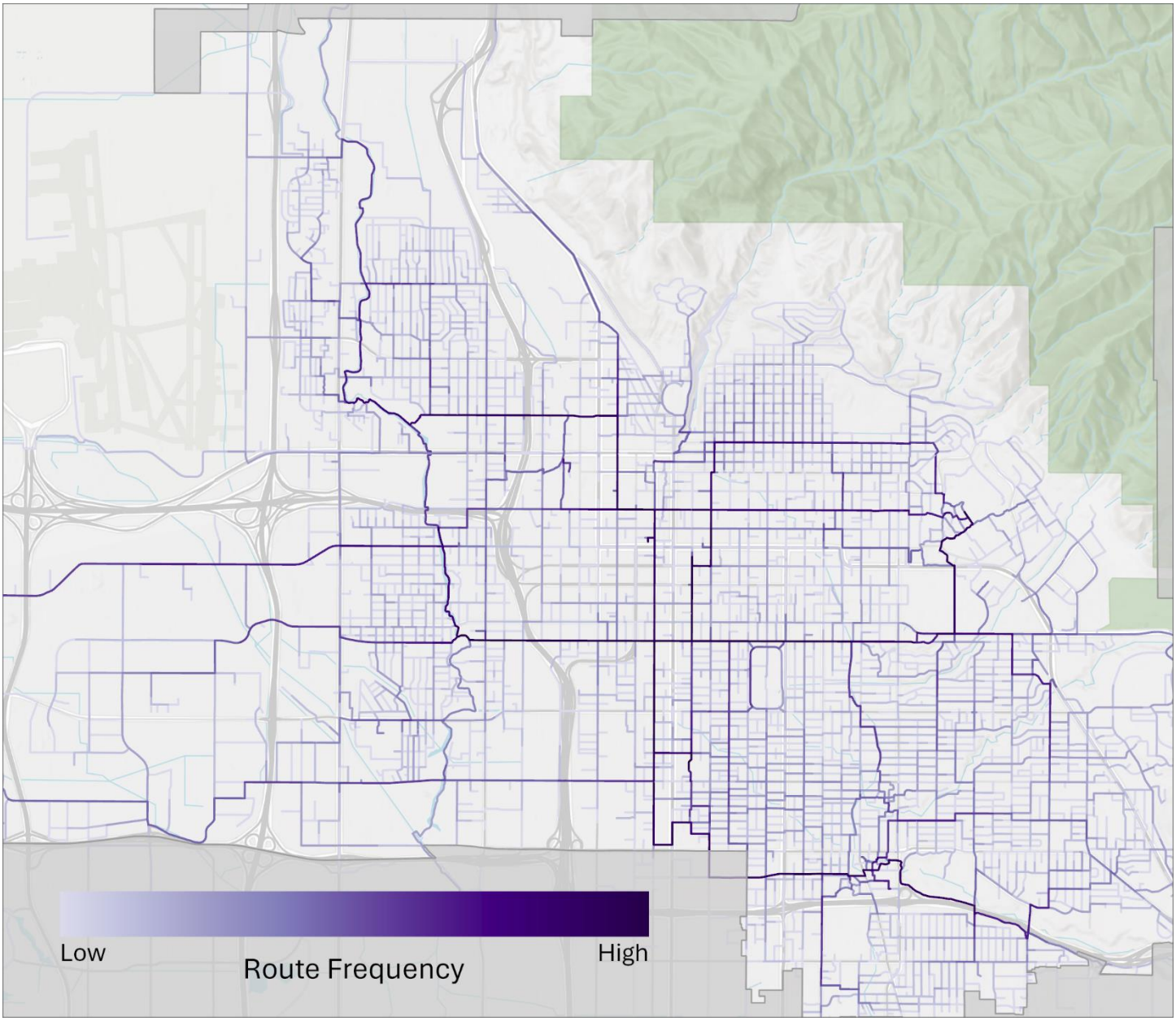
The distribution of ATO scores may seem counter-intuitive given prevailing narratives about bicycling in different parts of Salt Lake City. However, the presence of bicycle infrastructure does not necessarily mean that riding somewhere is comfortable. While downtown is where most of the city's protected and buffered bike lanes are concentrated, most of its streets are high-speed and many lack any bicycle facilities at all. The Westside, on the other hand, offers direct access to multiple high-comfort trails via quiet neighborhood streets.



A trip's comfort depends not only on the quality of the bicycle infrastructure, but on its length. When normalizing by distance, more central parts of Salt Lake City like downtown and Ballpark have higher ATO scores than they previously did. In other words, the closeness of destinations balances out the lower comfort routes used to reach them. However, even places with a high concentration of destinations can still have low ATO scores if the local bicycle network is lacking. Trolley Square and the Rio Grande District are prime examples, as 400 South, 700 East, and other arterials effectively cut them off from the surrounding neighborhoods.

Looking at a heatmap of the routes generated by the analysis can help to illustrate the connectivity – or lack thereof – in Salt Lake City's bicycle network. Several corridors immediately stand out, including the Jordan River Trail, the 9-Line, Parleys Trail, and 200 South. Each of these corridors serves residents in multiple neighborhoods, allowing them to travel between different parts of the city comfortably and efficiently.

However, there are two main disparities. First, the east-west divide is clearly visible. Those who live on the Westside have few options to cross I-15 and the railroad tracks, and many of these are relatively low comfort. Residents often must go unnecessarily out of their way in order to safely make a trip by bicycle. Second, some neighborhoods are well-served by the street network while others are lacking. Sugar House has an extensive network of low-speed neighborhood streets, allowing residents to take a wide variety of



routes to reach different parts of the neighborhood and the rest of the city. Downtown, on the other hand, is dominated by high-speed arterials and lacks a finer-grained network, forcing bicyclists to decide between efficiency and comfort.

These findings illustrate two key takeaways. First, corridors with high-comfort facilities that directly connect neighborhoods act as the backbones of the city's bicycle network. Second, a strong network of secondary facilities helps bicyclists comfortably and efficiently reach the primary corridors nearest to them. Both types of infrastructure are important and necessary for a comfortable and effective bicycle network.

Sugar House is an excellent example of this relationship. Bicyclists who live in more residential areas can use low-speed, low-traffic neighborhood streets to reach the McClelland Trail or the S-Line, which offer easy connections to the 9-Line and the Jordan River Trail, opening up access to much of Salt Lake City. Major bicycling-priority corridors like these help bicyclists travel across the city comfortably and efficiently, while denser bicycle-friendly streets offer comfortable first- and last-mile connections to one's origin or destination. In neighborhoods like Sugar House, many trips remain entirely within the neighborhood as well, allowing residents to fully utilize quiet, pleasant residential streets.

It is important to remember that bicycling comfort is multi-faceted, and this analysis does not fully capture the multitude of factors that influence comfort. Further analyses could incorporate variables such as land use, slope, and tree canopy, as well as the impact of stopped freight trains. Additionally, publicly available activity data could be used to validate both the comfort of individual segments and the behavior of the routing algorithm itself.


McClelland Trail

Recommendations

Salt Lake City has the potential to become one of the best cities in the West for bicyclists, but significant work must still be done to reach this vision. First, the city has made good progress in creating bicycle-priority corridors in recent years, but connectivity in the broader network needs to be improved. This is particularly true along the I-15 corridor, which lacks comfortable, convenient crossings for bicyclists. Salt Lake Central Station and Central Pointe Station similarly lack comfortable access to nearby high-quality bicycle facilities. Creating better connections within the network would enable residents to more comfortably bike around the city.

Second, physical features are crucial for comfort, whether they are used to protect bike lanes or calm traffic on neighborhood streets. The improvements made through the city's **Neighborhood Byways** program are excellent examples of how simple infrastructure can create bicycling-friendly corridors. Features such as comfort-specific signage, greenery and art, and secure bicycle parking can improve the overall experience of bicycling as well.

Third, comfort depends not only on the built environment, but on addressing traffic violence and poor behavior by drivers. Almost every resident that I spoke with has felt unsafe while biking because of a driver's actions. Enforcing driving laws that affect bicyclists and educating drivers about their responsibility to be aware of bicyclists would help to improve safety and comfort for everyone.

Fourth, mixed-use development within residential neighborhoods should be encouraged. A short trip is often going to be more comfortable than a long trip, especially if that trip can utilize low-stress residential streets by remaining within the neighborhood. Developing bicycle-oriented, mixed-use corridors improves accessibility while generating economic benefits.

There is no one-size-fits-all solution to improve bicycling comfort and access to opportunity by bicycle. It is critical that Salt Lake City's bicycle infrastructure exists to serve everyone, not just the most fearless.

"You need to actually get on a bike in order to notice the issues."

Introduction

Bicycling is a critical but underutilized form of transportation in cities across the United States. It connects us to the places we need to go without the financial burden of car ownership or the rigidity of transit routes and schedules. It increases mobility for those who cannot drive, including the youngest and oldest among us. It improves our physical and mental health and strengthens our relationship with our community. And it's often just plain fun, bringing a sense of play back into our everyday lives.

Transportation networks are the foundation of accesssibility, or how well individuals are connected to basic needs and amenities within their community. The Wasatch Front Regional Council (WFRC) defines this as *access to opportunities* and believes that increased accessibility has a positive impact on both the livability of a community and the upward mobility of its residents. Being able to access basic amenities creates opportunities for individuals to support and take care of themselves and their families.

Accessibility varies widely within communities, however. Historical practices such as redlining and urban renewal have led to disinvestment and a lack of amenities in some neighborhoods, while car-centric transportation networks make access challenging for those without a car. Being able to access amenities by bicycle is crucial because bicycling remains one of the most egalitarian forms of transportation.

While bicycling avoids the financial and logistical challenges inherent to other modes, many barriers remain. American cities and roadways are largely designed for drivers, with bicyclists remaining an afterthought. The infrastructure that does exist is often fragmented and not particularly effective at connecting individuals with the places they need to go. Further, this infrastructure is frequently unsafe, uncomfortable, and dangerous to use. As a result, only a fraction of Americans actually use a bicycle for utilitarian trips such as commuting to work or running errands.

This is especially true in Salt Lake City, where fewer than 3% of residents commute to work by bicycle. Data from the most recent Utah Travel Study indicates that 15% of residents do not ride because they feel unsafe and over 60% feel there isn't enough bicycle infrastructure to meet their needs. This lack of infrastructure prevents residents from accessing everyday amenities in a way that is comfortable to them.

This report evaluates Salt Lake City's bicycle network with a focus on comfort and access to opportunities by bicycle. It is particularly focused on how this differs depending on where one lives within the city, since the presence and quality of bicycle infrastructure often depends on historical patterns of inequitable planning and development that are still visible today. The foundation of the report is a routing analysis that assesses how comfortably residents can access different amenities by bicycle depending on where they live.

What does comfort mean?

Comfortable bicycling is different for everyone because each of us prioritizes something different when we travel by bicycle. Some prefer safety and separation from traffic, while others prefer efficiency and directness. Some like to use dedicated bike lanes, while others like neighborhood streets. Comfort can be situational as well, varying by time of day and who we ride with.

As bicycling became more widely accepted over the past few decades, planners and researchers alike sought to clearly define how comfort may vary among individuals. In 2006, Roger Geller proposed a typology of bicyclists that has since been the foundation of bicycle planning across the United States.[1] Geller categorized individuals into four groups: "The Strong and the Fearless," "The Enthused and the Confident," "The Interested but Concerned," and "No Way No How." Geller suggested that each group had a different relationship with bicycling and each preferred different types of bicycle infrastructure.

Of particular interest are the 60% of individuals who Geller thought could be described as interested but concerned. These individuals like to ride and want to ride more but are afraid of traffic and worried about their safety. Geller argued that traditional American bicycle facilities such as painted lanes and sharrows on main roads weren't comfortable for most people, who would instead prefer separated paths and neighborhood streets with few cars.

Subsequent research confirmed Geller's typology, with a national survey of metropolitan areas finding that roughly 7% of individuals are strong and fearless, 5% are enthused and confident, 51% are interested but concerned, and 37% are "no way, no how".[2] These typologies have since been used to demonstrate how each bicyclist's needs are unique.

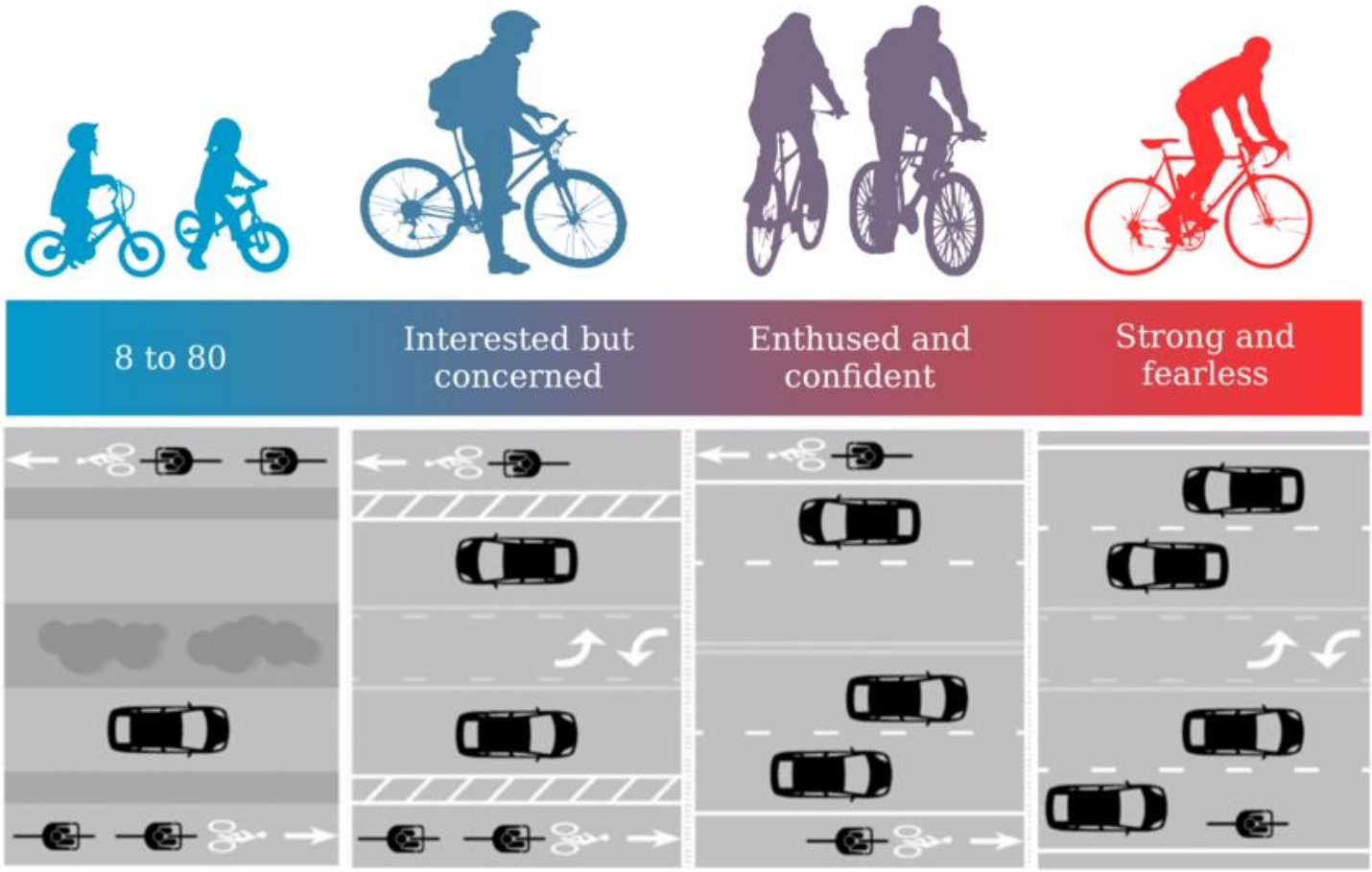


Figure 1. An example of a bicyclist typology from Alta Planning + Design.

Different people will feel more or less comfortable on different types of infrastructure depending on their identities and experiences. Strong, confident bicyclists – many of whom are younger, white, and male – may be fully comfortable riding on urban streets amid traffic. Others may be less comfortable for a variety of reasons, from physical fitness to confidence on a bike to demographics. As a result, improvements to bicycle infrastructure should not take a one-size-fits-all approach.

"It feels like the safe routes are a secret that can only be shared by other people who take them."

Why is comfort important?

Bicycling comfort influences an individual's perception of bicycling, which serves as a predictor of whether they will ride a bike or not.[3] If bicycling becomes more comfortable for an individual, then they will be more likely to use a bicycle for transportation, which can improve their access to opportunity.

As the comfort of the bicycle network increases, bicycling becomes more accessible for more people. Some of those in the interested but concerned group may find that their concerns have been addressed. Others who already bike may decide to ride more. This particularly benefits those who live in socio-economically disadvantaged neighborhoods, which have worse access to bike lanes.[4]

Increased comfort and accessibility improve choice as well. Being able to use multiple modes of transportation to get somewhere creates travel choices for individuals. Not everyone may want or need to bike, but it should be a viable option that is comfortable, safe, and pleasant.

Further, bicycling has societal benefits that positively impact everyone, not just those who bike. If bicycling is more comfortable and some decide to ride rather than drive, then congestion and air quality improve because there are fewer vehicles on the road. In this way, improving bicycling (and transit) actually makes the driving experience better for those who want or need to use a vehicle.

What does this mean for planners?

Given the role of comfort in encouraging bicycling activity and ensuring access to opportunity, transportation planners should consider comfort when planning and designing bicycle infrastructure. The Salt Lake City Pedestrian & Bicycle Master Plan emphasizes the need for and importance of developing a low-stress bikeway network with multi-use paths, protected and buffered bike lanes, and neighborhood byways. The draft citywide transportation plan, **Connect SLC**, similarly emphasizes the need for an expanded low-stress network. The plan specifically highlights the east-west divide as a critical issue to address, noting the need for safe, comfortable, and reliable connections for bicyclists. Following through on these recommendations will benefit not only those who bike already, but those who will decide to bike in the future because the network is now designed to meet their needs.

A Note on Nomenclature

In this report, the term *bicyclist* is used to refer to people who bike around cities for utilitarian or recreational purposes. In recent years, some transportation advocates have moved away from the term cyclist, which is often associated with vehicular cycling and doesn't represent the full diversity of identities or experiences of those who bike.

"I don't really identify with the term 'cyclist.' I think of myself as a person who rides a bike regularly."

Opportunity Factors

The routing analysis measures access to opportunity by calculating the comfort of the ideal route from an origin to an array of destinations, which represent common "opportunities" that someone may need to access on a daily basis. These destinations are often referred to as opportunity subfactors, and they can be grouped into five opportunity factors: wellness, education, employment, government and social services, and worship. Every factor and subfactor is assigned a weight that represents its relative importance for the average person on a weekly basis.

Table 1 lists the cumulative weight of each destination and **Appendix A** lists the individual weight of each factor and subfactor. These weights are not meant to be a perfect indicator of the importance or value of a particular destination. Instead, they are intended to capture the general distribution of trips that someone may wish to make by bicycle. Some trips are both frequent and important, such as one's commute to work, and receive a high weight as a result. Other trips are less frequent but still critical for overall wellbeing, such as being able to access government services. Not every destination is applicable for everyone; rather, they represent the average Salt Lake City resident.

Destination	Weight
Major employment centers	20.00%
Grocery stores	10.50%
Public schools	8.75%
Parks	7.00%
University of Utah	6.25%
Salt Lake City and County Government	4.50%
Salt Lake County Government	4.50%
Salt Lake Community College	3.75%
Libraries	3.75%
Community and recreation centers	3.50%
Doctors	3.50%
Dentists	3.50%
Pharmacies	3.50%
Hospitals	3.50%
Courthouses	3.00%
Other social services	3.00%
Christian worship (LDS)	3.00%
Childcare	2.50%
Christian worship (non-LDS)	1.50%
Other worship	0.50%

Table 1. The cumulative weight assigned to each type of destination.

Structure

The report is divided into five main chapters, each of which covers a different aspect of the analysis. The introduction chapter defines bicycling comfort and access to opportunity and discusses their importance. The local context chapter describes the city's existing and planned bicycle infrastructure, barriers to bicycling, and socioeconomic and cultural conditions. The methodology chapter goes into greater detail on the inputs and parameters used for the routing analysis and describes how the access to opportunity (ATO) score is calculated.

The findings chapter focuses on the two main products of the routing analysis: the ATO scores and the routes. The ATO score maps show how comfortable access to opportunity by bicycle varies depending on where one lives in Salt Lake City. The route maps show the main corridors, connections, and gaps in the city's bicycle network. The recommendations chapter identifies a wide range of design and policy solutions for improving bicycling comfort.

These chapters are supported by two supplemental sections. The community engagement section describes the workshop and interviews that were held to gather community input on the analysis and learn about the experiences of local bicyclists. The implementation section outlines how Sweet Streets SLC and other bicycle advocates can use this report and its findings to push for better bicycling infrastructure in Salt Lake City.

Inspiration and Collaboration

This report was inspired by a similar analysis of bicycling access to opportunity in Washington, D.C. Esri's research question and methodology formed the foundation of my analysis.

Over the past year, I collaborated with Sweet Streets SLC to create this report. Sweet Streets was instrumental in providing guidance on its direction and structure, as well as soliciting local bicyclists for the community engagement phase of the analysis.

Community Engagement

Context

The importance of community engagement in the transportation planning process cannot be overstated. While planners have largely moved away from a rational comprehensive planning approach to more community-centered methods, the profession still relies on design philosophies and principles that are outdated at best and harmful at worst. In particular, the voices and experiences of those who bike are often not heard or considered when planning bicycle infrastructure. Considering the technical nature of the routing analysis, I felt it was important to actively engage the local bicycling community while completing this report.

This reasoning was twofold. First, hearing about the experience of bicycling in Salt Lake City firsthand was critical for establishing the context around this report and identifying specific recommendations. I regularly bike around the city for both utilitarian and recreational purposes, by my experiences are shaped by where I live in Salt Lake City and my own identity.

Second, the detailed discussion of the city's bicycle network helped me assign appropriate preference values, which were used to account for streets where the default comfort value did not align with the actual comfort. Hearing from a diverse group of residents gave me a holistic perspective and helped me more accurately model behavior through the algorithm.

Process

I conducted two types of community engagement: a workshop and individual interviews. The workshop was held in early November with a dozen bicyclists who were recruited by Sweet Streets Salt Lake City and the Bicycle Collective. The interviews were held in February with five more bicyclists. The participants were geographically diverse and represented almost every neighborhood in Salt Lake City. There was high gender diversity, but lower racial and age diversity. The participants represented a wide range of comfort, experience, and activity levels.

The workshop was centered around an activity where participants identified low- and high-comfort routes, followed by a conversation about barriers or gaps in the city's bicycle network. The maps that participants created are shown in *Figure 2*.

The interviews focused on how individuals decide what route to take when biking somewhere and what factors influence their decision-making, as well as what would make biking in Salt Lake City more comfortable for them.

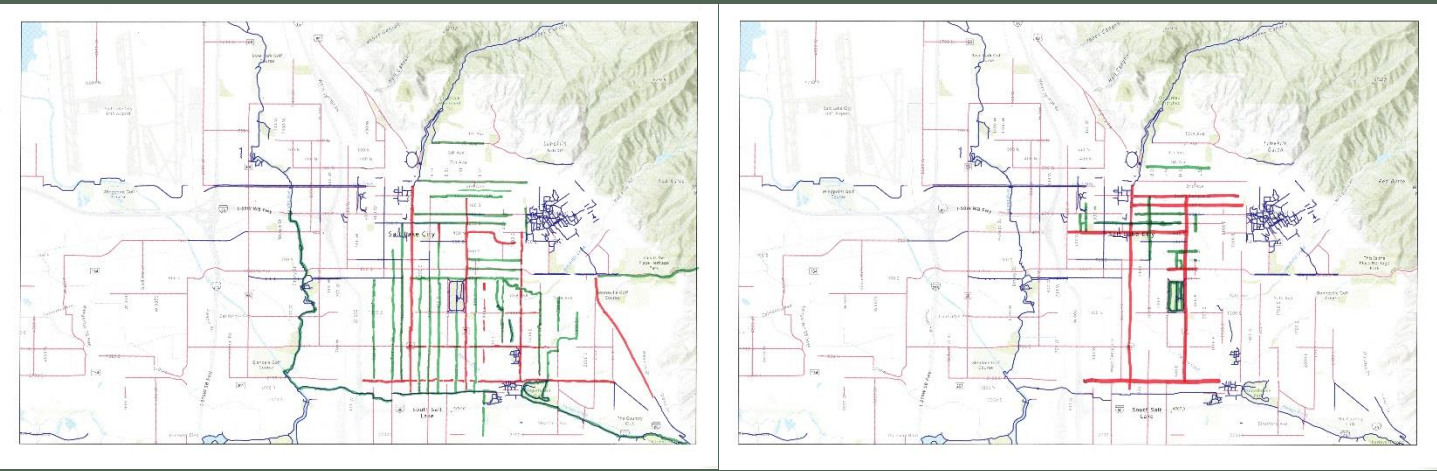
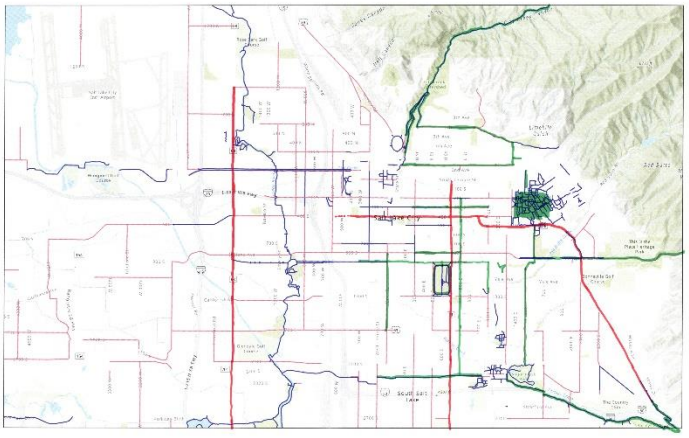
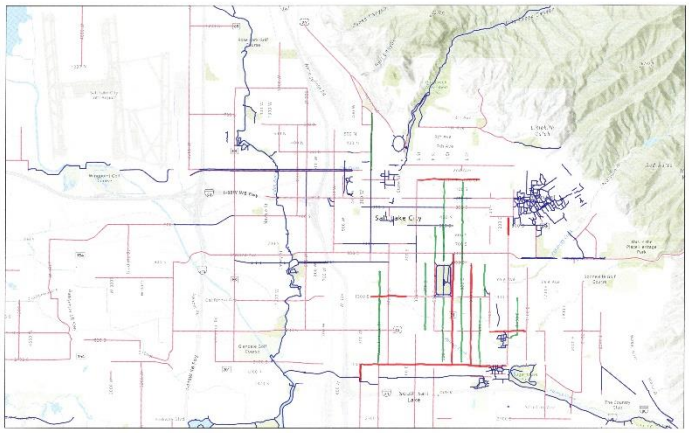
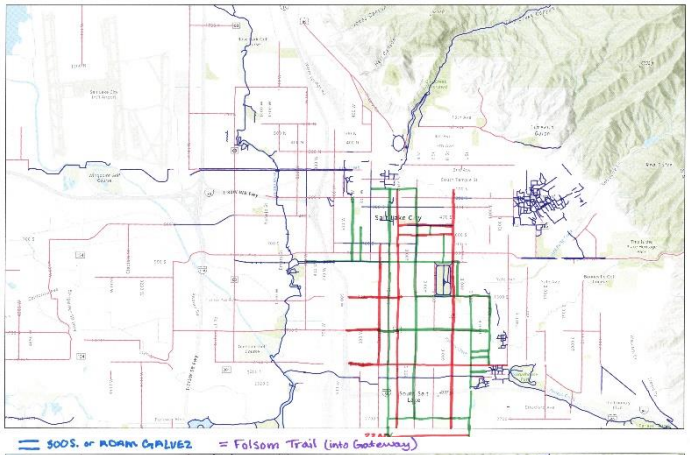
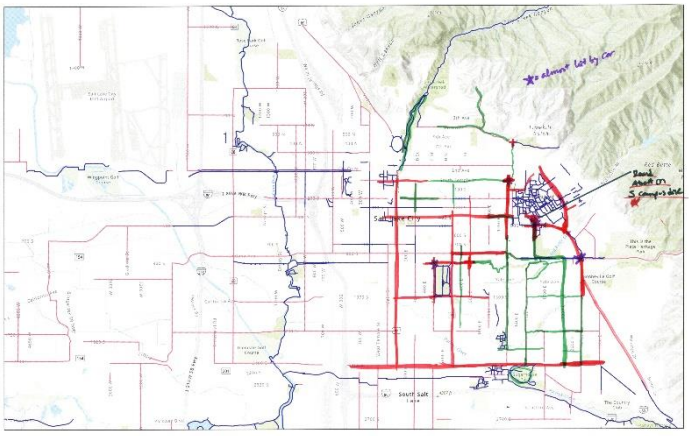


Figure 2. Participants were asked to identify streets that were more or less comfortable than their base comfort value might imply (green is more comfortable, red is less comfortable).

