

Strategies for Increasing Bikeability:

A Closer Look at the St. Louis Regional Bike Plan

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Chapter 1: Introduction

Transportation system planning in the latter half of the 20th Century has largely focused on the needs of automobiles, pushing the bicycle out of the picture. In recent years, bicycling has re-emerged as a viable mode of transportation, especially with rising gas prices, the need to reduce greenhouse gas emissions, and a desire for more sustainable and livable development patterns. Recent federal policy encourages local city and state governments to support new bike friendly transportation projects. For example, in March of 2010, Secretary of the U.S. Department of Transportation (DOT) Ray LaHood, released a signed policy statement summarizing key federal statutes and regulations regarding walking and bicycling. He reiterated the DOT policy to “incorporate safe and convenient walking and bicycling facilities into transportation projects. Every transportation agency, including DOT, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation system.” He cites federal statutes that require state and Metropolitan Planning Organizations “to integrate walking and bicycling facilities and programs in their transportation plans to ensure the operability of an intermodal transportation system.” In response, the City of St Louis, in conjunction with Great Rivers Greenway District, Missouri Department of Transportation, and East-West Gateway Council of Governments, is working to create a comprehensive bicycle plan which seeks to “encourage and accommodate bicycling as a viable transportation mode.” (St. Louis Regional Bike Plan, p. 3.1)

The goal of this thesis is to discuss strategies of increasing “bikeability” in urban areas. For the purposes of this paper, “bikeability” encompasses the extent to which residents feel comfortable navigating their community by bike. Specifically, I focus on maximizing ridership in urban areas given budgetary constraints. Whenever possible, I use ridership, or the number of trips taken by bicycle, as a measure of bikeability because of the significant amount and accuracy of ridership data available.

To accomplish this goal, I first look at the culture of cycling and supporting infrastructure in the United States, and more specifically the City of St. Louis. Next, I discuss the benefits of cycling to both a community and its citizen cyclists. Then I compare the different means of improving bikeability by looking at the three pillars of the City of St Louis’s Comprehensive Bike Plan: Education, Infrastructure, and Law Enforcement. However, due to the lack of law enforcement initiatives and emphasis on government structure, I am forced to incorporate the policy and enforcement initiatives into my discussions of Education and Infrastructure. I strive to focus on ridership studies and studies done in cities similar to St. Louis. However, due to the paucity of data on the topic, I am forced to expand my search to include both revealed preference studies and stated preference studies. I also include international studies of bikeability in some instances. Finally, I summarize my findings and establish priorities for implementing comprehensive bicycle plans.

I choose to emphasize cost efficiency in increasing ridership because funding for bicyclists is minimal and often the first to be curtailed when budgets are cut. In a 2005 study, Todd Litman shows that generally local governments spend only 5-15% of their transportation budgets on non-motorized transportation. Furthermore, states are spending less than 1% of their transportation budget on cycling infrastructure and initiatives. This is because non-motorized transportation has historically been undervalued. Policymakers are less inclined to provide funding for such projects because they believe cyclists do not pay vehicle user fees such as fuel taxes, vehicle registration, or road tolls. In reality, most local roads, where 90% of bicycling occurs, are funded primarily by general taxes paid by all residents (Mapes, p. 12). This is compounded by a lack of available data. Many policy makers are also unaware of the prevalence of non-motorized transportation in their community. It is often hard to justify spending when demand is difficult to predict.

I focus on the City of St Louis because cycling initiatives can have great impacts in a city like St Louis. St Louis residents may be more likely than residents of other cities to bike because the terrain around St Louis is relatively flat and smooth. Additionally, the relatively mild climate in St. Louis creates ideal conditions for cycling. The small geographical area of the city makes cycling more feasible. Furthermore, the low population size eliminates congestion and make on-street cycling much safer. Finally, the City of St. Louis' public transportation system (Metro) is incredibly cyclist friendly. It encourages residents to cycle to and from the Metro by accommodating the storage of cycles in buses and subway cars.

Chapter 2: Background

The bicycle may seem rudimentary to Americans who are accustomed to using the automobile for even the shortest of trips. However, the bicycle offers an inexpensive, non-polluting, non-congesting, physically active form of transportation in a country that increasingly seems to need such options. Heightened global competition for the world's oil supplies has ended the era of cheap fuel that made our automobile dependency possible. Our increasingly sedentary lifestyle is on the verge of creating an obesity epidemic that could shorten the lifespan of the next generation. Congestion is becoming increasingly problematic as we outstrip our ability to maintain and expand our network of roads and bridges to accommodate the growth of vehicles on the road. It may seem odd to talk about the simple bicycle in the same breadth as electric cars or biofuels or hydrogen-powered fuel cells that are presented as the ultimate solution to our energy and environmental woes. In fact, cycling can accomplish more than most people think. At the very least, the bicycle has the potential to be part of a broader green bundle of alternative transportation. While the automobile may better align with American ideals of manifest destiny and instant gratification, the bicycle has remained an integral part of American society for over a century. It has had a significant impact on American culture and offers important benefits to people today.

2