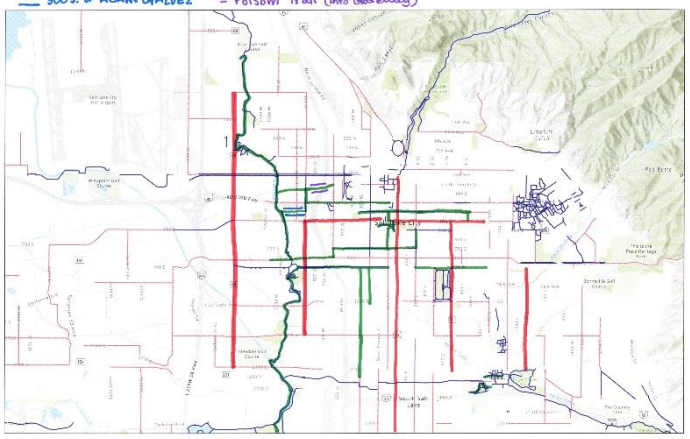


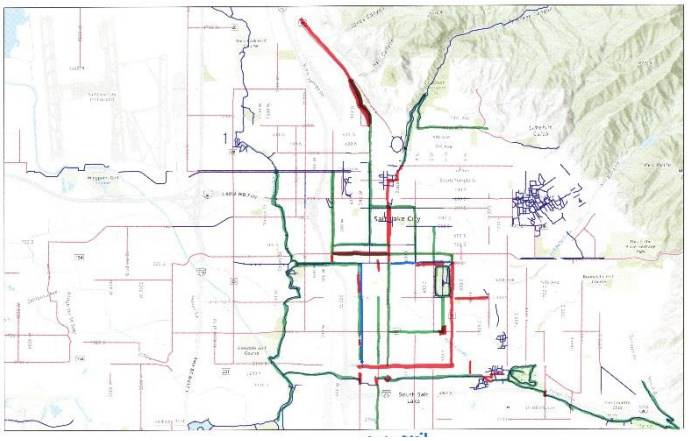


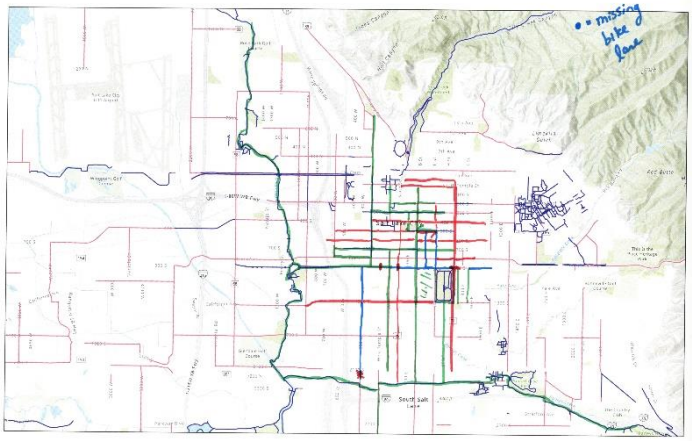


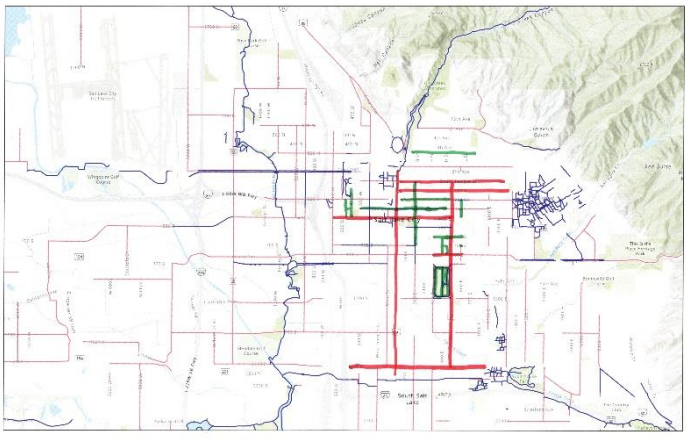


= 900S. or ADAM CALVEZ = Folsom Trail (into Gateway)









Themes

While the feedback and insights I heard during the workshop and interviews are incorporated throughout this report, I wanted to identify a few themes or comments that were particularly interesting.

First, participants were largely split on what type of infrastructure felt most comfortable for them. Some preferred extensive, dedicated bicycle infrastructure, while others preferred quiet, residential streets. Opinions about the 9-Line and the new 300 West cycle track were mixed but generally positive, while the Neighborhood Byways and the S-Line Trail were universally praised.

Second, participants generally felt that inconsistency – rather than quality – was the most critical issue with the city's bicycle network. While Salt Lake City is actively planning and building high-quality bicycle infrastructure, the connections between these corridors are lacking. Two prime examples are the missing connection between the S-Line Trail and 300 West and the University of Utah's separation from residential neighborhoods to the south. This inconsistency extends outside of Salt Lake City, with one participant noting: "There's a noticeable difference when you leave Salt Lake City. Bike lanes just end or change what street they're on."

Third, participants who moved here in recent years compared their experience in Salt Lake City to where they used to live. Many highlighted negative cultural attitudes toward urban bicycling and increased concerns about safety, primarily stemming from aggressive or hostile drivers.

"I'm almost always biking solo because my friends don't feel comfortable biking on the street. It's totally because I came from a biking culture in Madison. All of my friends bike there and it's so normal that you'd go bike to dinner. Here it's like, 'Whoa, you biked to dinner or the brewery?'"

"I'm more comfortable biking in traffic than most people [after living in Chicago and New York City], but it feels scarier here because the cars are going so much faster and they're not used to bikers."

Despite the issues that were raised, every participant had something positive to say about biking in Salt Lake City. For some, bicycling was a way to connect with the outdoors or experience the urban landscape. For others, bicycling helped them reach family or friends and remain engaged in their neighborhood. Many spoke favorably about the local bicycling community, which they saw as crucial for sustaining the city's character and welcoming new residents.

"Something I love about working downtown is that I can hop on my e-bike and be at the top of City Creek Canyon in less than an hour. It's really great having those assets so close by."

Local Context

Bicycle Infrastructure

Existing Bicycle Infrastructure

Salt Lake City has an extensive and rapidly growing bicycle network. Almost 20% of the city's bikeable roadways have some form of bicycle infrastructure, from paint to physical separation. More than 200 miles of conventional bike lanes crisscross the city, while roughly 20 miles of protected or buffered bike lanes are concentrated downtown along 300 South and 200 West. Further, the recent reconstruction of 900 South and 300 West has substantially increased the length of separated bidirectional cycle tracks.

Not included in these totals are more than 20 miles of off-street bike paths, from longer routes such as the Jordan River Trail and Parleys Trail to shorter connectors like the Folsom Trail and the McClelland Trail. Other facilities include shortcuts through local parks, campus paths, and more recreational routes such as North Canyon Road or Bonneville Boulevard at the base of City Creek Canyon.

The city's bicycle network is defined by several interconnected corridors. The Jordan River Trail runs the length of the Salt Lake Valley, connecting several Westside neighborhoods and intersecting with the 9-Line and Parleys Trail. The 9-Line runs along 900 South and connects Poplar Grove with Liberty Park and the 9th & 9th business district. Parleys Trail connects Glendale with northern Millcreek by way of the Sugar House neighborhood; this middle stretch is often referred to as the S-Line due to the eponymous streetcar that operates next to the trail. Additionally, the Folsom Trail provides a new connection between Westside and downtown.

Figure 3. McClelland Trail.

Figure 4. S-Line Trail.

Salt Lake City is primarily served by protected bike lanes on 300 South and 200 West. The newly reconstructed 200 South transit priority corridor offers an alternative route for those traveling east to the University of Utah. For those traveling south, the 300 West corridor features a raised bidirectional bike path and both Main Street and 300 East offer low-stress conventional bike lanes. Other north-south corridors include 900 West on the Westside and 1300 E, 1500 E, and 2100 E between Sugar House and the University of Utah.

Salt Lake City has identified several **Neighborhood Byways** across the city, which are low-speed, low-volume residential streets that have been targeted for small-scale infrastructure improvements. These improvements include crossing enhancements such as curb extensions, mid-block toucan crossings, and flashing signs; traffic calming features such as speed humps, bollards, traffic circles, and diverted intersections; and wayfinding signage. 600 East was the city's first neighborhood byway and work continues

Figure 5. Recent improvements to 200 South.

on other byways, including 800 East, Kensington Avenue, the McClelland Trail, and an array of roads on the Westside.

The city's physical bicycle infrastructure is further supported by a range of bicycling-related programs and organizations. **GREENbike** is a nonprofit bike share with approximately 50 stations and 300 classic and electric bikes that residents and visitors alike can use for short trips downtown. Unfortunately, GREENbike is unable to serve the University of Utah, which has an exclusive partnership with SPIN. In recent years, the Utah Clean Air Partnership, the University of Utah, and local bicycle retailers have established limited-time rebate programs for purchasing electric bikes.

Bike Utah is a nonprofit that aims to make Utah "a better place to ride" by pushing for bicycling-related legislation, collaborating on bicycle planning with local governments, educating bicyclists and motorists, and supporting local advocacy efforts. The **Bicycle Collective** is a local nonprofit bike shop that refurbishes, donates, and sells used bicycles and manages community events and educational programming. Finally, **Sweet Streets Salt Lake City** is a nonprofit that supports people-first streets and public spaces through a range of advocacy campaigns and events.

Barriers to Bicycling

Despite local efforts to improve conditions for bicycling, many barriers remain. Perhaps most significant is the east-west divide created by the railroad tracks and Interstate 15, which serves as both a physical barrier to connectivity and a demarcation of historic disinvestment and socioeconomic inequity. Crossing above or below the highway is often an unpleasant experience for bicyclists, who are forced to ride directly next to high-speed, high-volume arterial crossings. Crossing the railroad tracks at-grade can be both dangerous and inconvenient, as miles-long freight trains can block crossings for anywhere from a few minutes to more than an hour. Salt Lake City Councilmember Alejandro Puy recently began a **campaign** to address this issue and many residents have expressed how disruptive the delays are to their everyday life.

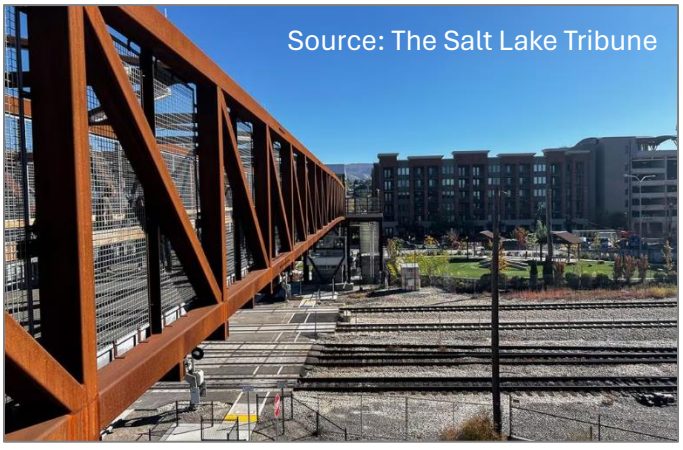


Figure 6. A new pedestrian bridge over the railroad tracks at 300 North.

In recent years, Salt Lake City has begun to recognize and address both this physical separation and the broader east-west divide. In 2021, the Transportation Division conducted the **Westside Transportation Equity Study**, which concluded that the city was actively investing in better transportation access and options but falling short when it came to engagement and community-building. In 2022, the city received a $2 million grant from the USDOT **Reconnecting Communities** program to support the analysis and prioritization of various transportation solutions. More recently, the city constructed a pedestrian and bicyclist bridge over the 300 North railroad crossing and the Utah Department of Transportation (UDOT) is planning a multi-use path along 400 South.

On the other side of the city, the University of Utah faces its own barriers to bicycle travel. Nestled up in the foothills, the "U" (as it is affectionately known by Utahns) is largely separated from the surrounding neighborhoods by state-owned roadways. Commuters from Sugar House, the East Bench, and other neighborhoods south of campus are forced to decide between taking circuitous routes via neighborhood streets, navigating sidewalks that abruptly end, or riding on dangerous, high-volume arterials in order to access campus. Neither the university nor the city have any meaningful influence on the design of these arterials, which are intended to move vehicles as efficiently and quickly as possible. Further, the extensive network of sidewalks and bikeways present on the academic campus disappears after crossing Mario Capecchi Drive and entering the medical campus and Research Park. As a result, only 3% of students, faculty, and staff commute by bicycle out of a campus population of more than 75,000.[5]

Other barriers are related to how bicyclists feel while riding around Salt Lake City due to the actions of drivers. These concerns are discussed in greater

detail later in this chapter, but one relates specifically to the built environment: speeding. Salt Lake City's streets are among the widest in the nation at 132 feet, which many residents like to claim is the result of an 1850's edict by Brigham Young that the streets should be wide enough for a wagon team to make a U-turn without "resorting to profanity." This excessive width encourages drivers to speed, particularly on neighborhood streets on the Westside. While the recent **20 is Plenty** campaign successfully reduced the posted speed limit for neighborhood streets to 20 mph, it does not change the fact that the design speed is significantly higher.

Finally, the city's topography and climate can act as a barrier to bicycling in certain circumstances. The University of Utah is 400 to 700 feet higher than downtown Salt Lake City and homes in the Avenues or East Bench can be even higher. This elevation gain, coupled with steep road grades, makes utilitarian bicycling challenging for even the fittest individuals. An e-bike can help significantly, but the expense can be prohibitive for many.

The weather varies dramatically between seasons, with summer afternoons regularly reaching 100°F and semi-frequent snowstorms in the winter. Apart from being physically uncomfortable, such conditions pose safety concerns. Salt Lake City does not maintain its multi-use paths during the winter and snowplows often push snow directly into the bike lane. The cold temperatures also cause frequent inversions where air quality worsens as particulate matter increases. Bicycling in such conditions, which can happen during the summer as well due to wildfire smoke, can have significant long-term negative health effects.

Figure 7. An excessively wide neighborhood street on the Westside.

Salt Lake City Pedestrian & Bicycle Master Plan

In recent decades, many major cities have adopted active transportation master plans that establish a framework, recommendations, and policies for improving and expanding urban bicycle facilities. Salt Lake City developed their first bicycle master plan in the early 1990s and most recently updated the plan in 2015. The **Pedestrian & Bicycle Master Plan** establishes five goals: integration, network, maintenance, programs, and transit connections. Of particular relevance to this study is the second goal: *"Develop a safe, comfortable, and attractive bicycling network that connects people of all ages, abilities, and neighborhoods to the places they want to go."*

The plan specifically notes the importance of developing a low-stress bikeway network with multi-use paths, protected and buffered bike lanes, and neighborhood byways. Feedback from residents indicated support for this goal, as separated and protected facilities were rated more favorably than sharrows and conventional painted lanes. The plan outlines an aggressive 2035 vision for the city's bicycling network with an extensive set of neighborhood byways, a significant increase in buffered or protected lanes, and several new multi-use paths. Some of these recommendations have already been realized, including the 9-Line, 300 West, the Folsom Trail, and sections of Parleys Trail.

The bicycle master plan is complemented by Salt Lake City's **Complete Streets Ordinance**, which was adopted in 2010 and requires city streets to be designed, operated, and maintained for all modes of transportation. Rather than establishing specific design criteria or standards, the two-page ordinance acts as a guiding statement. More explicit design guidance is provided in the city's **Street and Intersection Typologies Design Guide**.

Planned Bicycle Infrastructure

A wide range of immediate and long-term projects are underway across Salt Lake City. Some of these projects, such as the ongoing reconstruction of 1100 East, involve adding conventional painted bike lanes with some protection at intersections or transit stops. Other projects involve adding physical elements such as speed humps, raised crosswalks, and roundabouts to calm traffic on neighborhood streets, making them safer for bicyclists. Many of these traffic

calming projects are associated with the Neighborhood Byways program, while others are in response to resident concerns or serious accidents.

The city's Transportation Division is planning several major bicycling-related projects that will be completed by 2025. Chief among them are the reconstruction of **2100 South** in Sugar House and **600/700 North** in Rose Park and Fairpark. Both projects will include new bicycle infrastructure and various elements to calm traffic and protect bicyclists and pedestrians, as well as enhance the character of each corridor.

Other improvements are being planned on state-owned roadways. In early 2024, UDOT will begin constructing a shared-use path along 700 East between the S-Line and Liberty Park. Additionally, UDOT and Salt Lake City are partnering to construct a multi-use path on 400 South that will provide a safer crossing over Interstate 15 and the railroad tracks. The path will link the 900 West bike lane and the 300 West cycle track, creating a critical connection between the Westside and downtown.

Looking further ahead, Salt Lake City is nearing completion of a design concept for the **Green Loop**, which would create a linear park system around downtown. The Green Loop would adapt existing streets to include more green space, public space, and active transportation infrastructure. The city is also studying concepts for redesigning **Main Street** to enhance the existing public space and improve walking and biking. Neither project has identified funding yet and construction would likely not begin until the end of the decade.

In addition, Salt Lake City recently completed a screening analysis for the **Rio Grande Plan**, a resident-created concept that would realign the railroad tracks to a train box under 500 West. While the proposal is more focused on transit and development opportunities, it would improve bicycle connections between the Westside and downtown.

Many of these projects are included in WFRC's **2023-2050 Regional Transportation Plan** (RTP), which establishes a long-range, regional planning strategy for transportation in Salt Lake County and enables specific projects to receive federal funding. In addition to the neighborhood byways, sections of the Green Loop, and 600/700 North, the RTP includes extensive shared use paths on the Westside, protected and conventional bike lanes across the city, and intersection improvements along Foothill Drive.

While most bicycle infrastructure is planned at the local level, the state is becoming more involved in regional bicycling connections with the recent passage of SB 185, which allocates significant ongoing funding toward the creation of a statewide trail network known as the **Utah Trail Network**. Many of the trails will be more recreational in nature, particularly those outside of the Wasatch Front, but the initial list of potential projects includes important urban connections in Salt Lake County.

Figure 8. Proposed Green Loop routes released by Mayor Erin Mendenhall in early 2024.

Figure 9. Residents walk on Main Street during a temporary closure for Open Streets.

Socioeconomic Conditions

Salt Lake City was home to 204,653 people in 2022, according to the most recent estimates from the American Community Survey (ACS).[6] Despite rapid growth along the rest of the Wasatch Front, the city's population has remained relatively stable over the past five years. It is slightly more male (50.7%) than female (49.3%) and the median age is 31.9 years old. Roughly 15% of the population is under 18 years old and 11% is 65 years or older, with the 25-34-year-old range representing the plurality of residents.

Salt Lake City is more diverse than Utah as a whole. Approximately 79% of the city's population identifies as white, 8% as Asian, 5% as Black, 4% as American Indian and Alaskan Native, 2% as Native Hawaiian and other Pacific Islander, and 17% as some other race. Twenty percent of the population identifies as Hispanic or Latino.

There were 90,195 households in Salt Lake City in 2022, with an average household size of 2.2 people. The median household income is $75,529 and 7% of families had an income below the federal poverty level. More households rent (55%) than own (45%), and the median home value is over $560,000.

These demographic characteristics vary substantially depending on where one lives within Salt Lake City. Westside neighborhoods such as Glendale, Poplar Grove, and Rose Park have higher proportions of non-white residents and lower household incomes than neighborhoods on the east side like Yalecrest and the East Bench. These differences are due in part to the historic practice of redlining, which restricted the approval of mortgage loans in neighborhoods that were considered "risky" by the federal government. These historic designations are shown in *Figure 10*. This practice directed federal money away from neighborhoods which were predominantly non-white and low-income, contributing to inequities that are still present today.

These inequities are clearly shown by the Area Deprivation Index (ADI), which uses ACS data to determine the degree to which a neighborhood is socioeconomically disadvantaged. A neighborhood's ADI is directly linked to individual and community health and wellbeing. *Figure 11* visualizes the ADI scores for local block groups according to their statewide rank. The map illustrates the clear disparity in socioeconomic advantage between the west and east sides of the city.

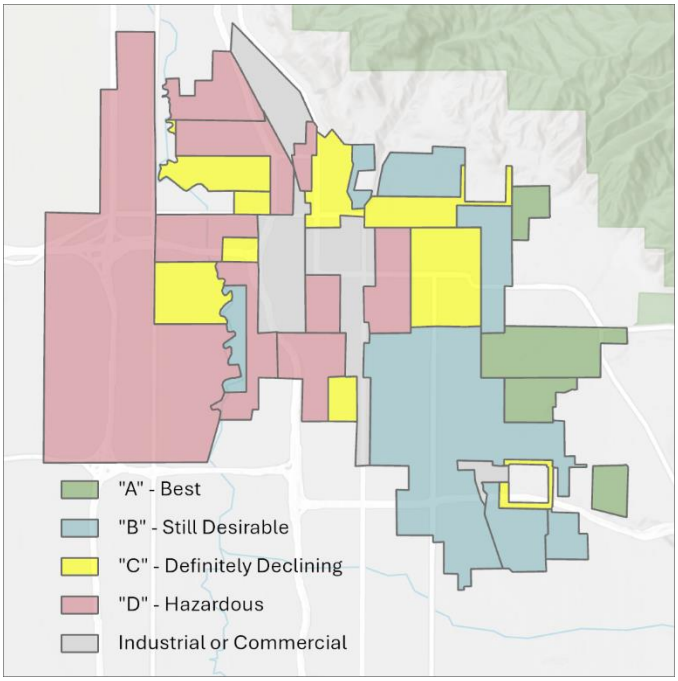


*Figure 10. Historical redlining designations (Source: **Mapping Inequality**).*

Travel Behavior

Over nine out of every 10 households in Salt Lake City have at least one vehicle available. Almost 43% of households have a single vehicle, 33% have two vehicles, 16% have three or more vehicles, and only 8% have no vehicle. Excluding those who work from home, 75% of residents drive to work alone and an additional 11% carpool. Only 2.5% of residents bike to work, with the rest using transit (3.7%) or walking (5.4%).

Separate from the U.S. Census Bureau's collection of commute mode data, WFRC partners with UDOT and the other metropolitan planning organizations to conduct a detailed statewide household travel study to inform transportation planning efforts. The most recent **Utah Travel Study** was completed in 2013 and an updated study is currently underway. Over 9,000 households completed a travel diary in 2013, including almost 6,000 along the Wasatch Front. Roughly 2,500 of all households completed an additional bicycling-specific debrief survey.

The travel study found a similar mode share regardless of the trip purpose. Almost three quarters of households owned at least one adult bicycle and approximately 1.7% of trips were taken by bicycle. More than half of respondents to the debrief survey reported that they never biked, and an additional

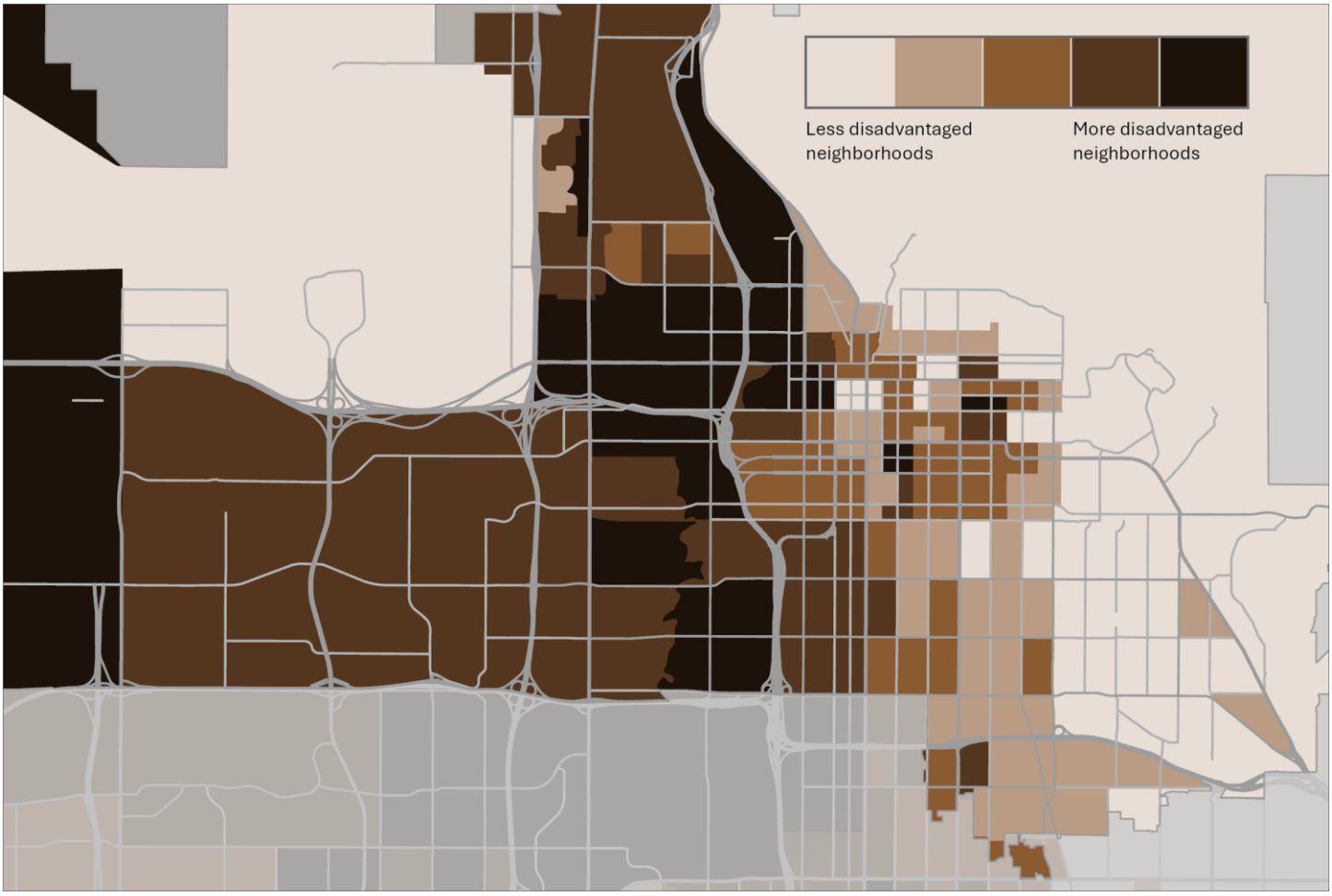


*Figure 11. Area Deprivation Index values by census block group (Source: **Neighborhood Atlas**).*

quarter reported that they hadn't biked within the past two weeks for any purpose. Roughly 6% biked less than one day per week, 7% biked one to three days per week, and 4% biked more than three days per week. An overwhelming majority said exercise was their typical purpose for bicycling, rather than more utilitarian purposes.

Cultural Conditions

Despite the widespread popularity of mountain and road biking in the foothills and canyons, broader cultural attitudes toward urban bicyclists are fairly negative, especially outside of Salt Lake City itself. Almost every resident that I spoke with could recount an instance when they felt unsafe while biking because of a driver's actions. While some drivers are deliberately aggressive or even hostile, many simply exhibit poor driving behaviors that endanger bicyclists, including passing too closely, turning without looking, or parking in the bike lane. This all adds up to a common feeling that local drivers don't respect bicyclists.

Even corridors with good bicycle infrastructure can be uncomfortable or dangerous to ride on because of drivers' inattentiveness. Several residents said that they felt unsafe riding on the 9-Line and 300 West because drivers pull into the bike lane without looking for bicyclists. Some drivers don't know how to navigate such infrastructure and are unaware that they need to look for oncoming bicyclists, while others simply forget.

"It's interesting how many mountain bikers we have in the city and the state, and that they feel safer biking down the mountain than they do in the city. It's a super outdoorsy city but no one feels safe biking in their own community."

Several of the bicyclists that I spoke with noted the contrast and disconnect between mountain biking and urban riding. A newcomer to the state said that they had never seen somewhere with more bike racks

on cars than Salt Lake City. Others commented on how many people drove to trailheads: “It’s like the suburban gymgoer who drives 15 minutes to a gym to walk on a treadmill because their neighborhood doesn’t have any safe places to walk.” Some even felt like mountain biking was safer than urban riding, joking that they would take their chances with trees rather than local drivers.

Despite the prevailing attitudes toward urban bicyclists, there is a small but strong community in Salt Lake City. This community is fostered by local organizations like the Bicycle Collective or Sweet Streets SLC, which organize group rides and events like Bike Prom. Many local bicyclists speak proudly of how they navigate the city by bicycle and act as informal activists within their neighborhoods and communities. The community retains some countercultural elements as well, seen most clearly in the 999 – an unsanctioned weekly ride around the city with thousands of bicyclists.

Methodology

Inputs

At its most basic, a routing analysis requires three inputs: an origin, a destination, and a network. The following sections describe how each input was defined and prepared, as well as the parameters for the routing algorithm. These inputs and parameters are the foundation of the analysis and the decisions made in defining them can have significant impacts on the outputs. I tried to account for human behavior as much as possible so that the routing analysis would accurately reflect how someone would bike from their house to a destination.

Origins

Each origin serves as a starting point for multiple routes in the routing analysis. Since the origins will be used to identify which parts of Salt Lake City have more or less comfortable access to opportunity, they must be detailed enough to show variation within neighborhoods but general enough to show clear trends. Additionally, the origin points should be linked to polygons in some way to allow for more meaningful visualization and analysis.

Census boundaries are the best choice since they represent standard geographic areas and allow for direct comparisons with socioeconomic data from the American Community Survey. Within Salt Lake City, there are approximately 50 census tracts, 150 census block groups, and 2,500 census blocks. I chose to use blocks for the high amount of detail they provide at the sub-neighborhood level.

I calculated the center point, or centroid, of each block in Salt Lake County and then selected those within Salt Lake City. Centroids within 800 meters of the network were snapped to the nearest segment and the remaining centroids were removed. The distribution of the origin points is shown in *Figure 12*.

Destinations

Each destination serves as a potential ending point for one or more routes in the routing analysis. These destinations are based on the opportunity factors and subfactors described in the introduction. The destinations were primarily sourced from the Utah Geospatial Resource Center (UGRC), WFRC, and manual searches or placements. Some UGRC data was originally sourced from the U.S. Department of Homeland Security's Homeland Infrastructure Foundation-Level Data (HIFLD). The data source and number of destinations for each subfactor are shown in *Table 2*.

Some subfactors had many possible destinations, while others had only a single destination. I included points that were up to one mile outside of the city boundary to reflect human behavior more accurately.

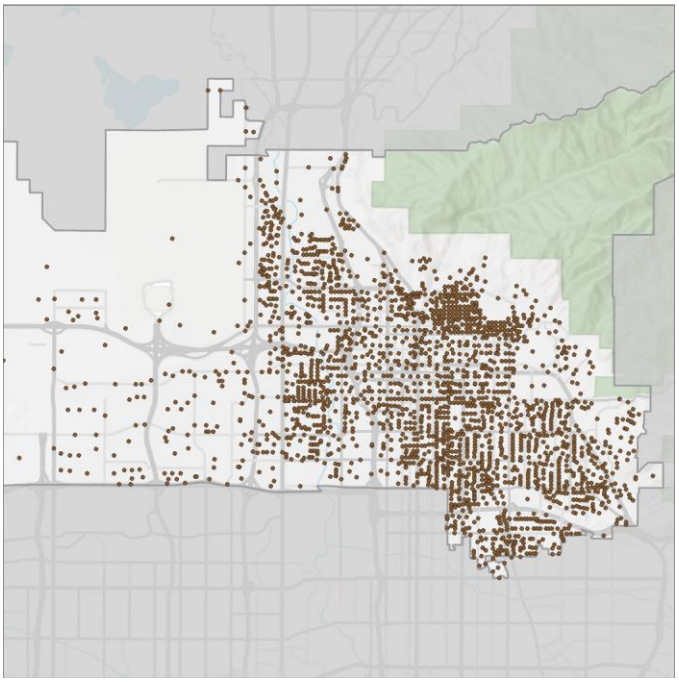


Figure 12. Distribution of origin points.

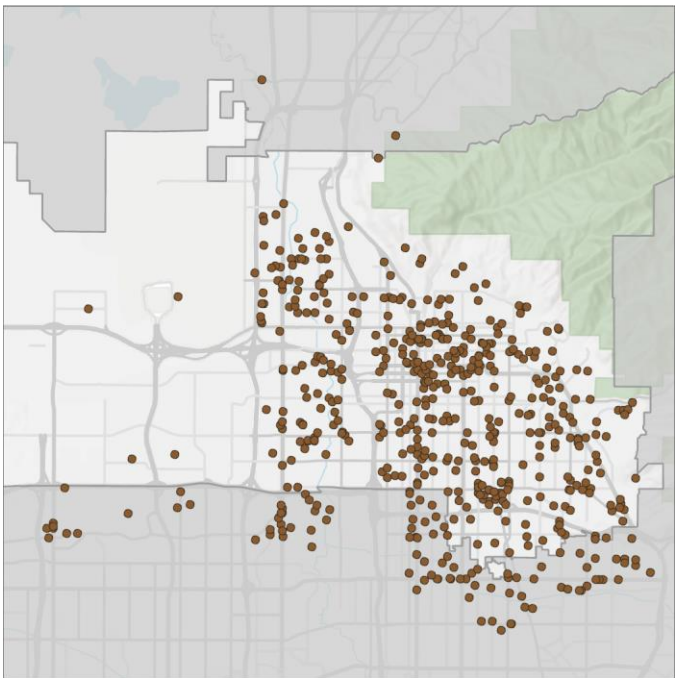


Figure 13. Distribution of destination points.

For example, someone living in Brickyard may choose to visit a destination in South Salt Lake with a shorter and/or more comfortable route than a destination in Salt Lake City with a longer and/or less comfortable route.

I manually reviewed every destination; removed outdated, erroneous, or irrelevant points; and added missing points. For destinations that are traditionally thought of as areas, such as parks or campuses, I calculated the centroid of each polygon.

Opportunity Subfactor	Data source	Number of destinations
Wellness		
Grocery stores	UGRC	70
Parks	UGRC	92
Community centers	WFRC	15
Hospitals	WFRC	16
Doctors	Manual search	14
Dentists	Manual search	52
Pharmacies	Manual search	37
Education		
Public elementary, middle, and high schools	UGRC	64
University of Utah	Manual placement	1
Libraries	UGRC	10
Salt Lake Community College	Manual placement	1
Childcare	UGRC	52
Employment		
Major employment centers	WFRC	19
Government and Social Services		
Salt Lake City & County Building	Manual placement	1
Salt Lake County Government Center	Manual placement	1
Courts	Manual placement	3
Other social services	WFRC	25
Workship		
Christianity (The Church of Jesus Christ of Latter-day Saints)	UGRC	15
Christianity (non-LDS)	UGRC	91
Buddhism, Islam, and Judaism	UGRC	8

Table 2. The data source and number of destinations for each opportunity subfactor.

The following subfactors had specific criteria or processing steps:

- ***Grocery stores:*** Excluded convenience stores
- ***Parks:*** Excluded small parks without amenities (e.g., picnic tables, playsets, etc.)
- ***Hospitals:*** Added urgent care facilities
- ***Doctors:*** Generally limited to clinics and health centers with multiple doctors
- ***Dentists:*** Generally limited to offices with multiple dentists
- ***Education:*** Included charter schools but not private schools
- ***Other social services:*** Included wide array of government services (e.g., SSA, DMV, DCFS) and nonprofit services (e.g., food pantries)

Major employment centers were defined using employment data from WFRC, which acts as the regional planning body for Salt Lake City and the surrounding area. WFRC develops population, housing, and employment estimates for thousands of traffic analysis zones, or TAZs. I defined major employment centers as the 10 TAZs with the highest job count and the 10 TAZs with the highest job density (one TAZ was included on both lists). This accounted for both large areas with a single large employer, such as the airport, and small areas with many small employers, such as an individual city block.

I assigned each destination with a unique identifier and combined the subfactors into a single object. Similar to the origins, I snapped every point to the nearest street to simplify the routing analysis. The distribution of all destinations is shown in *Figure 13* and the distribution of each subfactor is shown in **Appendix B**.

Network

Routes connect each origin and destination by following a network, which consists of streets, trails, and paths that can be used by bicyclists. UGRC collaborates with UDOT and local municipalities to maintain separate datasets for roads and trails. Before combining the datasets, I removed segments that would be unsuitable for daily bicycling, such as hiking-only trails, natural surface trails, service roads, driveways, and those listed as planned or under construction.

Since I was combining two separate datasets into a single network, I had to ensure that there was proper connectivity in order for the routing algorithm to work properly. I added vertices where road and trail segments intersected and then split the respective segments, which created a fully interconnected network with discrete segments. I also manually reviewed one-way streets to ensure that travel was only allowed in a single direction.

The final step in creating the network was assigning comfort and preference values to each segment, which would be used to program the routing algorithm and calculate the access to opportunity scores. These values are critical, since they tell the algorithm which segments to prefer or avoid when determining a route. I wanted to accurately reflect the perceived comfort of each road while ensuring that the analysis remained objective and valid. To balance these competing interests, I decided to use an objective comfort value and an optional subjective preference value.

The comfort values were based on three variables: the presence of bicycle facilities, the type of bicycle facilities, and the speed limit. I assigned the values according to the designations shown in *Figure 14*, where 1 represents the most comfortable facility for bicyclists and 7 represents the least comfortable facility. Every segment in the network received a comfort value.

The preference values account for the difference between perceived comfort while bicycling on a particular road and its actual bicycle infrastructure. For example, 700 East has a conventional bike lane from 2100 South to Liberty Park, but very few people would feel comfortable using it given the speed and volume of traffic. 600 East, on the other hand, does not have a conventional bike lane, but it feels significantly more comfortable since it is a low-volume neighborhood street with enhancements for bicyclists.

The preference values were based on feedback gathered from local bicyclists and comfort maps created by Sweet Streets SLC, Salt Lake City, and WFRC. Only 5% of the segments were assigned a preference value (either prefer or avoid), since the comfort value for the vast majority of streets was similar to the perceived comfort. **Appendix C** includes a map and table of the streets that were assigned a preference value.

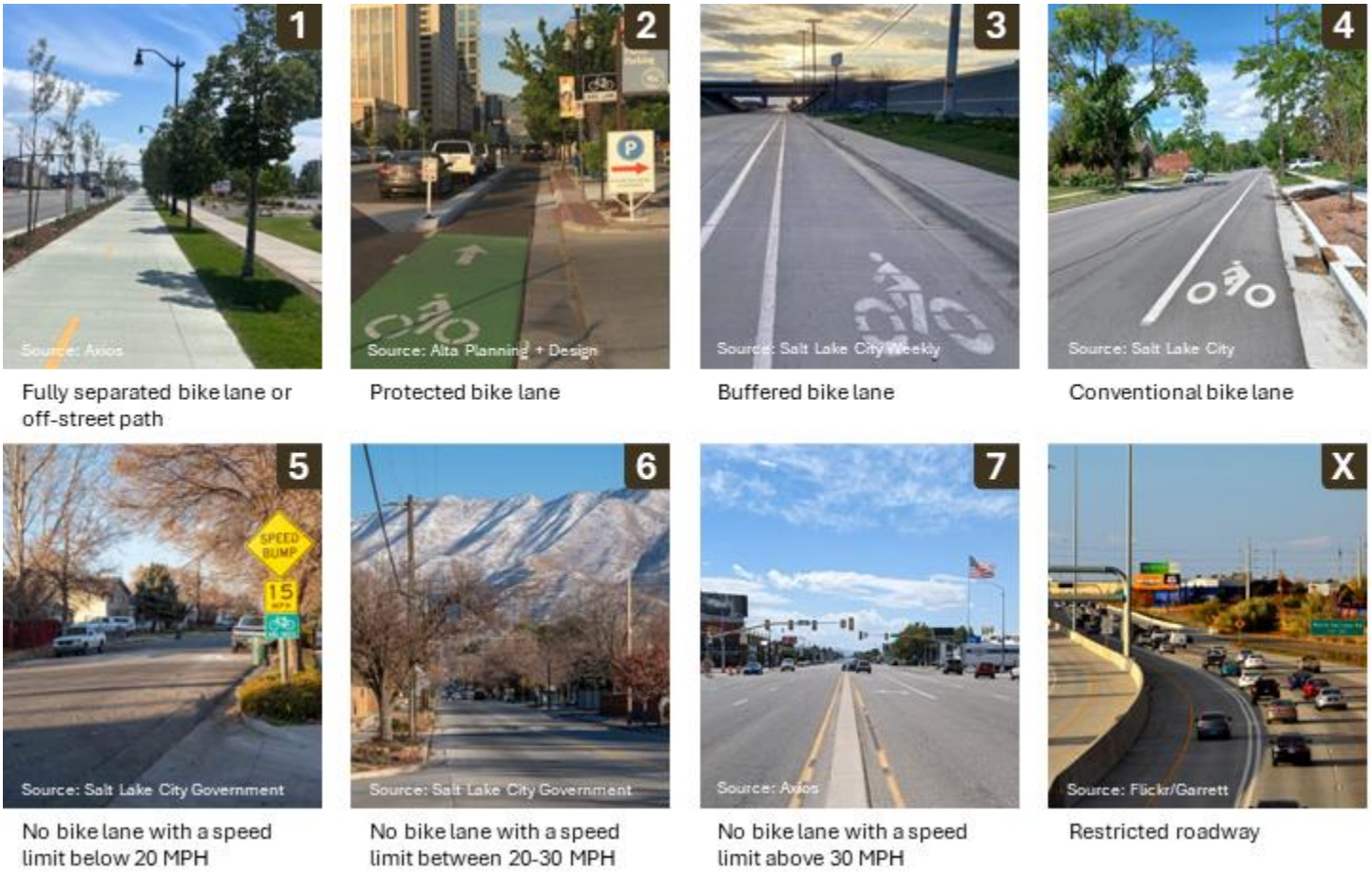


Figure 14. Examples of different bicycle and road facilities and their respective comfort values.

Routing Algorithm

The ArcGIS Pro Network Analyst extension allows users to model transportation networks using six types of network solvers. The closest facilities solver identifies the best route between an origin and a destination based on a set of restrictions and measures the costs associated with the route. For this analysis, the restrictions were the comfort and preference values, and the costs were the distances traveled on each type of bicycle facility.

After creating the network dataset, I added the combined comfort and preference values as travel restrictions. ArcGIS Pro supports eight types of travel restrictions: prohibited, avoid (high, medium, and low), neutral, and prefer (low, medium, and high). Each comfort value was assigned a restriction as shown in *Table 3*. An avoid or prefer value increased or decreased the restriction, respectively. I also configured the restrictions based on travel direction to account for one-way streets and segments with different bicycle facilities on either side. *Figure 15* shows the network with the restrictions.

Travel Restriction	Facility Type (Comfort Value)
Prohibited	Restricted roadway (X)
Avoid (high)	High-speed road with no bike lane (7)
Avoid (medium)	Medium-speed road with no bike lane (6)
Neutral	Low-speed road with no bike lane (5)
Prefer (low)	Conventional, buffered, or protected bike lanes (4, 3, 2)
Prefer (medium)	Fully separated bike lane or off-street path (1)

Table 3. The travel restriction used in the routing algorithm for each type of facility.

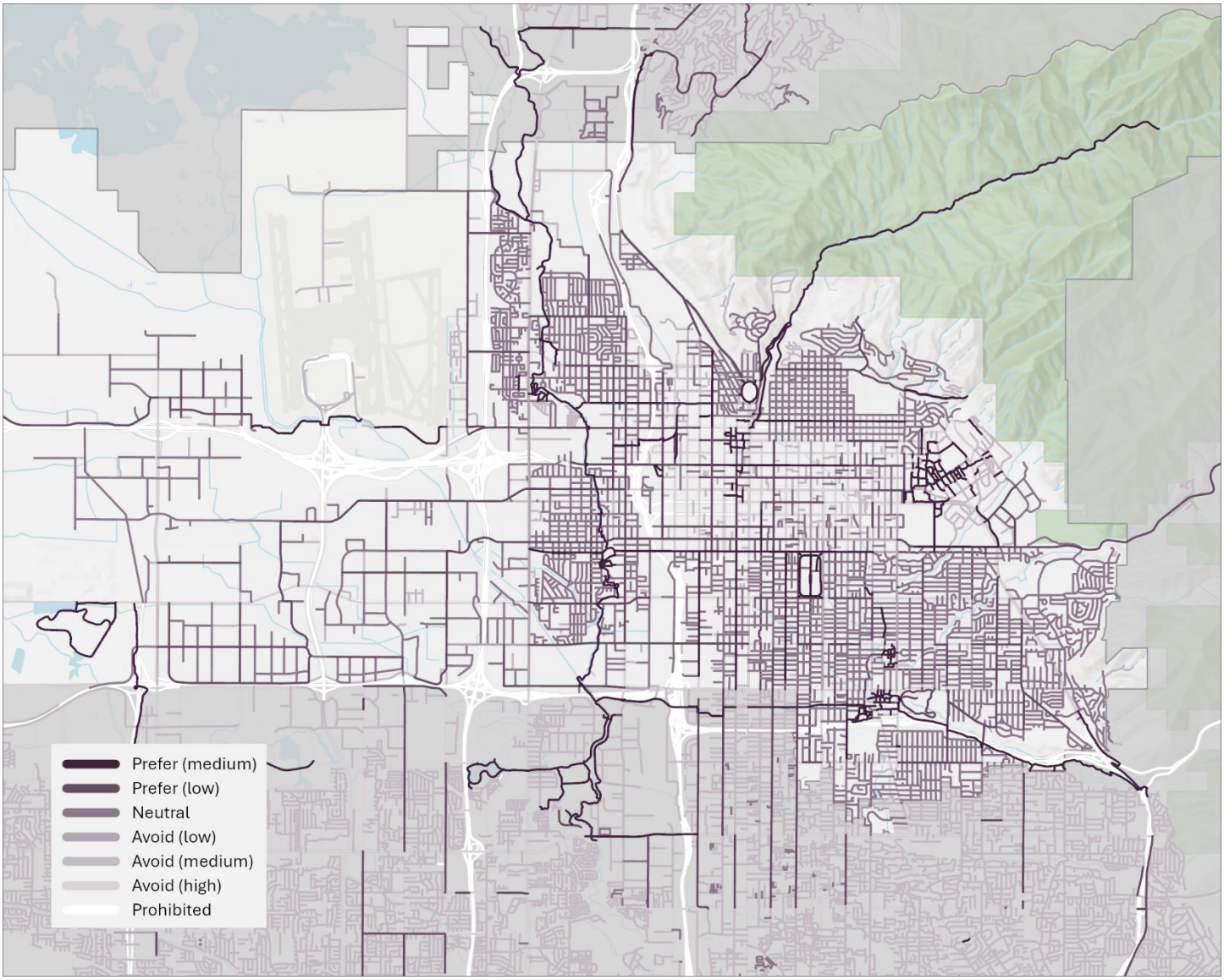


Figure 15. The travel restriction assigned to each segment based on the comfort and preference values.

Next, I configured the travel mode and cost settings so that each route would follow the restrictions and calculate the cumulative distance traveled on each facility type. Finally, I built the network dataset and performed the closest facilities analysis using the origins as incidents and the destinations as facilities. I generated separate route layers for the twenty sub-factors, which I combined into a single layer.

Access to Opportunity Score

The routing algorithm generated 49,420 routes, or one route for each opportunity subfactor for each census block. Using the distance traveled on each facility type and its respective weight, as well as the weights assigned to the opportunity factors and subfactors, I calculated an access to opportunity score to quantify how comfortable it is to bike to key destinations depending on where one lives in the city.

I began by calculating a comfort score for each route, which is a measure of how comfortable it would be to bike that route based on the quality of the physical infrastructure. When creating a route, the algorithm calculated the cumulative distance traveled on each of the seven facility types shown in *Figure 14*, as well as the total distance. I used these values to calculate what percentage of the route was spent traveling on each facility type, and then weighted the percentages according to the following equation:

$$\begin{aligned} route\ score = {} & (\%\ Type1 * 2) \\ & + (\%\ Type2 * 1.5) \\ & + (\%\ Type\ 3 * 1.25) \\ & + (\%\ Type4 * 1) + (\%\ Type5 * 1) \\ & + (\%\ Type6 * -0.25) \\ & + (\%\ Type7 * -1) \end{aligned}$$

These weights reflect the relative comfort of each type of facility. Dedicated physical infrastructure for bicyclists is weighted favorably, while faster streets without bicycle infrastructure are penalized. The equation treats painted bike lanes and low-speed streets as equal, since feedback from local bicyclists indicates that people feel differently about what feels most comfortable to them. Some prefer using established bike lanes, while others prefer using neighborhood streets.

Next, I applied an opportunity subfactor weight to each route score based on the route destination and its respective weight. Finally, I calculated an access to opportunity (ATO) score for each block by taking the twenty weighted route scores and combining them according to the opportunity factor weights (see **Appendix A** for factor and subfactor weights).

The ATO score can range from -100 to 200, with higher scores indicating more comfortable access to opportunity by bicycle. The highest possible score would indicate that someone could bike from their house to every destination and only use fully separated bike lanes or off-street paths. The lowest possible score would indicate that someone would only use high-speed streets without bicycle infrastructure to reach their destination.

In reality, most scores are somewhere in between those extremes. A negative score generally means that most of the routes from a particular origin require bicyclists to primarily use streets with a comfort value of 6 or 7, such as 2100 South or Redwood Road. A positive score means that most of the routes primarily use streets with comfort values of 1-5. Higher positive scores use more separated paths and protected bike lanes, while lower positive scores use more painted bike lanes and neighborhood streets.

Findings

The following findings are drawn from the routing analysis described in the previous chapter, which generated almost 50,000 routes between a set of origin points representing local neighborhoods and an array of destination points representing common amenities or "opportunities" that someone may need or want to access. The algorithm sought to find a route that maximized comfort while minimizing the total distance traveled, essentially modeling the decisions that urban bicyclists make every time they decide to ride.

While the origins and destinations naturally play an important role in the analysis, the most critical factors are how the network is defined and how the algorithm is programmed. These decisions are described in greater detail in the previous chapter, but a brief discussion of their impact on the findings is necessary.

In short, it is incredibly challenging to quantify bicycling comfort, which varies greatly between individuals and can incorporate many different factors. In the workshop and interviews that I conducted for this report, each person that I spoke with had a different opinion on what type of infrastructure felt most comfortable for them. Some preferred streets with dedicated bicycle facilities, while others preferred neighborhood streets. Some sought out protected bike lanes for their separation from cars, while others felt such lanes placed them in uncomfortable or dangerous conditions.

This variation in preference stems from how comfort is conceived at the individual level. Each of us prioritizes something different when traveling by bicycle, whether that be a lack of traffic, directness, aesthetics, safety, pleasantness, or a myriad of other factors. Comfort is situational as well. A street that is pleasant to ride during the daytime may be unsafe at night, just as commuting to work is different from riding to the park with young children.

These competing factors make it challenging to define bicycling comfort in a holistic way. While public data can be used to the extent that it is available, comfort is both variable and highly experiential, requiring an individualized assessment at the block level. Such an assessment is both impracticable due to the size of the network and subject to concerns over the validity of the ratings. This analysis sought to use a simple but defensible rating scheme supplemented by a preference variable to account for edge cases. This approach is not inherently better or worse than other approaches, but the choice of approach does have an impact on the findings.

It is important to remember that the following maps and findings represent only a single measure of comfort. Further, they are subject to the limitations of the public data sources that were used for the analysis. Finally, even at its best, the algorithm is simply an approximation of human behavior and does not fully capture the complexities of the real world.

Access to Opportunity

The access to opportunity (ATO) score quantifies how comfortable it is to bike from various neighborhoods in Salt Lake City to a range of destinations. Routes were generated for twenty types of destinations that were categorized into five opportunity factors: wellness, education, employment, government and social services, and worship. The score was based on what type of bicycle infrastructure was present on each route, which served as a proxy for comfort.

The highest possible ATO score (200) would indicate that someone could bike from their house to every destination and only use fully separated bike lanes or off-street paths. The lowest possible ATO score (-100) would indicate that someone would only use high-speed streets without bicycle infrastructure to reach every destination. In reality, the majority of scores were somewhere in the middle, indicating that someone would use a mix of bike lanes and low-speed residential streets. The maximum and minimum observed values were -30.7 and 172.4, respectively. The median value was 106.0 and the interquartile range was 97.1 to 119.3.

The analysis generated 2,459 ATO scores, each of which represented the routes originating from a different census block in Salt Lake City. Since census boundaries are based on population rather than area, the point distribution varies based on population density and land use. Further, the placement of an origin (e.g., which cross street it is located on) can impact its ATO score. For these reasons, I used an inverse distance weighted (IDW) interpolation to visualize the ATO scores as a continuous surface. For each cell in the surface, IDW generates a weighted average based on the 12 nearest points. *Figure 16* shows the ATO scores for Salt Lake City.

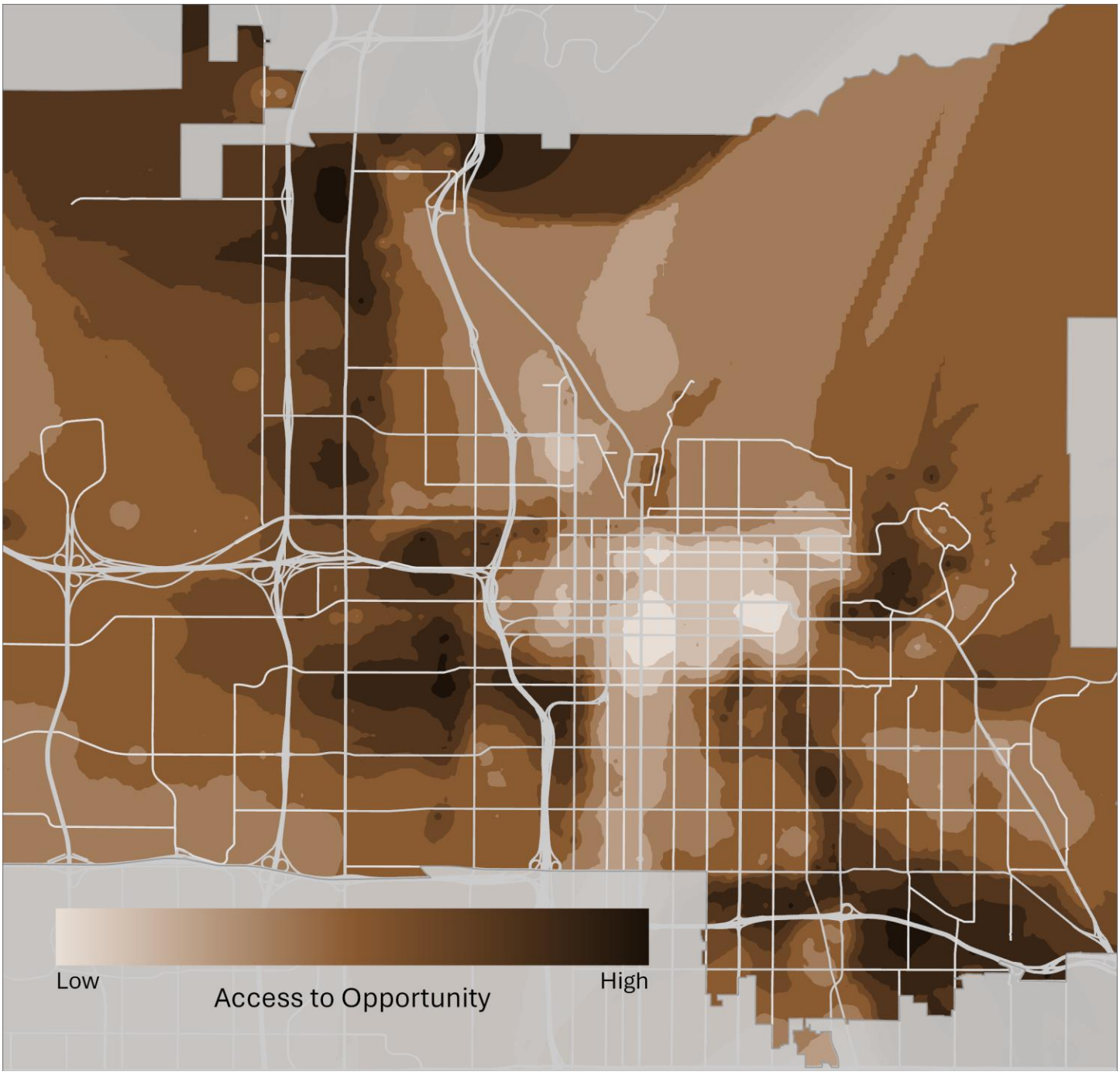


Figure 16. Distribution of access to opportunity scores in Salt Lake City.

There are clear disparities in comfortable access to opportunities by bicycle depending on where one lives in Salt Lake City. In darker neighborhoods, such as Sugar House and Poplar Grove, residents are able to use higher comfort facilities to reach their workplace or school and amenities such as grocery stores, doctors, and parks. In lighter neighborhoods, such as much of downtown Salt Lake City, residents must use lower comfort facilities to reach the same types of destinations.

ATO scores are highest where there is high-quality bicycle infrastructure, such as fully separated paths. This can be seen clearly on the Westside, where the highest scores follow the Jordan River Trail as it travels south through Rose Park before turning east near Fairpark and Poplar Grove. There is a similar improvement in scores along the McClelland Trail as it travels from 9th and 9th to Sugar House. Routes from many different neighborhoods converge onto facilities like these, which act like bicycle highways, allowing residents to travel efficiently between

different parts of the city. An excellent example is the 9-Line Trail west of State Street, which provides a comfortable and efficient connection from Poplar Grove and Glendale to destinations on the east side of Interstate 15 and the railroad tracks.

At first glance, the distribution of ATO scores may seem counterintuitive considering the prevailing opinions about transportation quality in different parts of the city. For example, a common narrative is that the Westside lacks bicycling infrastructure compared to downtown or 9th and 9th, and this may be true when comparing the amount of bike lanes. However, comfort is multi-faceted, and the presence of a protected bike lane does not mean that the entire area has comfortable infrastructure.

While downtown is where most of the city's protected and buffered bike lanes are concentrated, most of its streets are high-speed and many lack any bicycle infrastructure at all. Despite the presence of high-quality infrastructure, bicyclists must still navigate low-comfort streets to reach their destinations or make connections between bike lanes. The Westside, on the other hand, has direct access to the Jordan River Trail, the Folsom Trail, the 9-Line, and Parleys Trail, all of which are high comfort facilities that can be directly accessed from low-speed neighborhood streets. (Some will note that these trails may not be comfortable for some people, given their secluded nature and the presence of homeless encampments. These are valid concerns that should be considered when evaluating these findings.)

Examples can help to illustrate these differences. If you live in Rose Park and need to pick up a prescription at Smith's on 600 North, you can likely bike there entirely on low-speed residential streets. On the other hand, if you live near the Main Library and need to pick up a prescription at the City Creek Harmons, you must ride on high-speed streets for the last few blocks since the nearest streets all lack bicycle infrastructure. These cases illustrate a key takeaway: the location of the destination is just as important as the surrounding network. Many downtown destinations are located on and surrounded by car-centric streets, which means that the end of each trip is uncomfortable.

Some would argue that if the majority of the trip is on high comfort facilities but the destination is located on a low-comfort street, then the sidewalk could be used to access the destination and the trip shouldn't be considered uncomfortable. This misses the point for two reasons. First, riding a bicycle on the sidewalk should not be considered a comfortable and sufficient alternative. The surface quality is often worse, pedestrians and other obstructions act as obstacles, and the roadway is still right next to you. Second, bicyclists should not have to justify their existence. Streets can – and should – serve both bicyclists and drivers.

Appendix D contains individual distribution maps for the ATO scores for the five opportunity factors, which generally follow a similar pattern to the overall ATO score.

Neighborhood Variation

While *Figure 16* provides a more granular view of the origin-level scores, it can be helpful to look at trends at the neighborhood level. Since these boundaries are often contested and can be difficult to define, they can be represented instead by two proxies: census tracts and council districts.

Figure 17 shows the ATO score for census tracts in Salt Lake City, which is calculated by taking the average of the individual scores in a particular tract. Additionally, the variation among individual scores within a larger geography can serve as an indicator of how comfort changes depending on where one lives within a specific neighborhood. Neighborhoods with high variation have an inequitable distribution of comfortable bicycling routes; some households have easy access to high-quality facilities, while others must navigate low-comfort streets to reach the same facilities. *Figure 18* shows the variation in scores by census tract. The Granary District, downtown Salt Lake City, and Ballpark have the highest variation in block-level scores, since there are some facilities like 300 West and the 9-Line but also many high-speed, low-comfort roads like State Street and 600 South.

When considering ATO from the perspective of local governance, District 7, which represents the Sugar House area, had the highest average ATO score (119) out of the seven city council districts. It is followed closely by Districts 1 and 2 (114), which represent the Westside to the north and south of Interstate 80, respectively. District 4, which represents downtown, had the lowest average score (64) by a decent margin, as well as the highest variation among individual scores.

Figure 17. Average ATO score by census tract.

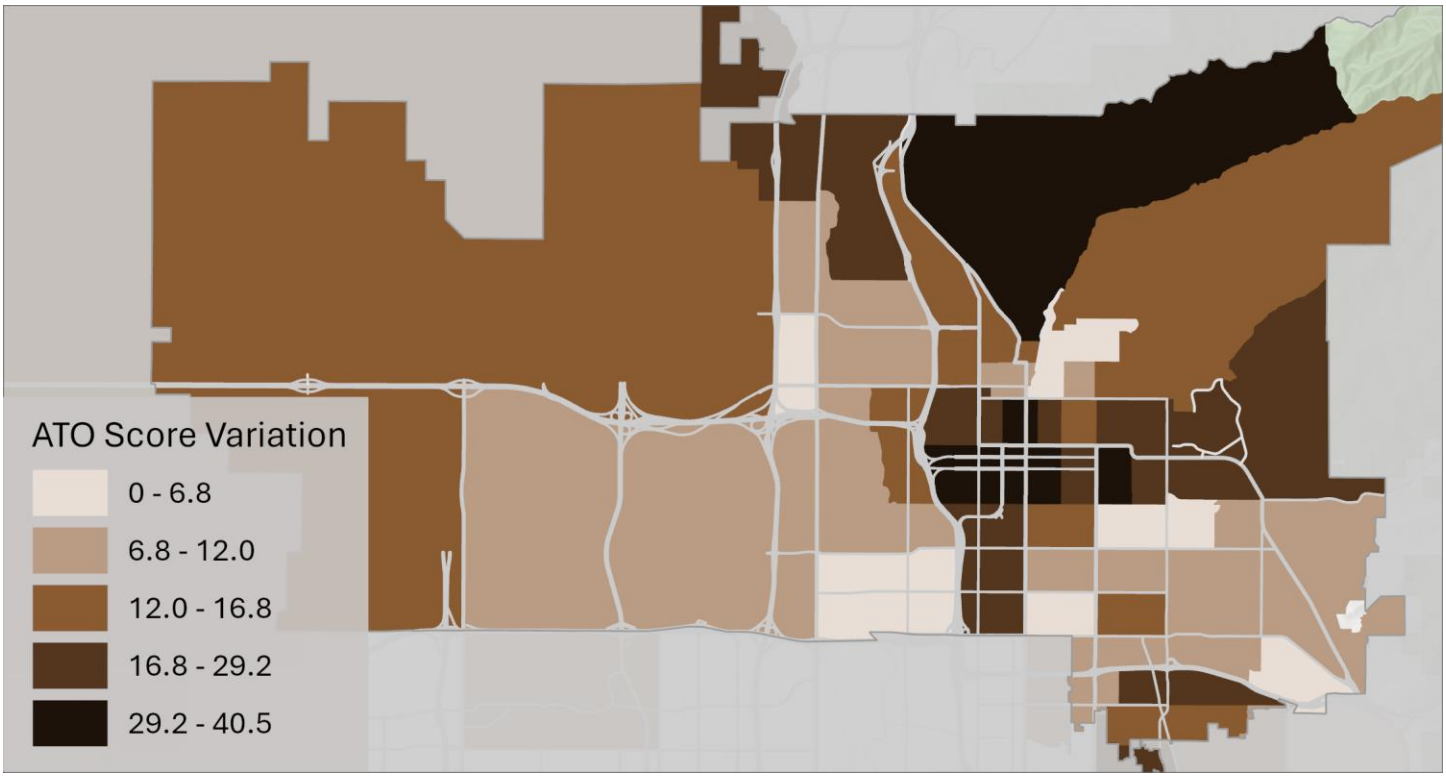


Figure 18. Variation among ATO scores within census tracts.

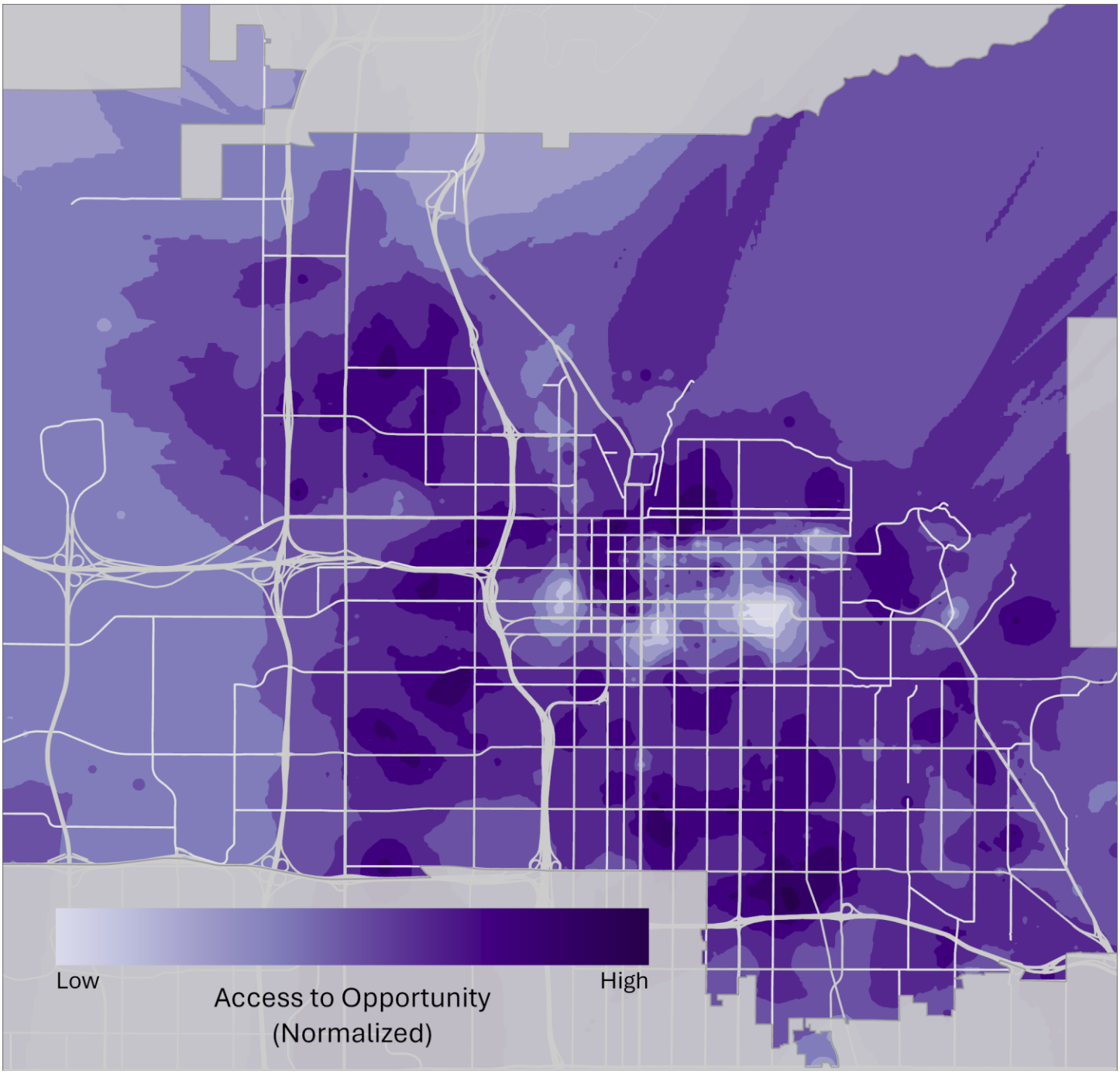


Figure 19. Distribution of normalized access to opportunity scores in Salt Lake City.

Normalized Access to Opportunity

A trip's comfort depends not only on the quality of the bicycle infrastructure, but on the accessibility of the destination. In other words, how far away is the location that you need to reach? Unlike a vehicle or transit trip, the effort required for a bicycle trip increases as the distance increases. A trip that only uses fully separated paths but is 8-10 miles long is probably not what many people would consider to be comfortable. As a result, it is necessary to consider trip distance when assessing access to opportunity.

I accounted for distance by dividing each route's comfort score by its length. The outputs were then used to calculate a normalized ATO score. *Figure 19* shows the normalized ATO scores for Salt Lake City. Similar to the previous map, darker areas have higher access to opportunity by bicycle.

After accounting for trip distance, more central parts of the city like downtown and Ballpark have higher

access to opportunity than they previously did. In these neighborhoods, the closeness of the destinations balances out the lower comfort infrastructure used to reach them. Sugar House and the Westside continue to have high scores compared to the rest of the city, which indicates that trips in these neighborhoods utilize higher comfort infrastructure while remaining a reasonable length.

However, there are still clear pockets of inaccessibility, particularly around Trolley Square and the 400 South corridor toward the Rio Grande District. These neighborhood centers are surrounded by low-comfort facilities which separate them from the surrounding neighborhoods. Despite their proximity to a wide array of destinations, residents must navigate uncomfortable streets like 400 South and 700 East to complete most trips.

Routes

The routing analysis generated 49,420 routes, which equates to 20 routes per origin and 2,471 routes per destination. The patterns shown by these routes help to illustrate the accessibility and connectivity of Salt Lake City's bicycle network.

Routes to destinations that are spread relatively evenly across the city, such as parks or schools, often utilize neighborhood streets. On the other hand, routes to destinations that are unevenly spread across the city or only have a single location often utilize major bicycling corridors. Since these destinations are usually farther away from a given origin, navigating to a high-comfort corridor that traverses the city is more efficient and comfortable than weaving through neighborhood streets.

Figure 20 shows an example of the routes generated from an origin point in Liberty Wells. Some destinations, such as the dentist's office or daycare, are very close and only require a short trip on neighborhood streets. Other destinations, like the doctor's office, are further away but can still be reached on neighborhood streets. The farthest destinations, like the University of Utah and urgent care, are reached by combining neighborhood streets with corridors such as the 9-Line or the S-Line.

The routes generated for a particular type of destination are even more insightful since they show how bicyclists from across the city access either a single destination or an array of similar destinations. The

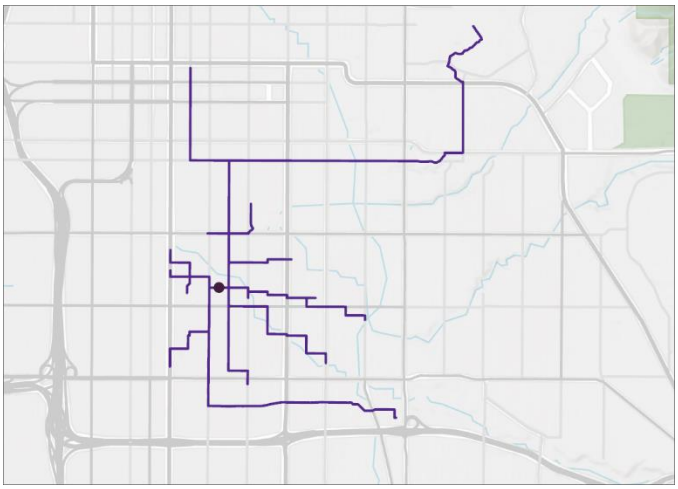


Figure 20. Example of routes generated from an origin point in Liberty Wells.

distribution of routes can be visualized as a heatmap, which overlays many transparent routes to show how frequently bicyclists use different streets and paths. **Appendix E** contains individual heatmaps for each opportunity subfactor.

For destinations such as universities or government offices, heatmaps show how residents access a key location depending on where they live in the city. Major bicycling corridors are seen clearly since the residents traveling the furthest will likely choose the most efficient route to cross the city. Gaps in the network may become apparent as well.

Figure 21 shows the distribution of routes to the Salt Lake City & County Building, which is the seat of the city government. Almost every route utilizes either 200 South or the 9-Line, which act as major corridors to reach downtown. The Jordan River Trail and North

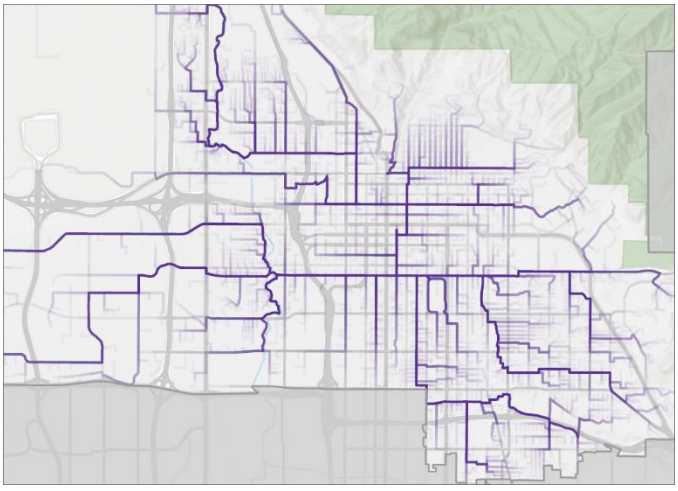


Figure 21. Routes to the Salt Lake City & County Building by frequency.

Temple act as "feeder" routes on the West Side, while the Kensington Byway-McClelland Trail connection is a critical feeder route for residents in Sugar House and the East Bench. 200 East and 300 East serve as the final connectors from 200 South and the 9-Line to the City & County Building.

This map illustrates two key takeaways. First, corridors with high-comfort infrastructure that directly connect neighborhoods across the city act as the backbones of the city's bicycling network. Second, a strong network of secondary facilities helps bicyclists comfortably and efficiently reach the primary corridors nearest to them. Both types of facilities are equally important and necessary for a comfortable and effective bicycling network.

For destinations with multiple locations, such as grocery stores or schools, heatmaps show how residents access locations within their own neighborhood. Major bicycling corridors become less important for hyperlocal destinations since they can be accessed using the local street network. *Figure 22* shows the distribution of routes to public elementary, middle, and high schools. Since many students go to school near their home, they can rely on neighborhood streets, which are more comfortable and usually more direct than dedicated corridors.

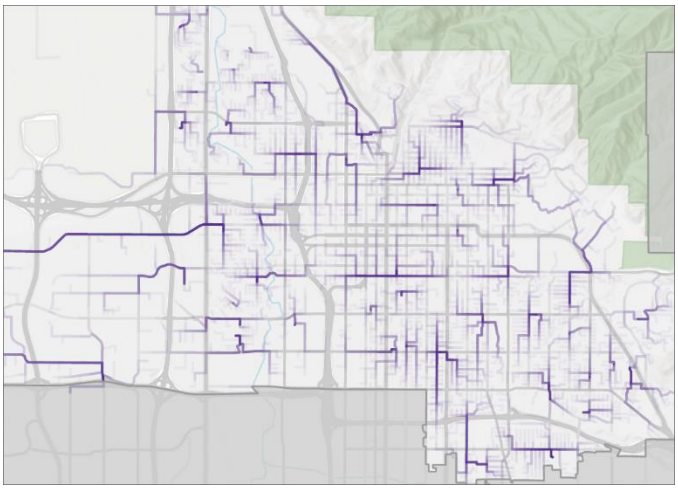


Figure 22. Routes to public elementary, middle, and high schools by frequency.

The distances of the routes in question offer some insights as well. The average and median distances of all routes were 1.32 miles and 1.95 miles, respectively. The longest route was almost 17 miles, but many were much shorter. Over 1% of routes were less than a downtown city block in length (660 feet) and 40% were less than a mile long. Only 13% of routes were longer than four miles. *Table 4* lists the 5th, 50th, and 95th percentile distances for each subfactor. *Figure 23* shows how the average distance traveled increases for less central origins.

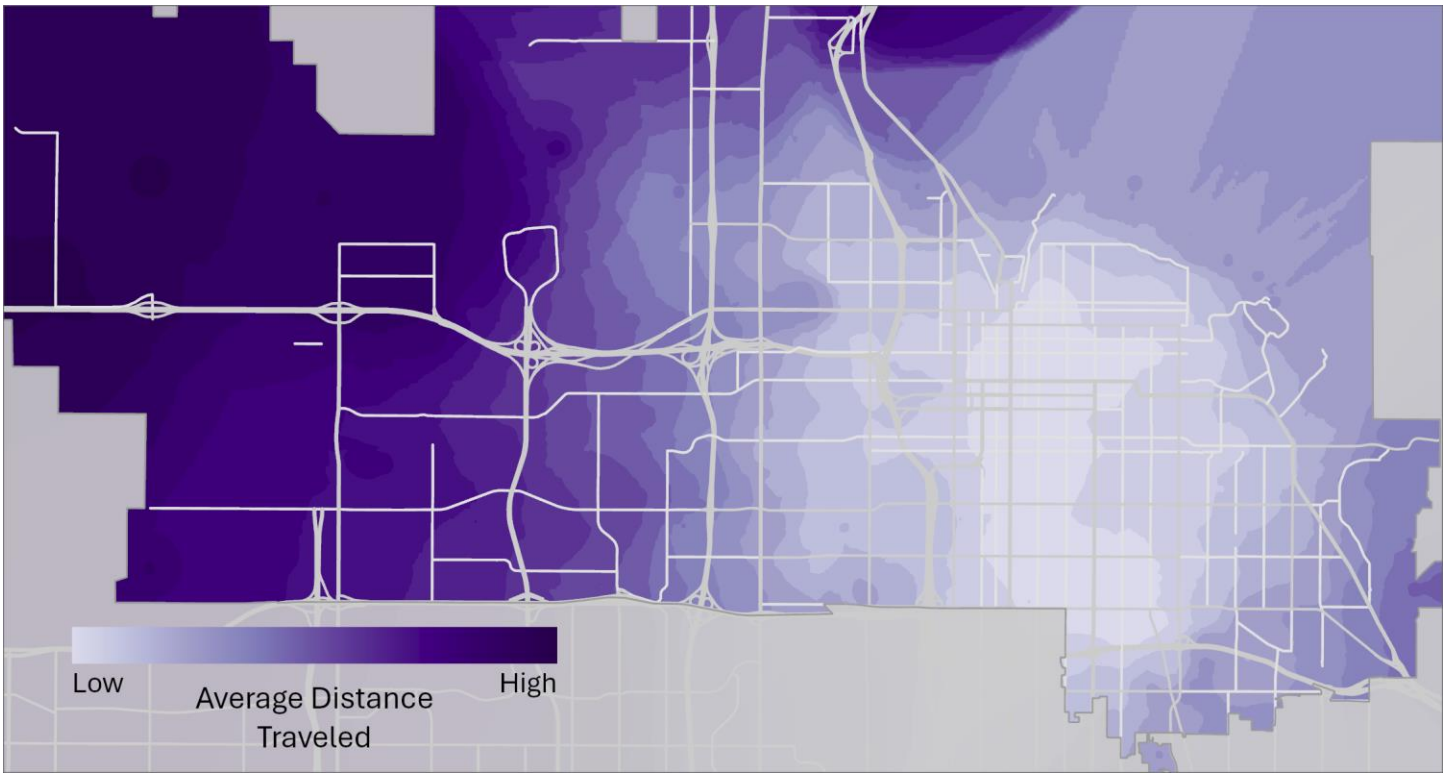


Figure 23. The average distance traveled to reach a destination from a particular origin.

Opportunity Subfactor	5% Percentile	50% Percentile	95% Percentile
Wellness			
Grocery stores	0.16 miles	0.62 miles	2.22 miles
Parks	0.14 miles	0.48 miles	1.93 miles
Community centers	0.36 miles	1.40 miles	3.71 miles
Hospitals	0.13 miles	0.48 miles	1.93 miles
Doctors	0.34 miles	1.21 miles	3.26 miles
Dentists	0.22 miles	0.86 miles	2.78 miles
Pharmacies	0.09 miles	0.77 miles	2.98 miles
Education			
Public elementary, middle, and high schools	0.08 miles	0.55 miles	1.89 miles
University of Utah	0.81 miles	4.17 miles	8.78 miles
Libraries	0.16 miles	1.34 miles	2.90 miles
Salt Lake Community College	0.47 miles	3.60 miles	7.35 miles
Childcare	0.08 miles	0.74 miles	2.90 miles
Employment			
Major employment centers	0.14 miles	1.63 miles	3.68 miles
Government and Social Services			
Salt Lake City & County Building	0.67 miles	3.30 miles	6.84 miles
Salt Lake County Government Center	0.60 miles	4.20 miles	7.87 miles
Courts	0.39 miles	2.84 miles	6.19 miles
Other social services	0.12 miles	1.31 miles	4.86 miles
Worship			
Christianity (The Church of Jesus Christ of Latter-day Saints)	0.06 miles	0.42 miles	2.23 miles
Christianity (non-LDS)	0.11 miles	1.09 miles	3.79 miles
Buddhism, Islam, and Judaism	0.19 miles	1.61 miles	4.01 miles

Table 4. The median and outer bound route distances for different types of destinations.

Connectivity

Connectivity is a key aspect of a comfortable bicycling network. Even if a city has several high-comfort bicycle-priority corridors, the overall bicycling experience could be uncomfortable if the connections between them are lacking. The connectivity of Salt Lake City's bicycle network can be assessed by looking at a heatmap of the routes generated in the routing analysis, as shown in *Figure 24*.

Several corridors immediately stand out, including the Jordan River Trail, the 9-Line, Parleys Trail, Main Street, and 200 South. Each of these corridors serves residents in multiple neighborhoods, allowing them to travel between different parts of the city comfortably and efficiently. Other common connections include McClelland Trail and the Kensington Byway to Sugar House and Sunnyside Avenue to the University of Utah.

The heatmap illustrates two disparities in Salt Lake City's bicycle network. First, the east-west divide is clearly visible. Residents who live on the Westside have few options to cross I-15 and the railroad tracks, and many of these are relatively low comfort. 600 North has a painted bike lane, but it remains highly dangerous given the high volume of vehicles entering and exiting the interstate and the lack of traffic signals at four of the eight conflict zones. 400 South is

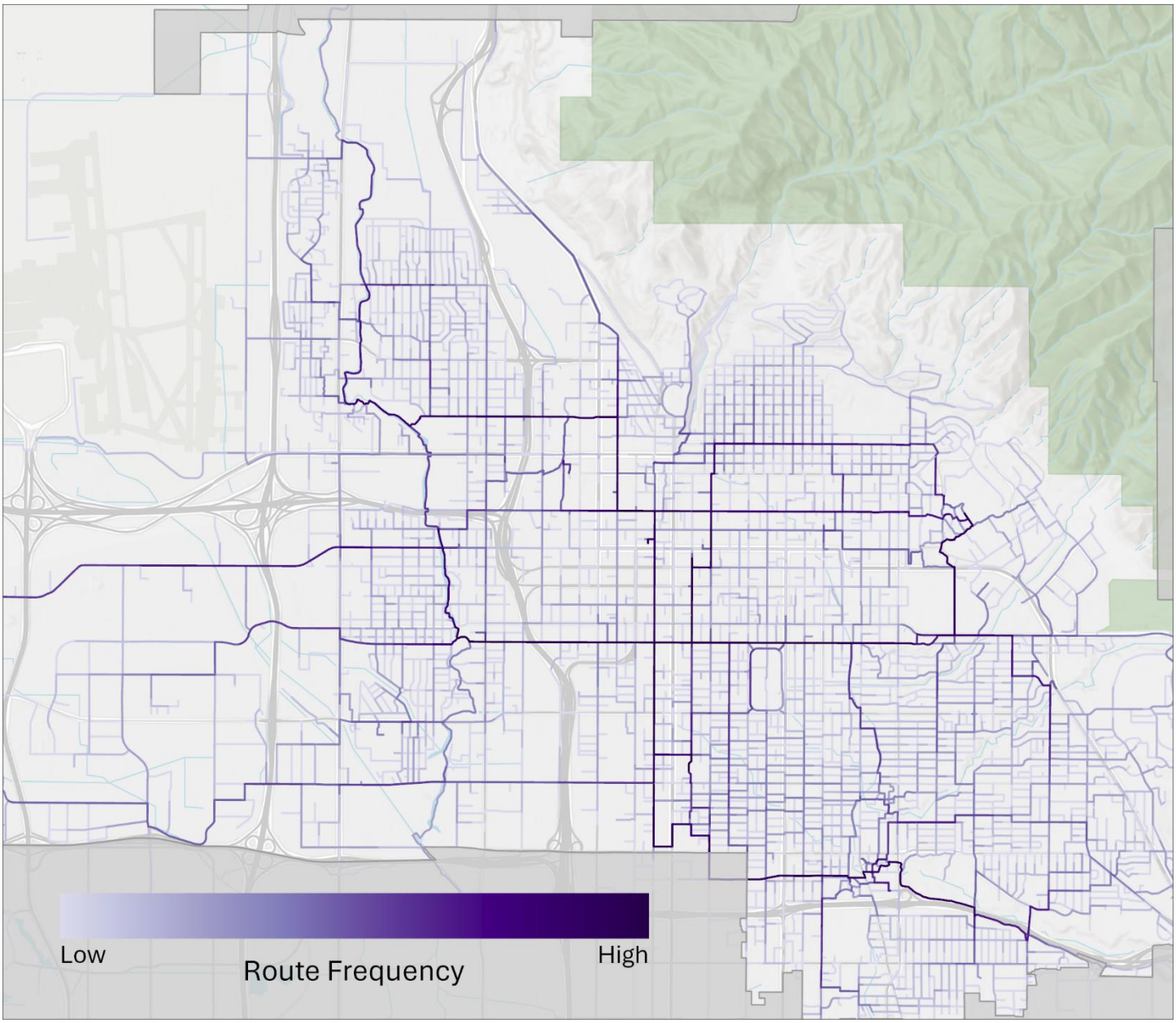


Figure 24. Heatmap of the routes generated by the routing algorithm.

similarly uncomfortable and 1300 South forces bicyclists to share the road with vehicles. Only a few routes – such as 300 West, the Folsom Trail, and the 9-Line – are truly comfortable. As a result, those who live on the Westside must go unnecessarily out of their way in order to safely make a trip by bicycle.

Second, some neighborhoods are well-served by the street network and others are lacking. The broader Sugar House area is perhaps best served since bicyclists benefit from a strong network of low-speed, residential streets. This allows residents to take a wide variety of routes to reach different parts of the neighborhood and the rest of the city. Downtown, on the other hand, is dominated by high-speed arterials and lacks the finer-grained network of residential streets. This can force bicyclists to decide between an efficient route and a comfortable route.

Downtown continues to grow as new housing is built along and adjacent to the North Temple and State Street corridors, and centers like the Granary District and Central 9th gain more commercial development. However, these areas lack the bicycle network necessary to sustain an influx of residents and visitors and would benefit from both bicycling-priority corridors and a denser network of low-speed, bicycling-friendly streets.

Neither type of infrastructure is better or worse than the other, and planners shouldn't view it as either/or. Both types should work together and be prioritized equally in order to create a truly connected and comfortable network. Major bicycling-priority corridors help bicyclists travel across the city comfortably and efficiently, while denser bicycle-friendly streets offer first- and last-mile connections between the corridors and one's origin or destination.

Sugar House is an excellent example of this relationship. Bicyclists who live in more residential areas can use low-speed, low-traffic neighborhood streets to reach the McClelland Trail or the S-Line, which offer easy connections to the 9-Line and the Jordan River Trail, opening up access to much of Salt Lake City. This is demonstrated by the mixing of dark purple and medium purple lines on the heatmap.

By taking advantage of how different types of bicycle infrastructure complement each other, planners can create a network that serves the entire city. Major interconnected bicycling corridors form the backbones of the network, while neighborhood streets fill in the gaps and create first- and last-mile connections.

Future Research

There are four ways in which the routing analysis could be improved in the future. Each would help the routing algorithm more accurately reflect real-life behavior, which is the underlying goal of all modeling.

First, the process of defining comfort ratings could be expanded to include other measures that better reflect the true comfort of a given street segment. This analysis defined only seven broad categories of bicycle infrastructure, but the variation is much larger in reality. Rather than treating all streets with a painted bike lane as the same, an expanded rating scheme could consider the number of travel lanes, posted speed limit, daily traffic volume, road width, and more. Other variables such as tree canopy coverage, land use, and slope could be incorporated. Bicycle activity data from Strava could be used to validate the ratings. In an ideal scenario, local bicyclists would provide direct input on the ratings.

Second, the algorithm could be expanded to model the impact of intersections and the railroad tracks, both of which impact the comfort of a trip. Some intersections in the city are more dangerous or uncomfortable to navigate than others, while stopped trains can cause substantial delays. This impact can be modeled by adding a time penalty and/or increasing friction for certain intersections or crossings.

Third, the inputs and parameters for the algorithm could be better defined. As I discussed earlier, the publicly available street network does not capture some off-street connections that bicyclists use in real life. Similarly, the parameters that dictate which streets should be preferred or avoided may not fully reflect the actual decisions that bicyclists make. Using better data would improve the accuracy of the findings.

Fourth, the outputs could be validated against other sources of bicycling comfort-related data. The ATO scores can be compared to Bike Score, which is the cousin of Walk Score. Both are commonly accepted measures of the bikeability or walkability of a specific location and are frequently used in real estate contexts. Further, the heatmap of generated routes could be compared against a heatmap of Strava data. Activity data can be used not only to validate the comfort of individual segments as mentioned earlier, but to validate the modelled patterns of activity across the entire network. Validating the outputs would confirm the soundness of the findings.

Recommendations

The following recommendations are based on the findings contained within this report, feedback from local bicyclists, and active transportation planning best practices. The recommendations are separated into two categories that capture the main determinants of bicycling comfort: the physical experience of riding a bicycle in Salt Lake City and the social structures that influence this experience. The role of land use and development is addressed at the end of this chapter, since comfort and accessibility depend not only on the trip itself, but on the location of the destination.

Figure 25. A separated bike lane in Austin with concrete barriers to protect bicyclists from traffic.

Built Environment

Streets and Paths

Continually expanding and improving the region's bicycling network is the most straightforward way to improve bicycling comfort. This can be accomplished in three ways: expanding the network by adding new bike lanes, strengthening the network by adding physical protection, and connecting the network by linking bike lanes. Each action should be considered equally important; all three are necessary for creating a comfortable, cohesive, and effective bicycle network.

The residents that I spoke with generally thought that Salt Lake City had made meaningful progress in improving local bicycle infrastructure in recent years. However, they largely felt that the bicycle network was good but not great, with clear room for further improvement.

These conversations and the accompanying analyses identified a number of general recommendations for planning and designing high-comfort local bicycle infrastructure. These include:

- ***Creating connections between bike lanes.*** The presence of high-quality bike facilities does not necessarily mean the trip is comfortable if there are not adequate connections. Bicyclists are often forced to ride on the sidewalk or navigate heavy traffic in order to fully utilize the city's bicycle network. Other connections are indirect or confusing, which can discourage those who are less familiar with the network. The city's network should be truly interconnected and intuitive to navigate.
- ***Protecting bike lanes with immovable infrastructure.*** Residents felt safest when using a lane with physical protection, such as a concrete curb or grade separation. Flexible posts do not stop vehicles and drivers often disregard painted buffers.
- ***Focusing network expansion on streets that are already bicycling-friendly.*** Driving will always be an important travel mode in Salt Lake City, and streets such as 400 South or 700 East remain better suited for moving vehicles rather than bicycles. It is more feasible from both a political and a design perspective to build comfortable bicycle infrastructure on streets that are not major arterials for vehicles.
- ***Adding better infrastructure on the uphill side of sloped streets.*** Residents feel less safe while riding uphill because of the greater difference in speed between themselves and drivers. The city should prioritize adding bike lanes on the uphill side of the street, which would improve comfort and address concerns about removing parking. For example, 1300 South has two travel lanes and two parking lanes. Converting a parking lane to a bike lane would increase comfort for those riding uphill while preserving some parking, since those riding downhill would traveling be near the speed of traffic and could utilize the full travel lane.
- ***Using more green paint.*** The color green has become associated with bicycling facilities and green paint is used in Salt Lake City to designate bike boxes and conflict areas (such as driveways that cross the bike lane). More green paint should

Figure 26. Using bright green paint to delineate a bike lane in Philadelphia.

be used to delineate and increase the visibility of bicycling infrastructure, especially in high conflict areas or where drivers routinely disregard bicyclists.

- ***Using fewer sharrows.*** Sharrows are often seen as a politically feasible tool for improving urban bicycling, but research indicates that streets with sharrows are less safe than streets with no bicycle infrastructure, since they are often placed on low-comfort streets.[7] Sharrows are not a replacement for bike lanes and should only be used for neighborhood byways or on the downhill side of streets where limited right-of-way only allows for an uphill bike lane.
- ***Continuing the Neighborhood Byways program.*** Utilizing streets that are inherently low-stress due to their low speeds and traffic volumes is an easy way to increase comfort for both intra- and inter-neighborhood trips. Particular attention should be given to Westside streets, many of which are significantly wider and more dangerous than streets in other neighborhoods since their observed driving speed is higher.
- ***Calming local streets.*** Driver behavior is shaped by street design. A driver will drive faster if a street straight and wide with few visual obstructions, regardless of the actual posted speed limit. Most neighborhood streets and many city streets can be calmed by narrowing travel lanes, adding bulb-outs and chicanes, and planting trees.
- ***Improving bicycle infrastructure further south in the valley.*** Several residents already biked or wanted to bike to visit family and friends in other parts of the valley but were unable to do so comfortably. While the Jordan River Trail is a high-quality north-south route, it lacks east-west connections to the cities it passes by.

Several specific improvements were identified through my analysis and engagement with residents who frequently bike around the city. These include:

- ***Creating connections between the S-Line, 300 West, and Central Pointe Station.*** This node has the potential to be one of the county's strongest multimodal hubs, given the presence of two high-quality bicycling corridors, three TRAX lines, the S-Line streetcar, and two buses. However, none of these facilities have safe or comfortable connections. Addressing this is especially challenging since this node is just inside of South Salt Lake, which has been unwilling to plan for such connections.

Figure 27. Using chicanes to calm traffic in a Seattle neighborhood.

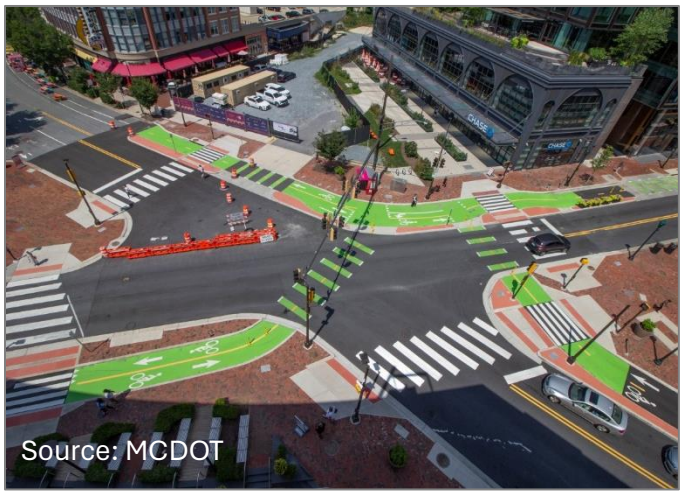


Figure 28. Creating safer connections for bicyclists in Bethesda, MD.

- ***Creating connections between Salt Lake Central Station and nearby protected bike lanes.*** The surrounding road network is fragmented due to Interstate 15 and its local exits, which forces unsuspecting bicyclists to take circuitous routes on low-quality or non-existent bicycle facilities. Creating high-quality connections with 300 South and 200 West would allow regional commuters and visitors to reach their destinations more easily from FrontRunner.
- ***South Temple Street.*** South Temple's historic architecture, tree canopy, and numerous apartments make it a strong candidate for a separated path. The wide sidewalk and road verge (the grass strip next to the roadway) could be converted into a multi-use path.
- ***North Temple Street.*** North Temple is a critical connection between the Westside, downtown, and North Temple Station, but bicyclists are relegated to a narrow, painted bike lane on the busy, high-speed street. Adding physical protection or converting one side of the street to a bidirectional cycle track or multi-use path would create a more comfortable connection, particularly as high-density housing development continues along the corridor.
- ***Continuing the 1300 East bike lane north of 600 South.*** As bicyclists approach the University of Utah, the 1300 East bike lane abruptly ends at 600 South as the road transitions from a single travel lane to three travel lanes. Bicyclists are forced to navigate two highly trafficked blocks before reaching a bisecting bike lane; otherwise, they must go significantly out of their way to cross at 1100 East or Guardsman Way.
- ***West Temple Street.*** This low trafficked neighborhood street provides a quiet and pleasant alternative for bicyclists, particularly as they travel further south to the center of the valley. West Temple has intermittent painted bike lanes, which could be extended and upgraded to provide a strong north-south route from Salt Lake City to South Salt Lake and Millcreek.
- ***The Green Loop.*** The proposed linear park system would create high-quality connections between existing bicycle infrastructure. This would improve conditions near the Granary District in particular, which lacks north-south bike lanes.
- ***Main Street.*** Downtown has relatively little high comfort bicycle infrastructure. Closing Main Street to vehicles would create a high-quality connection to City Creek Center, Temple Square, and other destinations. Outside of downtown, Main Street has the potential to be a premier north-south route given its lower traffic volume and reduced travel lanes. The city should add physical features within the painted buffer to further increase comfort.
- ***Neighborhood Byways.*** Residents frequently utilized 600 East because it was both highly comfortable and very useful for connecting downtown with Sugar House. They expressed support for continuing to expand the program across the city.

Figure 29. A pedestrianized street with bike lanes in New York City.

Intersections

Intersections are highly dangerous for pedestrians, bicyclists, and drivers alike. They are often unpleasant to navigate for bicyclists in particular, especially when actuated signalization is used, which relies on detecting when cars or pedestrians are present. The following recommendations can improve safety and comfort for bicyclists:

- ***Implementing leading pedestrian (or bicycle) intervals (LPIs).*** An LPI adjusts the traffic signal timing to give pedestrians and bicyclists several seconds to begin crossing before the light turns green. By increasing the visibility of pedestrians and bicyclists in the intersection, drivers are more likely to see and yield to them. LPIs have been found to significantly reduce pedestrian crashes.[8]
- ***Adding specific push buttons for bicyclists.*** A separate push button directly next to the bike lane allows bicyclists to call for a green light without forcing them to dismount and walk to the pedestrian button. Salt Lake City has installed bicyclist-specific push buttons along the 600 East Neighborhood Byway and should continue to install them on bicycling-oriented corridors.
- ***Using fixed-time signals at select intersections.*** Many intersections in the city rely on the presence of vehicles or pedestrians to determine when signals change. However, they often cannot recognize when a bicyclist is present, which means that the signal will not change unless the bicyclist actively dismounts and pushes the pedestrian button. Signals along bicycling-oriented corridors should operate with fixed timing.
- ***Installing bicycle rests at intersections along bicycling-oriented corridors.*** Foot and hand rests at intersections allow bicyclists to wait more comfortably since they do not need to dismount and can accelerate more easily. Rests can be dedicated features or they can be strategically created using existing lane protection (e.g., raised curbs). Salt Lake City has installed some rests along the 9-Line and 300 West, but they are not always placed at logical or convenient places for bicyclists to easily use them.

Other Infrastructure

Bicycle parking, directional signage, and aesthetic features all contribute to how comfortable a trip feels and their impact on bicycling activity is often undervalued. Recommendations for these types of features include:

- ***Installing more bicycle parking with a focus on safety and security.*** A lack of adequate parking can deter someone from using a bike for a particular trip. While this is most evident when there is no parking at all, the increase in ownership – and theft – of electric bikes means that bicyclists are increasingly aware of whether they can securely store their bike (which can cost upwards of $5,000). A bike rack directly in front of a business is the simplest solution, but bike lockers are even better. UTA, for example, has begun installing lockers at select TRAX and FrontRunner stations.
- ***Creating dedicated bicycle parking infrastructure at key destinations.*** This could include specific places such as the Gallivan Center or the

Figure 30. A push button for bicyclists at Liberty Park.

Figure 31. Bicycle storage lockers at the West Jordan City Center TRAX station.

Delta Center, or highly trafficked areas such as Sugar House or 9th and 9th. An easy and low-cost solution would be bike lockers, but dedicated bicycle facilities such as the **Downtown Bicycle Station** in St. Louis are becoming more common in the United States.

- ***Using signage to indicate where bicycle parking can be found.*** Parking is only useful if bicyclists know it exists. Many offices, grocery stores, and parking garages have bicycle parking on the premises, but it can be hard to find or unadvertised.
- ***Continuing to add directional signage.*** Salt Lake City already has extensive signage that serves to indicate the presence of bicycle lanes or routes or to provide details about the route, such as the distance signs along the Jordan River Trail. However, this signage can be small and easy to miss, particularly along neighborhood byways and at connections between two bicycle facilities (e.g., the on-street section of the S-Line at Haven Avenue). Improving this signage makes the bicycle network easier to navigate and can more clearly identify high-comfort neighborhood streets.

Figure 32. Signage that indicates the physical difficulty of different routes to the University of Utah.

- ***Adding more comfort-specific signage.*** Bicyclists traveling from downtown to the University of Utah have likely noticed ski-inspired signs that identify routes based on their difficulty. Such signage should be added for other hilly routes in Capitol Hill, the Avenues, and the East Bench. Similar signs can also be used downtown to indicate lower- or higher-comfort routes.
- ***Adding more signage for drivers along 300 West and other bidirectional cycle tracks.*** 300 West is a major commercial corridor with many highly trafficked driveways, which create conflict points between drivers and bicyclists. Drivers will often drive onto the cycle track without looking for bicyclists (especially those traveling in the opposite direction). More obvious signage should be used to indicate that drivers must stop before entering the cycle track, rather than using it as a place to wait before turning.
- ***Planting street trees and greenery.*** Trees have many **positive impacts**, from calming traffic to making walking and bicycling more pleasant by providing shade during the summer. Ogden's Grant Avenue Promenade is an excellent example of an active transportation corridor that fully incorporates trees and greenery.
- ***Installing public art.*** Comfort is not only a matter of safety, but of enjoyment and pleasure. Art installations such as murals or sculptures create a sense of place and contribute to the pleasantness of a trip.

Figure 33. A bike lane protected with landscaping in downtown Ogden.

Policies and Programs

Bicycling comfort goes beyond the presence and quality of physical infrastructure. The following recommendations address how local government, the police, and advocacy groups can better support bicycling. They include:

- ***Enforcing driving laws that affect bicyclists.*** Drivers frequently speed, run red lights, pass without adequate room, and turn without looking – all behaviors which endanger bicyclists. Many are unaware of or simply ignore bicyclists' right to the roadway and some drive dangerously to purposely threaten bicyclists. The police should increase their enforcement of driving offenses that endanger bicyclists.
- ***Educating drivers on the rights of bicyclists and their responsibilities as a driver.*** Many people are unaware that bicyclists have a similar right to the roadway as drivers. Further, many drivers don't know or think to pay attention to bicyclists while turning or opening their door. Both government and advocacy groups should educate drivers on how to interact safely with bicyclists, from passing with at least 3' clearance to using the **Dutch Reach** when exiting their car.
- ***Continuing and expanding e-bike rebate programs.*** Riding an e-bike increases comfort by reducing effort and fatigue (particularly on hilly routes), lowering travel time, and allowing bicyclists to travel at or near the speed of traffic. However, their cost can make them unattainable for many residents.
- ***Maintaining bike paths and trails during the winter.*** Cities like **Minneapolis** and **Oulu, Finland** have shown that bicycling can be feasible and comfortable year round when snow clearing operations consider the needs of bicyclists. Salt Lake City clears some downtown bike lanes, but not multi-use paths like Parleys Trail.
- ***Updating the Salt Lake City & County Bikeways Map.*** The **map** identifies high, medium, and low comfort routes and includes other information about urban bicycling. The map was created in 2019 and should be updated to reflect the improvements that have been made over the last five years.

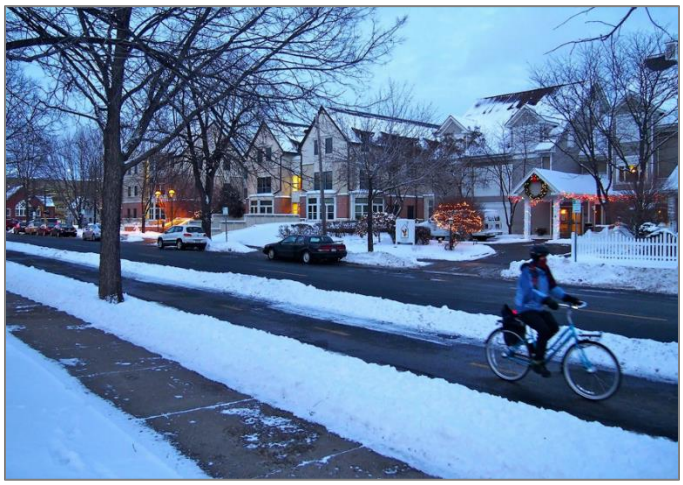


Figure 34. Winter bicycling in Minneapolis.

- ***Considering banning "right on red".*** Cities across the country are beginning to ban right turns at red lights. A driver looking for an opening to turn will often focus on traffic and not pay similar attention to bicyclists or pedestrians crossing in front of them.

Land Use and Development

While accessibility and the comfort of the trip itself are closely related, the presence and location of the destination are arguably just as important. After all, fresh produce and healthcare aren't accessible if there isn't a grocery store in the neighborhood or if the doctor's office is prohibitively far. The main factors that impact the mix and spread of destinations are land use policies and development activity.

Destinations are often spatially clustered around key nodes, or neighborhood centers. This clustering usually improves accessibility because the transportation system is designed to serve these nodes and individuals can access many destinations at once. However, accessibility can suffer if nodes are unevenly or inequitably distributed across the city. Uneven distribution can result from overly prescriptive land use policies, while inequities are often tied to historic patterns of disinvestment.

Salt Lake City has a reasonably good mix and spread of destinations across the city (see **Appendix B**). However, their quality can vary, and the distribution may be different for destinations that were not included in this analysis. Commercial amenities like retail or dining, for example, are more dependent on market forces than public amenities like schools or

social services, which the government has a responsibility to provide for everyone. Since a restaurant's main objective is generating revenue, it will locate where there is demand and not necessarily where there is need.

Salt Lake City should encourage mixed-use development in neighborhoods across the city, particularly on the Westside. This can primarily be accomplished through changes to the city's land use policies and zoning ordinances. Development should be concentrated at existing nodes to reduce neighborhood impact and to improve accessibility through clustering. Improving destination spread across the city will improve comfort, since a shorter trip is more comfortable than a longer trip. Further, a trip that remains within a neighborhood can better utilize low-stress neighborhood streets.

The exact location of a destination affects bicycling comfort as well, and even the difference of a single block can have a significant impact. For instance, a midblock coffee shop on Main Street is easier and more comfortable to access than if it was located a block over on State Street. The former has a buffered bike lane with one lane of medium-speed traffic, while the latter has no bike lane with three lanes of high-speed traffic. This sentiment was shared by several residents who said that they were more likely to visit restaurants and stores that were located on bicycle-friendly streets. Developing bicycle-oriented corridors with a variety of amenities improves comfort and accessibility while generating economic benefits.[9]

"I haven't owned a car in over seven years, so my whole lifestyle has been completed reoriented around places that I can get to by bicycle or transit."

Finally, improving public transit helps to make bicycling more viable by providing an alternative mode of transportation when bicycling isn't possible. For hesitant bicyclists who are concerned about bad weather or mechanical failures, frequent and reliable transit can act as a backup in case something goes wrong. Additionally, transit can "flatten" the city's topography by reducing the effort required to reach higher elevation destinations. For example, some University of Utah students or staff will take TRAX to campus in the morning and bike home in the afternoon.

A high-quality transit system is especially important for households with a single car or those who are interested in reducing the number of cars they own. When planned well, bicycling and transit can be highly complementary, particularly when it comes to solving the first/last mile problem. By pairing fast, frequent transit with direct, comfortable bicycling routes, cities encourage multimodal trips.

Implementation

Planning is an exercise in envisioning an ideal state and identifying what is necessary to reach it. Without clear, actionable steps toward implementation, it can be a futile effort. It is important to consider how the findings contained within this report can be used to inform and advance bicycling advocacy and planning.

The following recommendations identify how this report and its accompanying data can be used by Sweet Streets SLC to advance their mission of creating people-first spaces.

- ***Share the findings with stakeholders.*** The report should be made available on their website and its release should be publicized among their constituencies and stakeholders. The high-level findings can be summarized in a press release, email newsletter, and/or social media posts, and those interested in learning more can be directed to the full report.
- ***Incorporate the findings into ongoing and upcoming campaigns.*** The data and insights from the analyses and engagement can provide evidence or support for advocacy campaigns around local transportation projects or policies.
- ***Identify gaps in the local bicycle network for smaller-scale, shorter-term action.*** The heatmaps can be used to identify blocks or intersections where minor projects could have relatively major impacts. Salt Lake City's **Capital Improvement Program** allows community-based organizations to participate in the planning process by submitting requests for specific projects.
- ***Identify gaps in the local bicycle network for larger-scale, longer-term action.*** The access to opportunity maps and heatmaps can be used to identify sub-neighborhood-level areas or specific corridors that would benefit from major projects and could become the subject of long-term advocacy efforts. Further, the access to opportunity scores can be compared against the **Livable Streets Program** scores, which the city is using to prioritize the implementation of traffic calming measures in different neighborhoods.
- ***Incorporate the findings into public comments.*** Sweet Streets SLC encourages its members to comment during the planning process for local transportation projects. When relevant, the findings could be included in form letters or comments to provide further evidence and support for the issue at hand.

Two broader recommendations were identified during the community engagement phase:

- ***Encourage elected officials and government staff to ride around Salt Lake City.*** As one bicyclist shared with me: "You need to actually get on a bike in order to notice the issues." Encouraging officials to join group rides or setting up individualized tours could help decision-makers understand what biking locally is like. These rides should be focused not only on what issues need to be addressed, but on how enjoyable urban bicycling can be.
- ***Engage with and learn from the local mountain biking community.*** Several residents noted how effective mountain biking communities are at building and protecting unpaved trails across the country. More city-centric bicycling groups may be able to learn from the success of these communities and harness their advocacy, particularly in a region where mountain biking is an integral part of the communities abutting the Wasatch Range.

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This project would not have been possible without the support of so many.

Sweet Streets Salt Lake City was an invaluable partner from start to finish. In particular, I would like to thank Peter McDonald, Ben Wood, Johnnae Nardone, and Taylor Anderson for their involvement. Their guidance and assistance helped ensure that my analysis and recommendations reflected the lived experiences of those in Salt Lake City. Sweet Streets SLC does such incredible, meaningful, and necessary work, and I feel fortunate to have contributed to their mission.

Dr. Alessandro Rigolon provided critical feedback and support as my project advisor. When I would focus too much on the process and the data, he would remind me what this project was really about: giving voice and credence to the concerns of those who feel unsafe or uncomfortable biking around Salt Lake City. I can't express enough the impact that Dr. Rigolon, Dr. Andy Hong, and the rest of the City & Metropolitan Planning Department have had on my outlook and aspirations as a planner.

Finally, I would like to express my gratitude to my parents, my friends, and Aspen for their unfailing support over the past two years. Regardless of where the coming years take me, Salt Lake City and the Wasatch Front will always feel like a second home.

Sweet Streets SLC

Sweet Streets Salt Lake City is a nonprofit dedicated to changing land use and transportation from auto-dependent to people-first. They believe that streets and public spaces that welcome all users are essential to a society that is more connected, equitable, and sustainable. Sweet Streets SLC leads a range of campaigns to educate and advocate for people-first planning, budgeting, implementation, and operation of streets and public spaces in Salt Lake City and the broader valley. To learn more or become involved, visit their website at **sweetstreeetsslc.org**.

Appendices

Appendix A. Opportunity Factor and Subfactor Weights

Wellness (35%)

- Grocery stores (30%)
- Parks (25%)
- Community and recreation centers (15%)
- Hospitals (10%)
- Doctors (10%)
- Dentists (10%)
- Pharmacies (10%)

Education (25%)

- Public elementary, middle, and high schools (35%)
- University of Utah (25%)
- Libraries (15%)
- Salt Lake Community College (15%)
- Childcare (10%)

Employment (20%)

- Major employment centers (100%)

Government and Social Services (15%)

- Salt Lake City and County Building (30%)
- Salt Lake County Government Center (30%)
- Courthouses (20%)
- Other social services (20%)

Worship (5%)

- The Church of Jesus Christ of Latter-day Saints (60%)
- Christianity (non-LDS) (30%)
- Buddhism, Islam, and Judaism (10%)

Appendix B. Distribution of Destination Subfactors

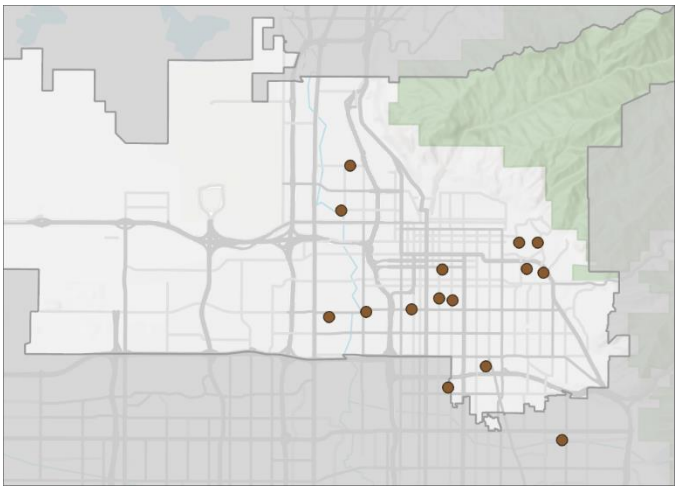

Figure 1. Wellness: Community centers.

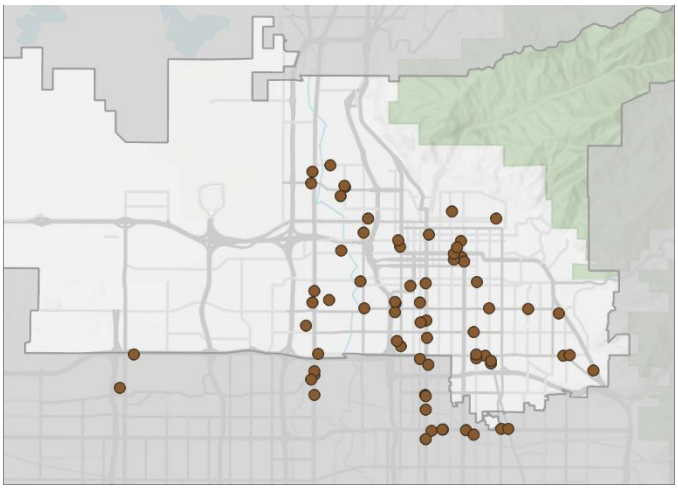

Figure 4. Wellness: Grocery stores.

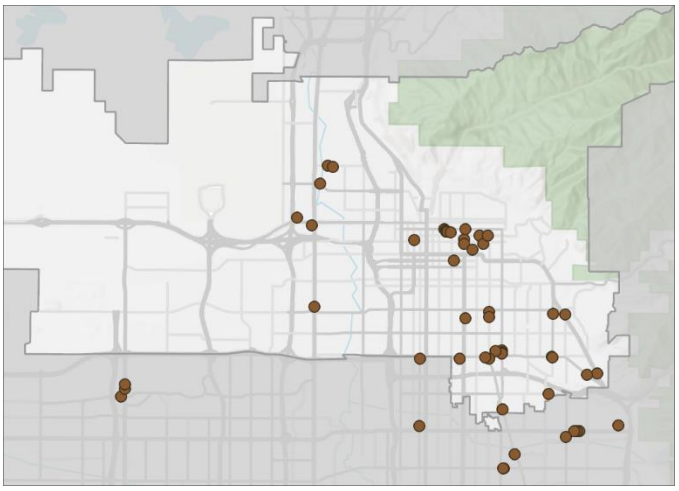

Figure 2. Wellness: Dentists.

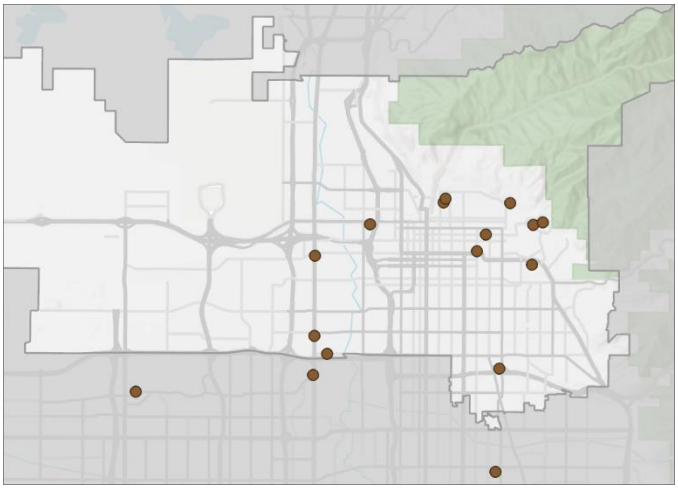

Figure 5. Wellness: Hospitals.

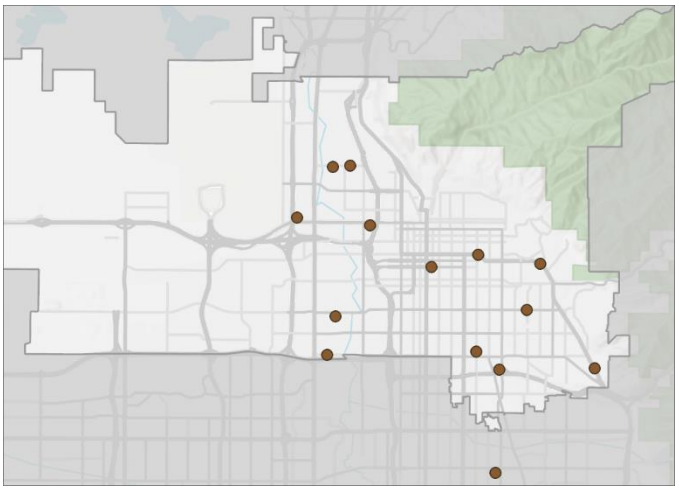

Figure 3. Wellness: Doctors.

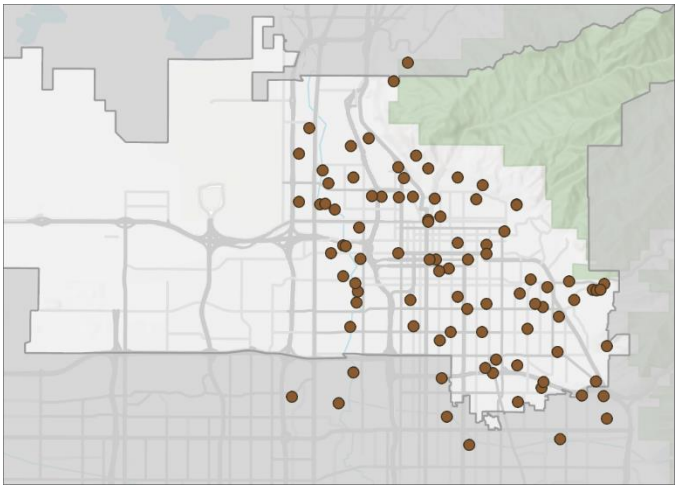

Figure 6. Wellness: Parks.

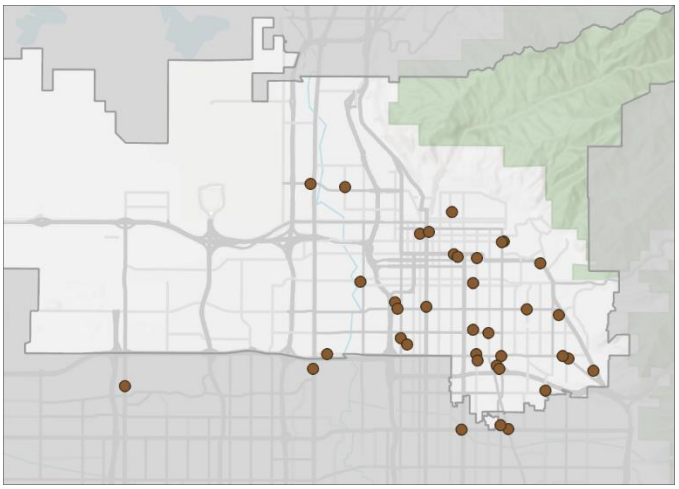

Figure 7. Wellness: Pharmacies.

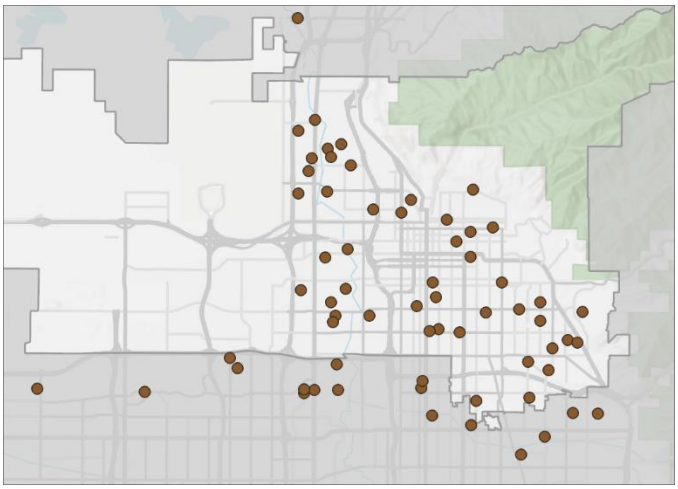

Figure 10. Education: Public elementary, middle, and high schools.

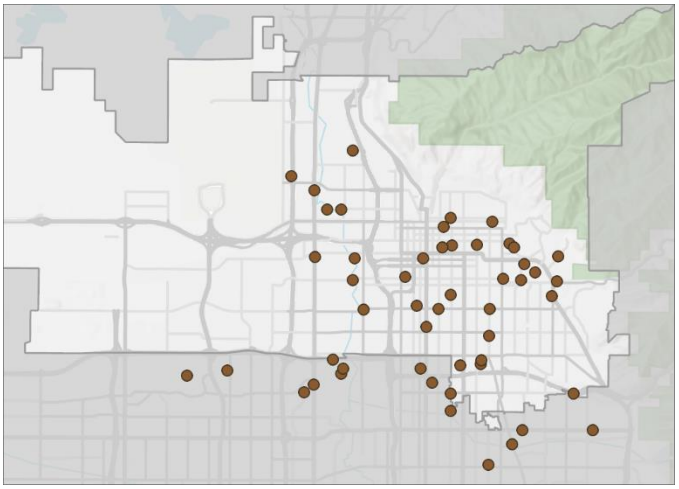

Figure 8. Education: Childcare.

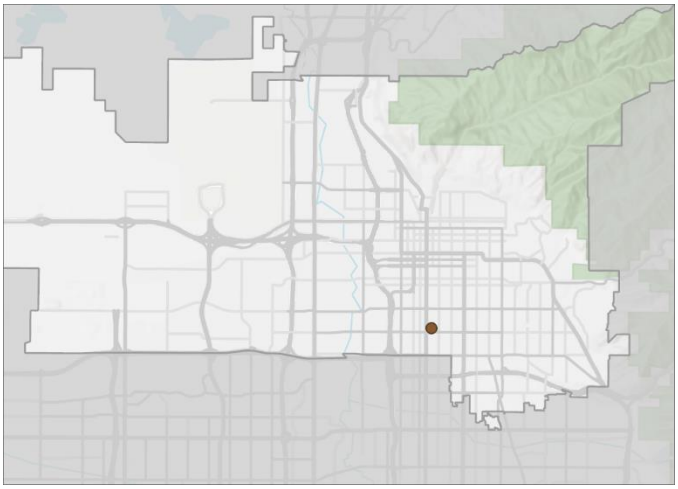

Figure 11. Education: Salt Lake Community College.

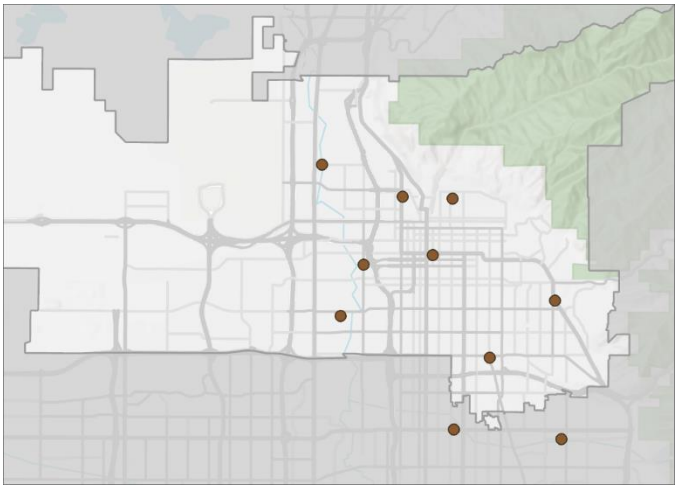

Figure 9. Education: Libraries.

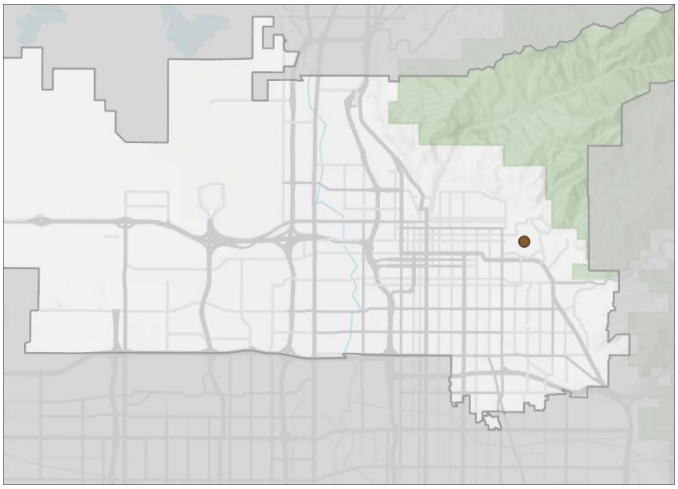

Figure 12. Education: University of Utah.

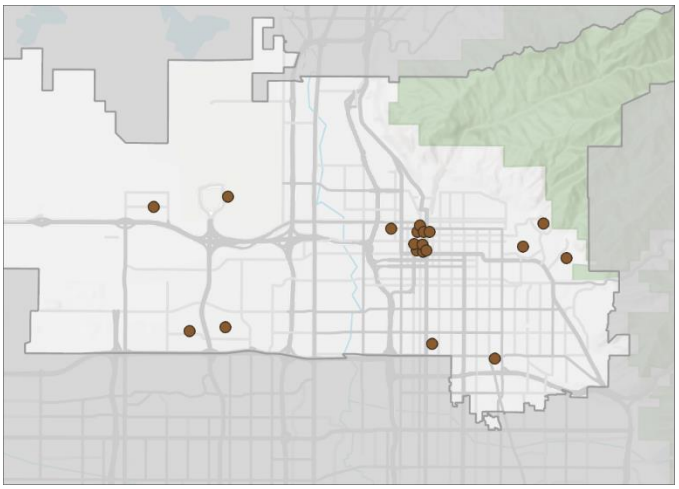

Figure 13. Employment: Major employment centers.

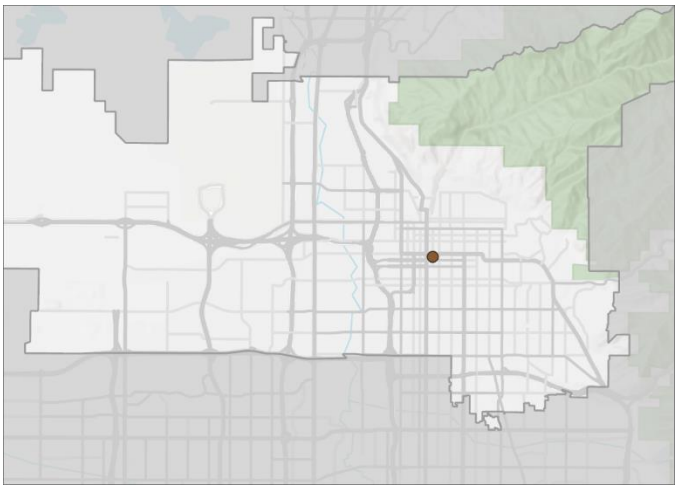

Figure 16. Government and social services: Salt Lake City & County Building.

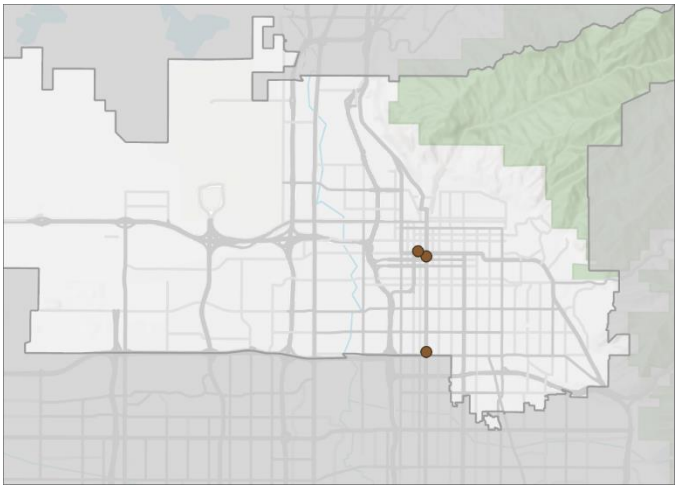

Figure 14. Government and social services: Courts.

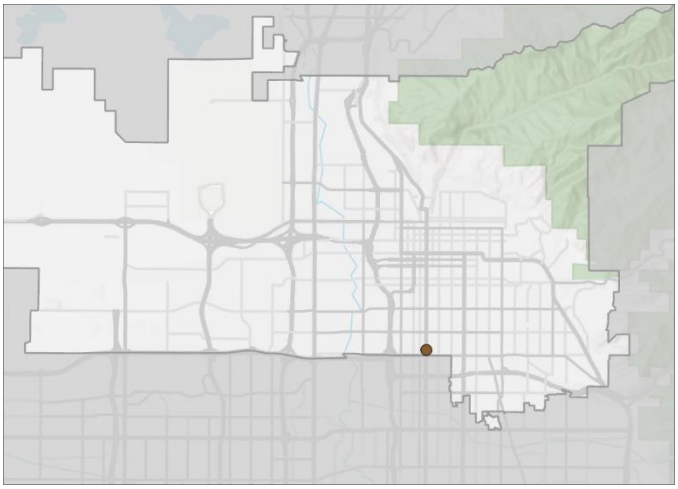

Figure 17. Government and social services: Salt Lake County Government Center.

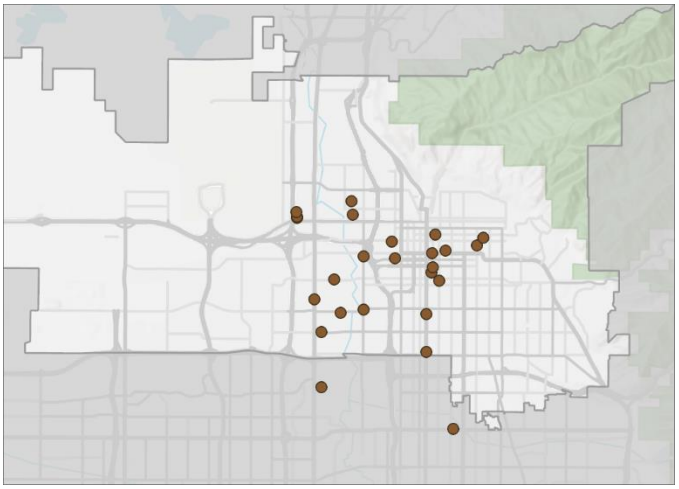

Figure 15. Government and social services: Other social services.

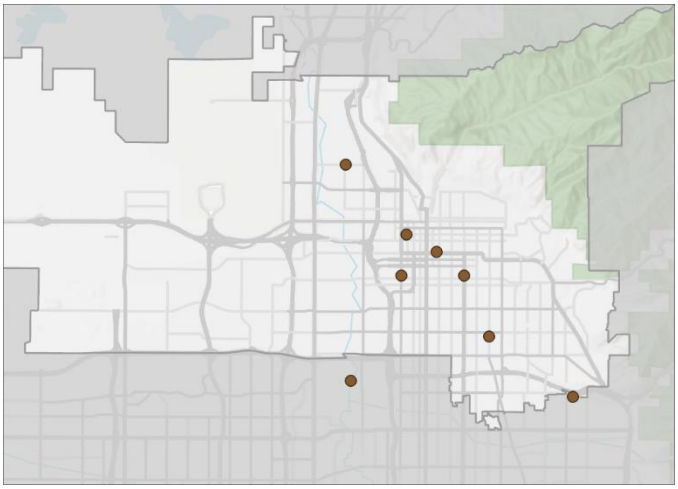

Figure 18. Worship: Buddhism, Islam, and Judaism.

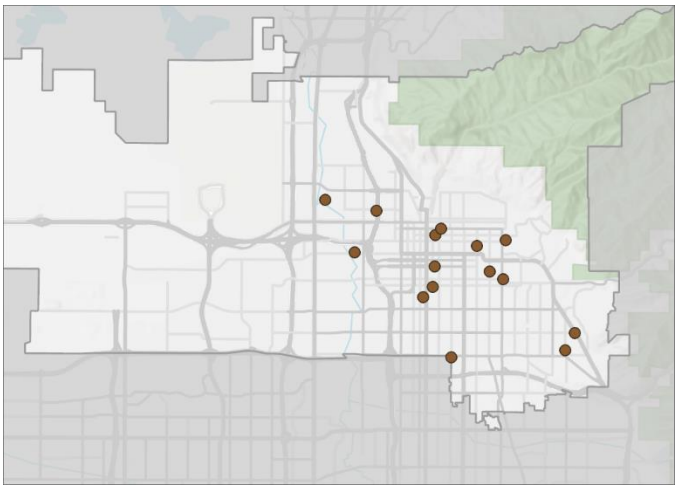

Figure 19. Worship: Christianity (non-LDS).

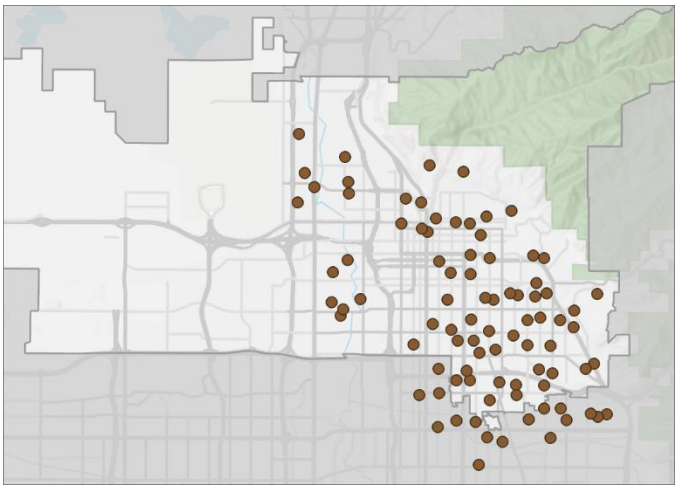

Figure 20. Worship: The Church of Jesus Christ of Latter-day Saints.

Appendix C. Preference Assignments

Preference values were used to account for the difference between perceived comfort while bicycling on a particular road and its actual bicycle infrastructure, as described in the methodology. The values were based on feedback from local bicyclists and comfort maps created by Sweet Streets SLC, Salt Lake City, and the Wasatch Front Regional Council. The map below shows which roadways received avoid or prefer values, while the table lists the rationale for assigning each value.

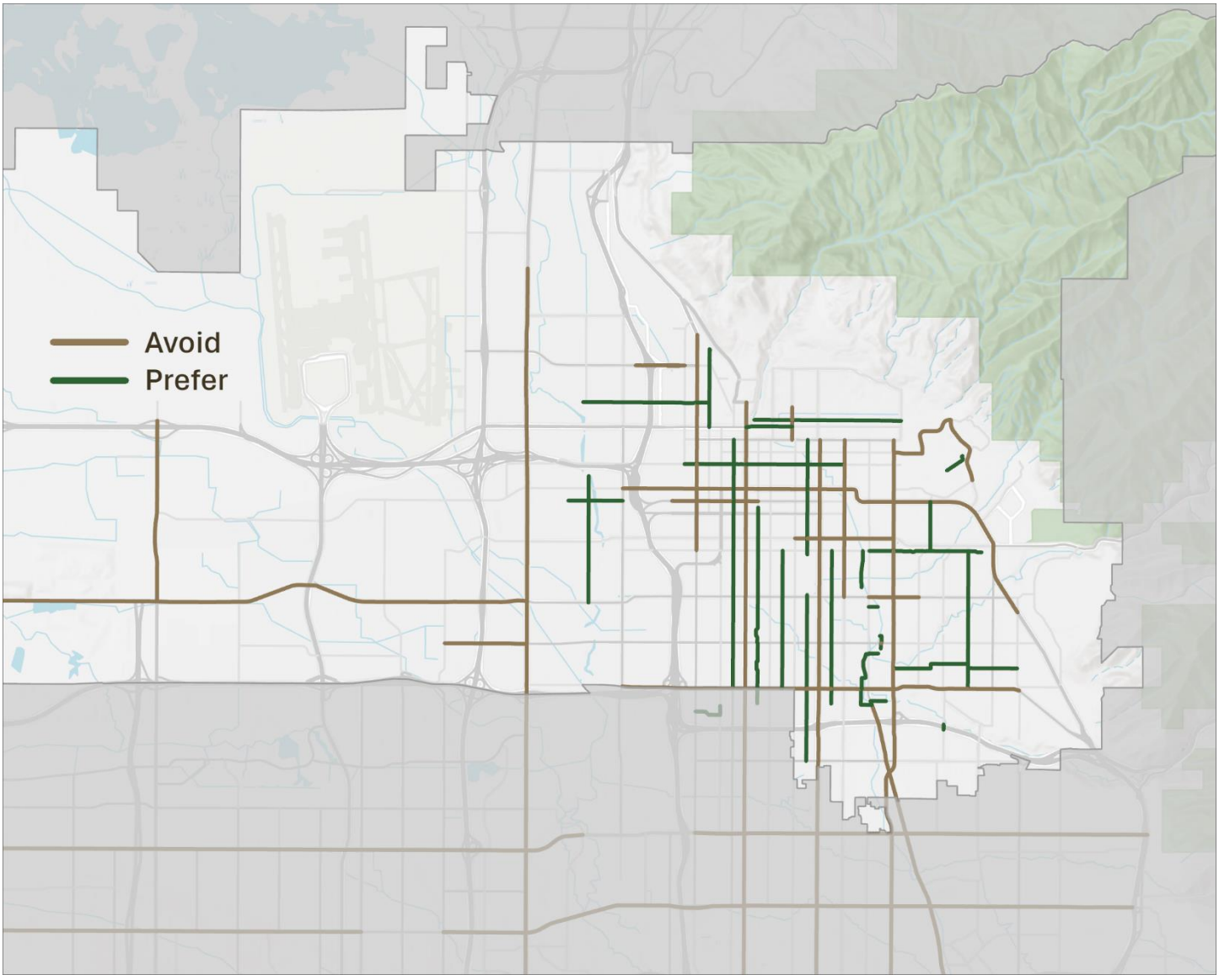

Figure 1. The preference assignments for roadways and paths in the network.

Roadway	Rationale
Avoid	
600 North	Dangerous to navigate the I-15 interchange
Campus Drive	High traffic speed/volume with no shoulder
400 South / Foothill Drive	High traffic speed/volume with no shoulder (heavily trafficked commute route to the University of Utah)
500 South	High traffic speed/volume when approaching I-15 interchange
800 South	Relatively uncomfortable despite painted bike lane
1300 South	Limited bicycle infrastructure on uphill stretch
California Ave	High traffic speed/volume
1700 South	Highly uncomfortable despite presence of painted bike lane
2100 South	High traffic volume with no shoulder
3300 South / 3500 South	High traffic speed/volume with no shoulder
3900 South / 4100 South	High traffic speed/volume with limited or no bicycle infrastructure
5600 West	Primary trucking route
Redwood Road	Dangerous roadway with high traffic speed/volume
300 West	Uncomfortable compared to nearby alternatives
State Street	Dangerous roadway with high traffic speed/volume
E Street	Uncomfortable compared to nearby alternatives
700 East	Highly uncomfortable despite presence of painted bike lane
900 East	Uncomfortable compared to nearby alternatives
1300 East	Uncomfortable despite presence of painted bike lane (heavily trafficked commute route to the University of Utah)
Highland Drive	High traffic speed/volume
Prefer	
300 North	New pedestrian/bicyclist bridge to avoid stopped freight trains
3rd Avenue	Comfortable compared to nearby alternatives
2nd Avenue	Comfortable compared to nearby alternatives

200 South	Lower volume transit-priority corridor with new bicycle infrastructure
900 South	Comfortable commuting route to the University of Utah
Westminster Avenue / Garfield Avenue	Neighborhood Byway
Haven Avenue	Prompt algorithm to follow Parleys Trail across road connection
Emery Street	Neighborhood Byway
200 West	Comfortable compared to nearby alternatives
Main Street	Relatively low traffic volume with ample space for bicyclists
200 East	Comfortable compared to nearby alternatives
400 East	Comfortable compared to nearby alternatives
600 East	Neighborhood Byway
800 East	Neighborhood Byway
McClelland Trail	Neighborhood Byway
Harrison Avenue / 1200 East / Wilson Avenue	Prompt algorithm to follow McClelland Trail across road connections
Guardsman Way	Higher comfort alternative to 1300 South and common commuting route
1700 East	Prompt algorithm to follow Parleys Trail across road connection
1900 East	Comfortable compared to nearby alternatives

Appendix D. Access to Opportunity Scores by Subfactor

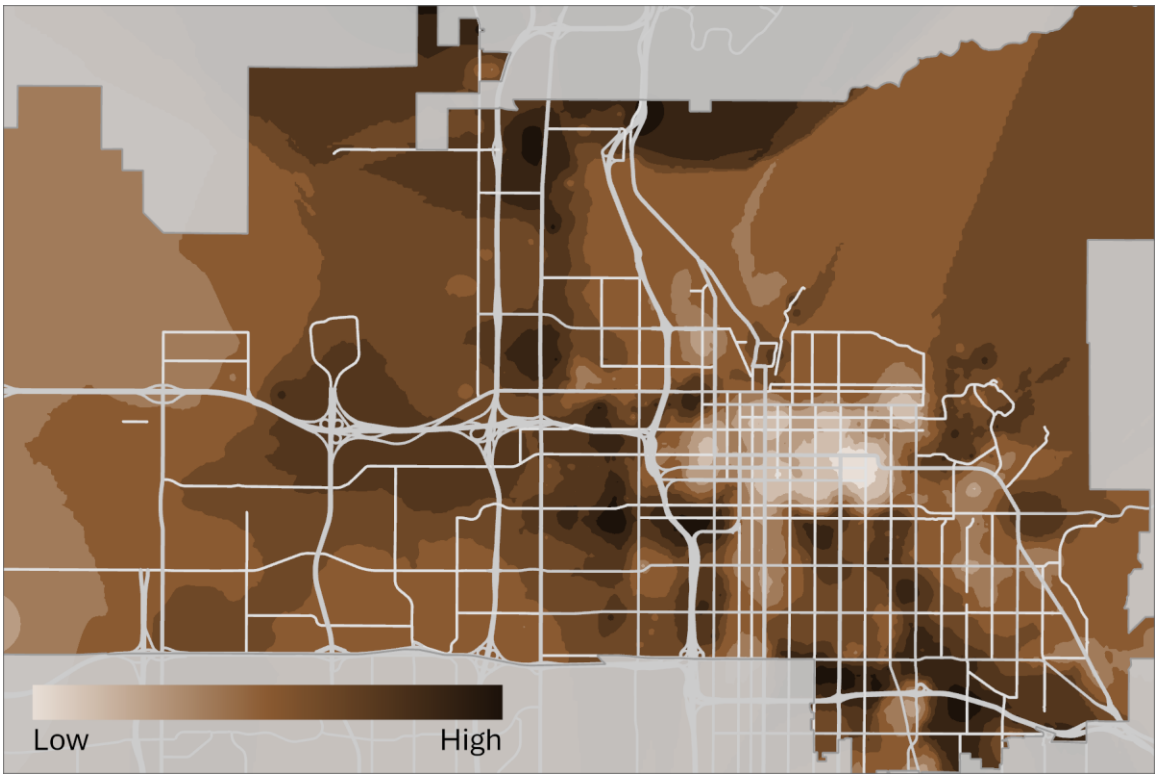

Figure 1. The score distribution for the wellness subfactor.

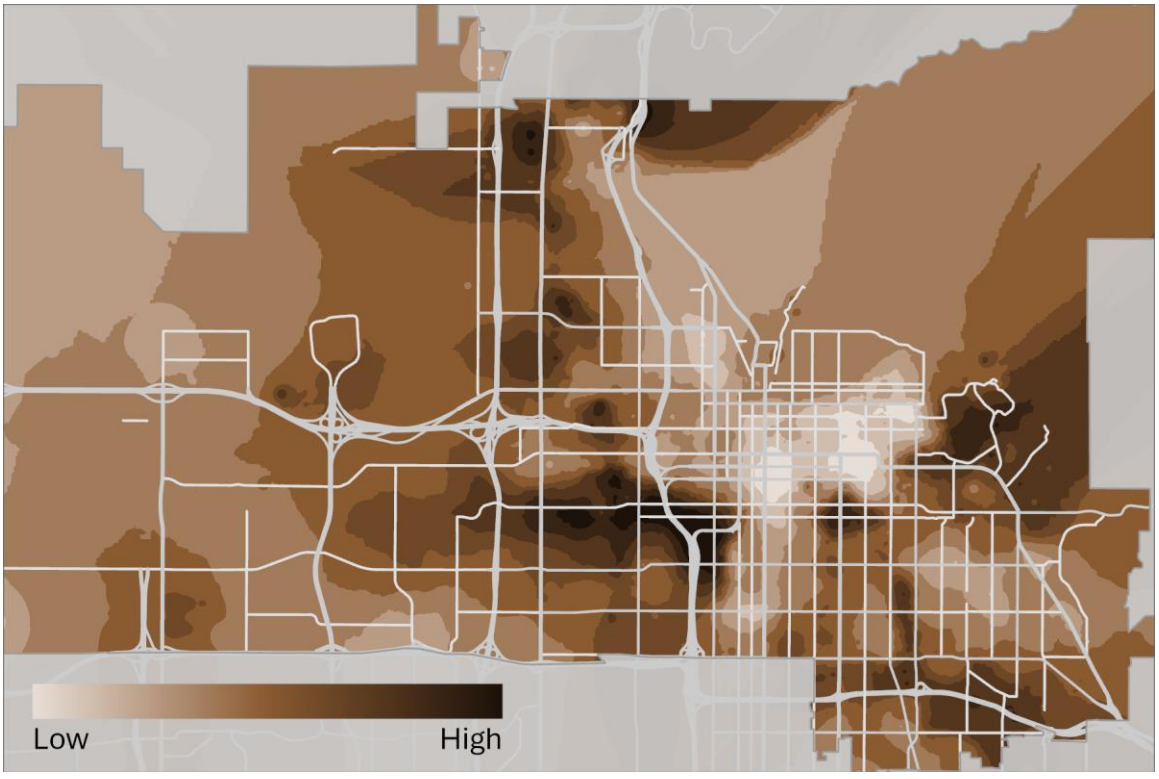

Figure 2. The score distribution for the education subfactor.

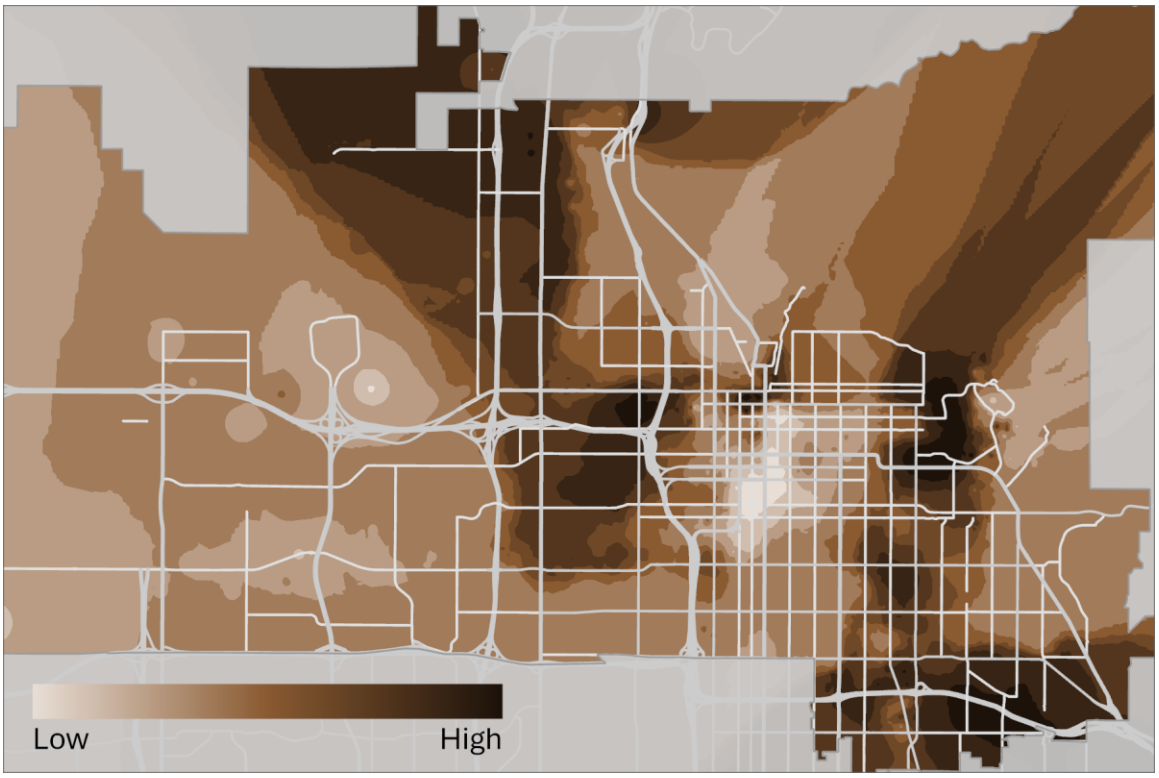

Figure 3. The score distribution for the employment subfactor.

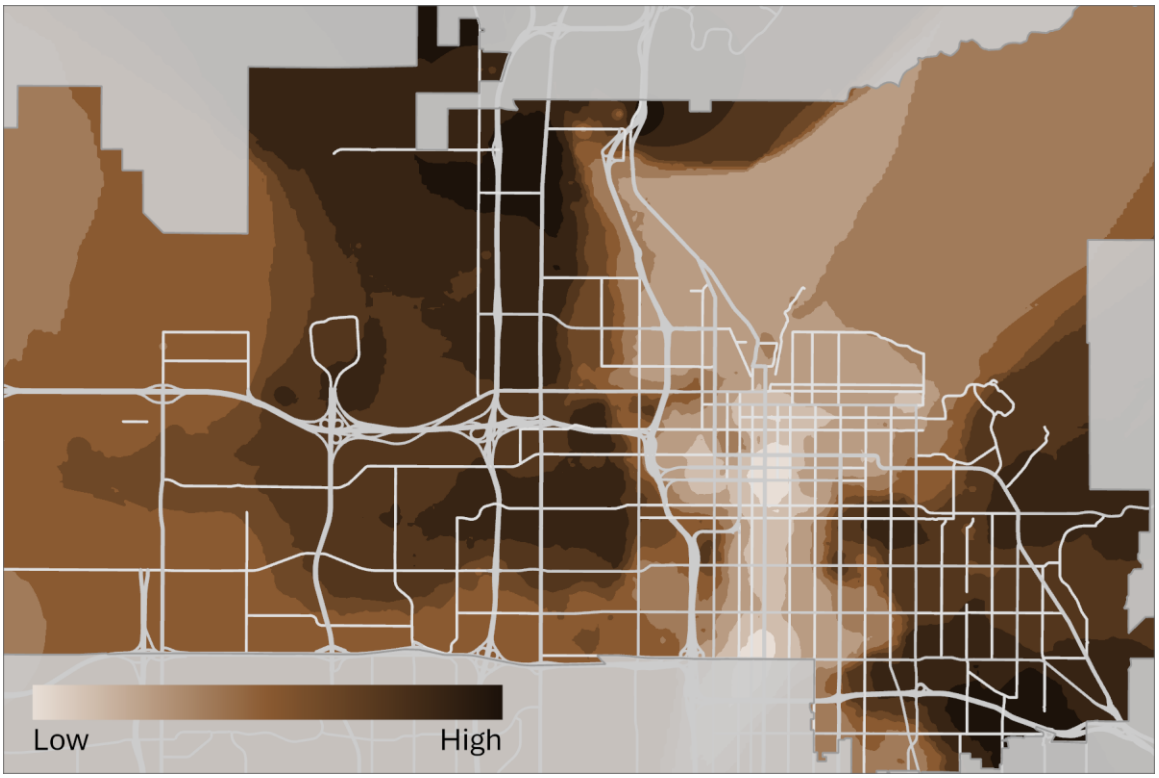

Figure 4. The score distribution for the government and social services subfactor.

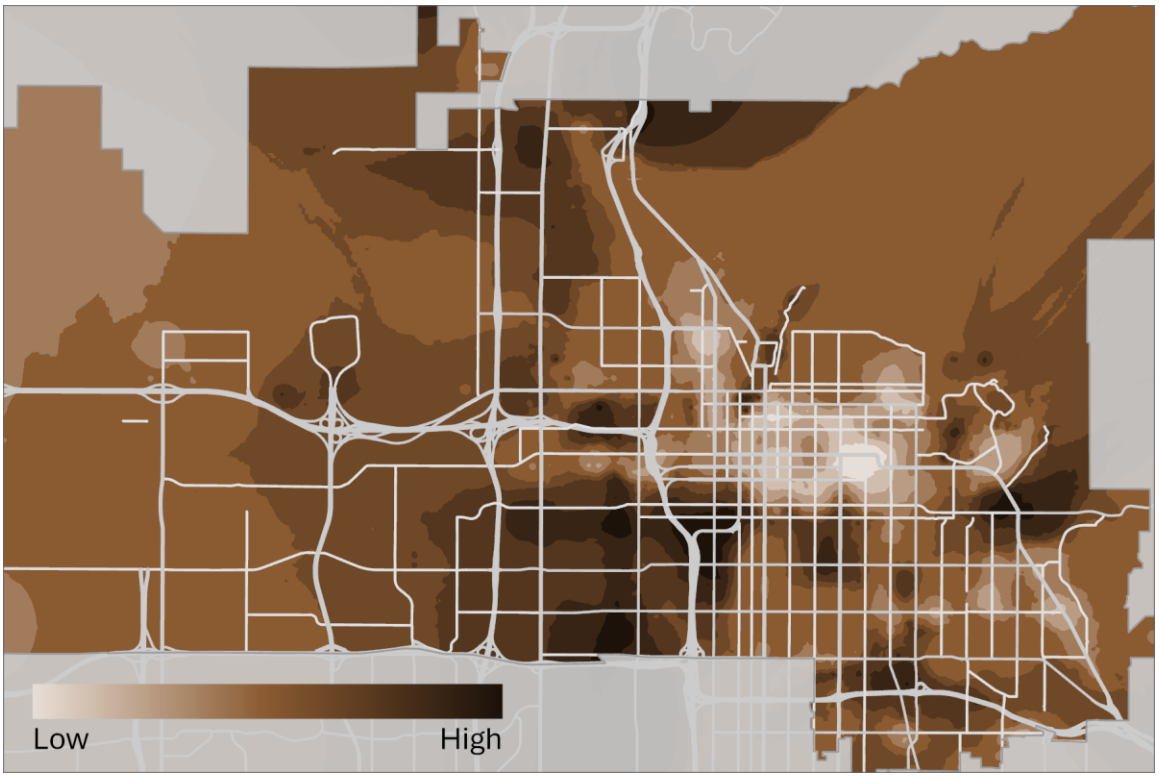

Figure 5. The score distribution for the worship subfactor.

Appendix E. Heatmap of Routes to Subfactors

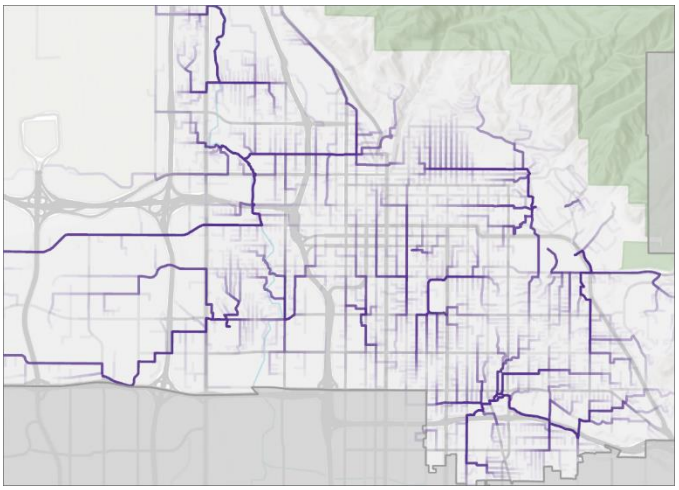

Figure 1. Wellness: Community centers.

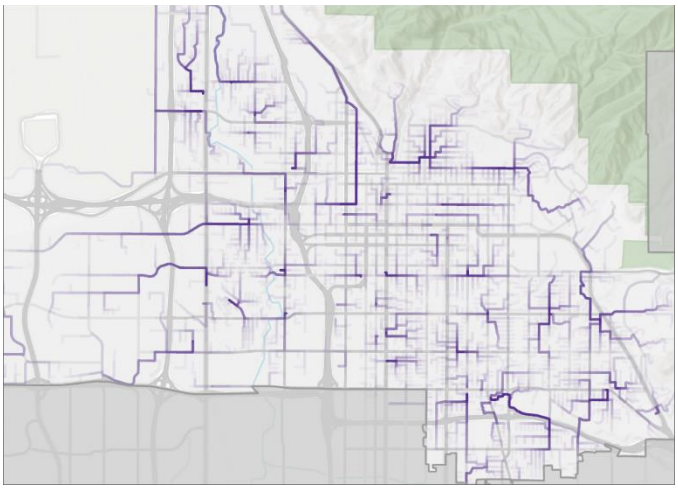

Figure 4. Wellness: Grocery stores.

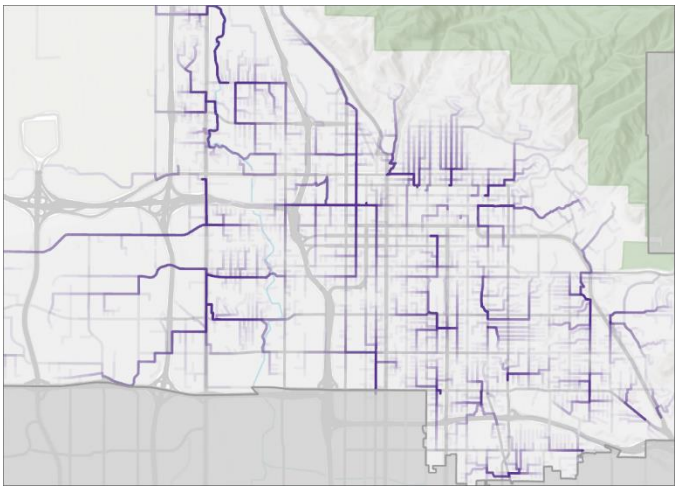

Figure 2. Wellness: Dentists.

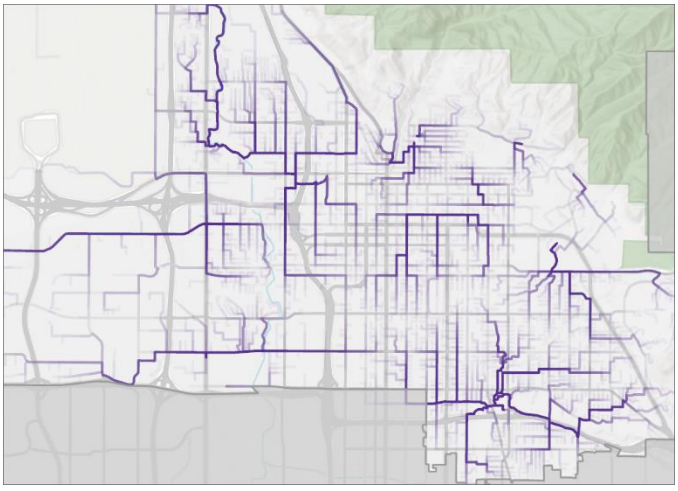

Figure 5. Wellness: Hospitals.

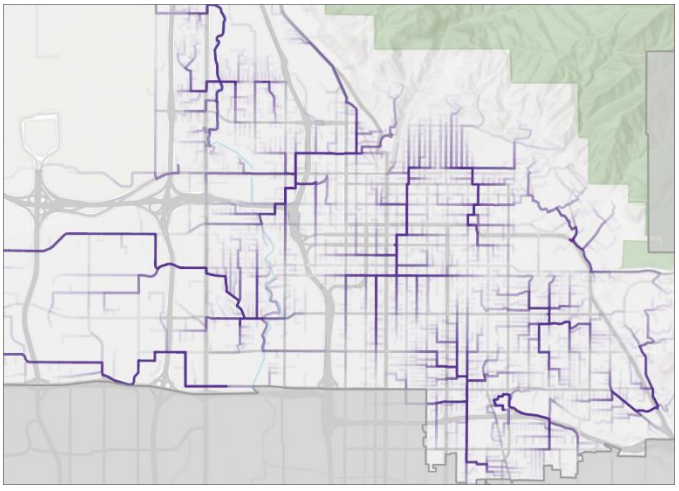

Figure 3. Wellness: Doctors.

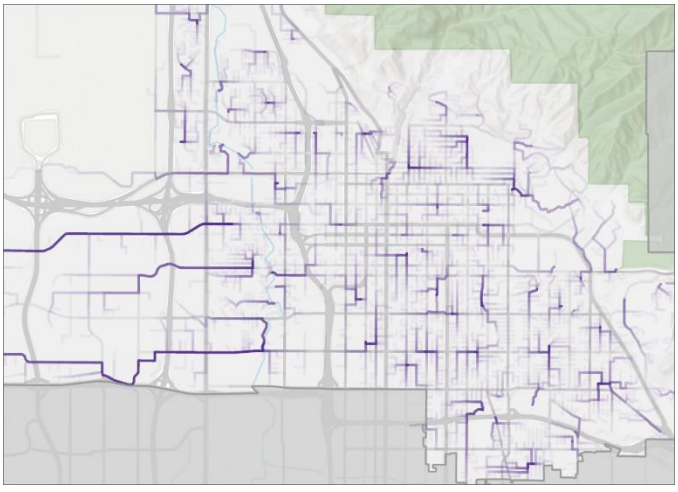

Figure 6. Wellness: Parks.

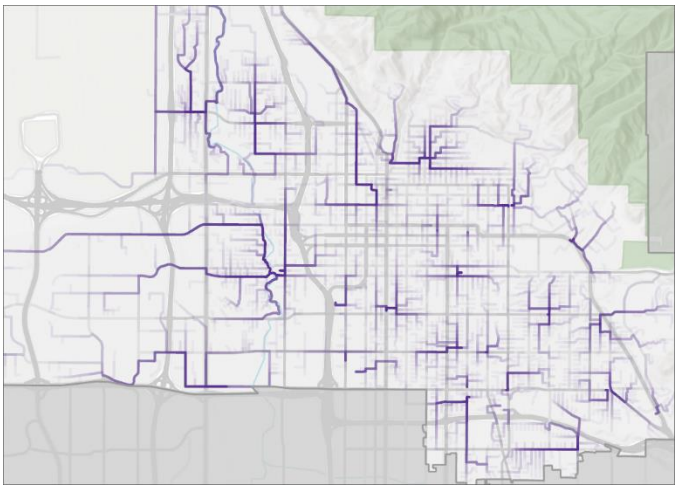

Figure 7. Wellness: Pharmacies.

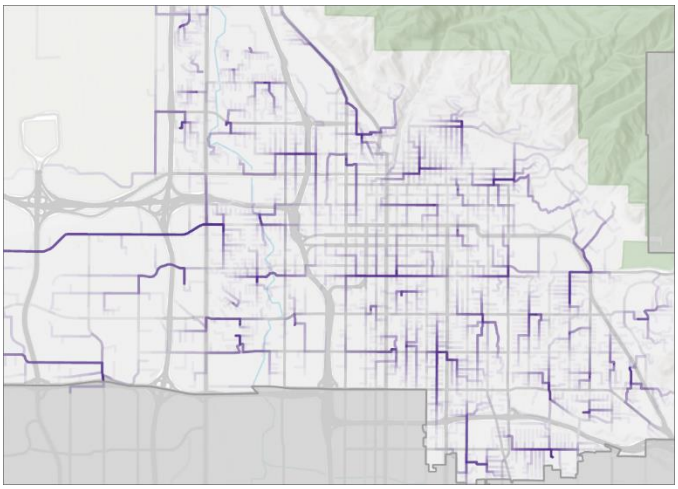

Figure 10. Education: Public elementary, middle, and high schools.

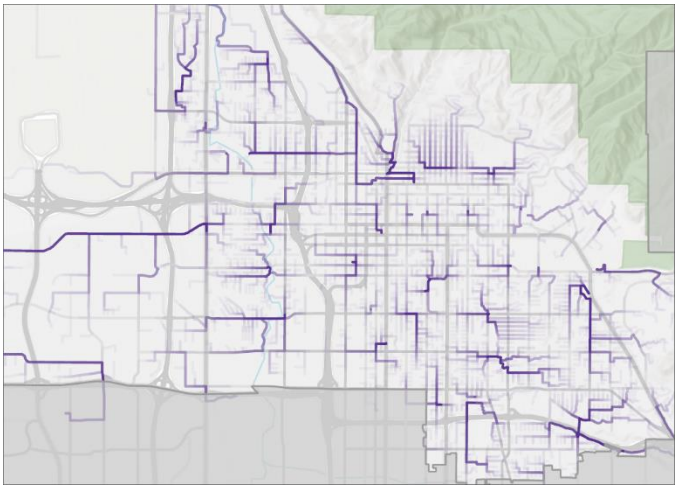

Figure 8. Education: Childcare.

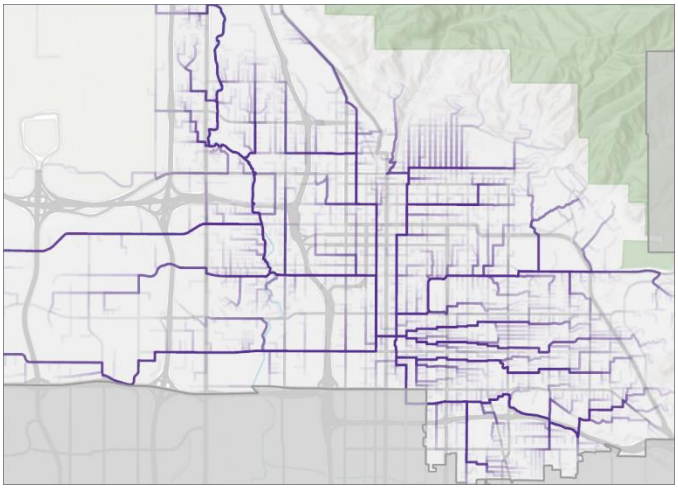

Figure 11. Education: Salt Lake Community College.

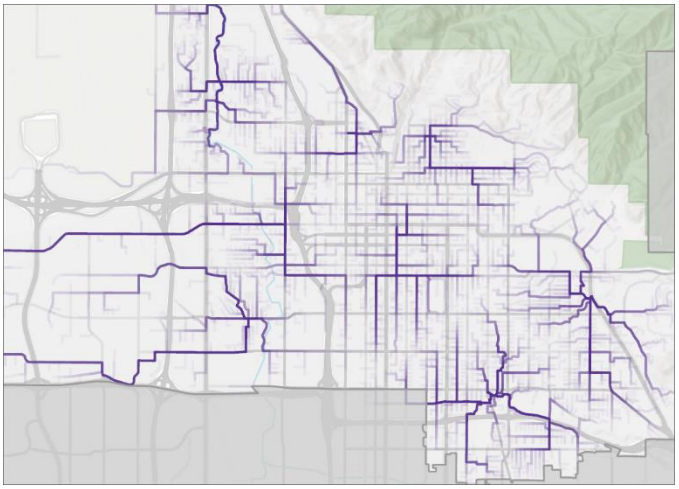

Figure 9. Education: Libraries.

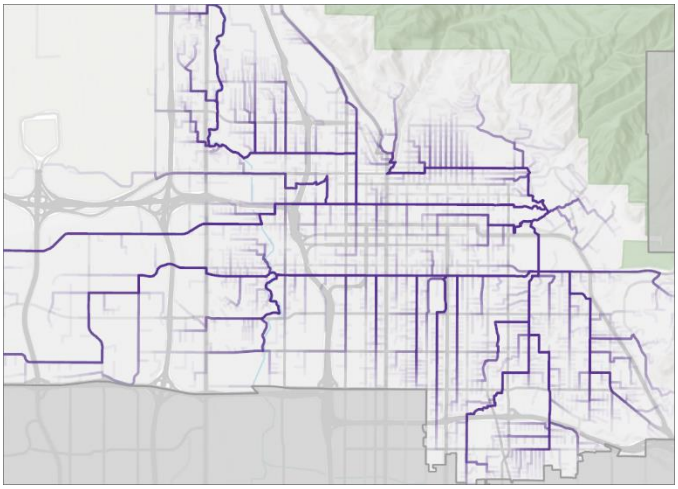

Figure 12. Education: University of Utah.

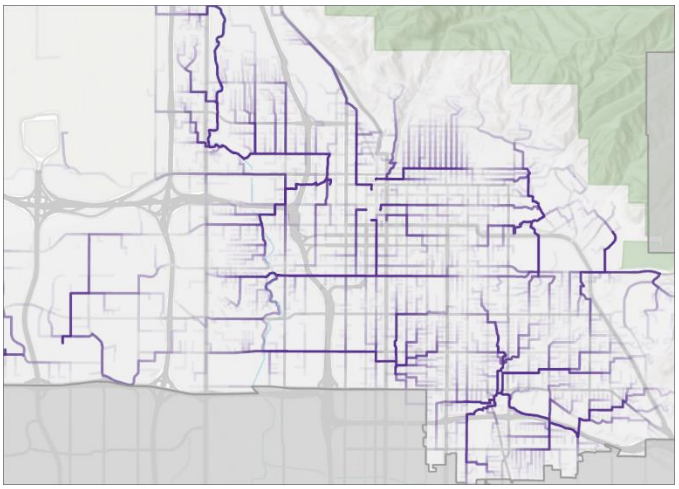

Figure 13. Employment: Major employment centers.

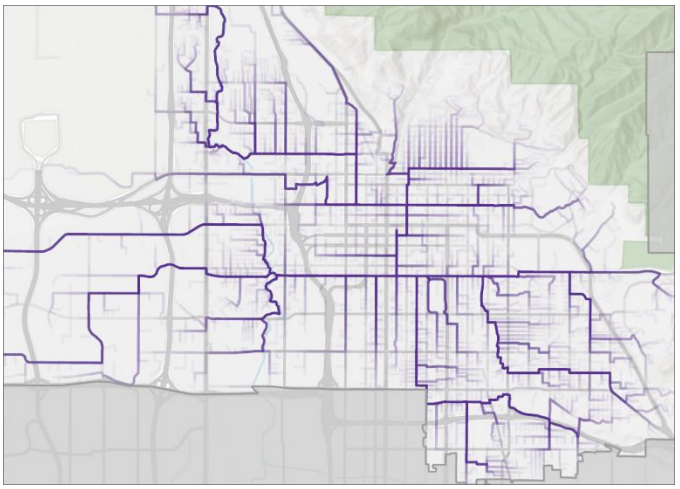

Figure 16. Government and social services: Salt Lake City & County Building.

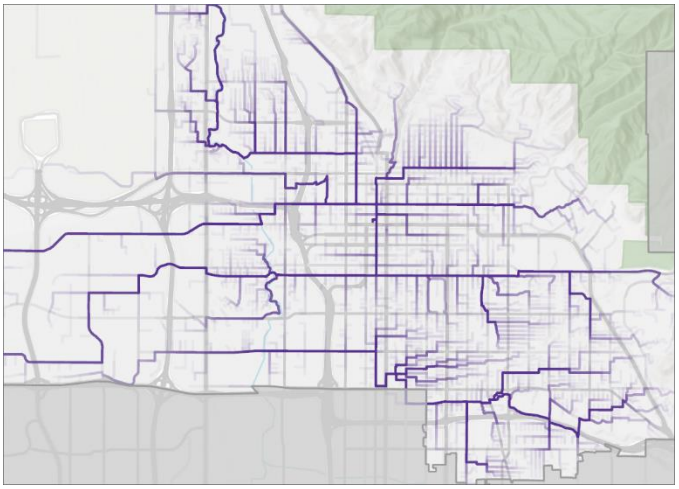

Figure 14. Government and social services: Courts.

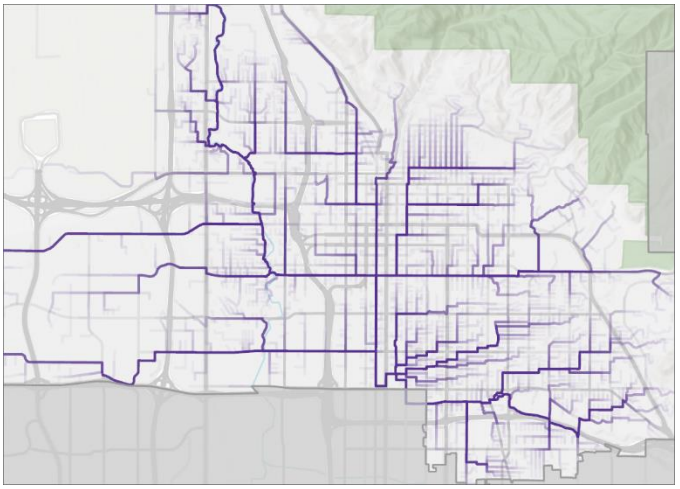

Figure 17. Government and social services: Salt Lake County Government Center.

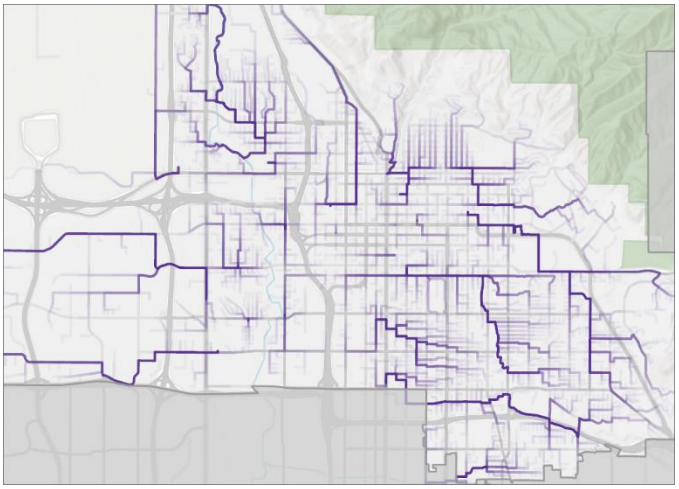

Figure 15. Government and social services: Other social services.

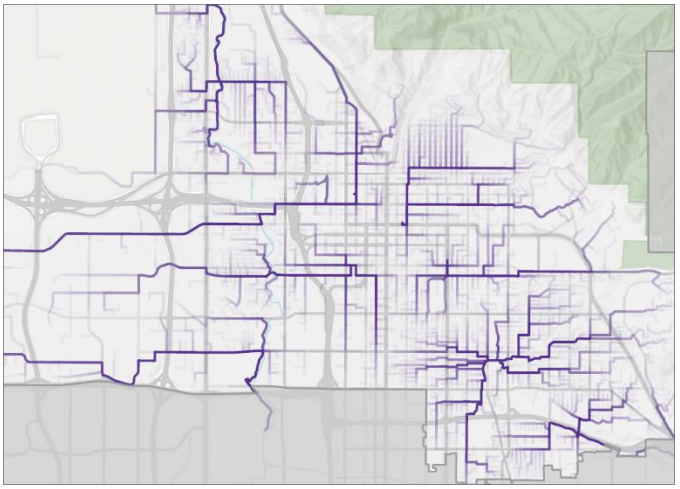

Figure 18. Worship: Buddhism, Islam, and Judaism.

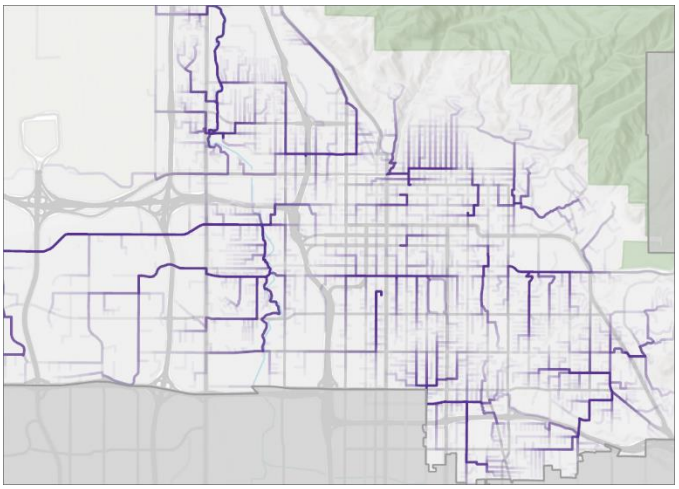

Figure 19. Worship: Christianity (non-LDS).

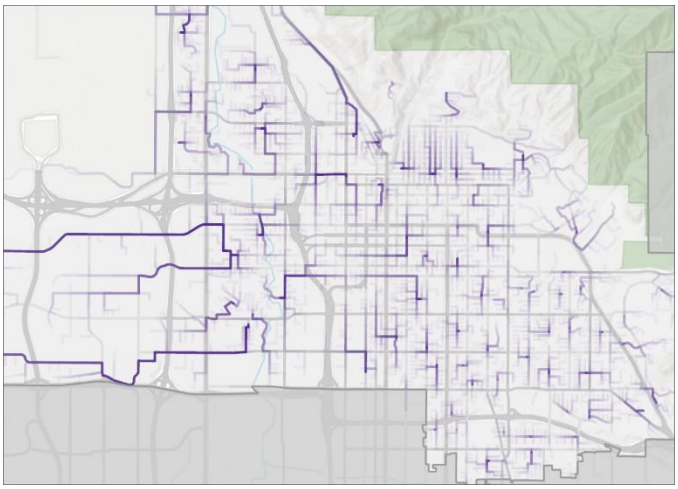

Figure 20. Worship: The Church of Jesus Christ of Latter-day Saints.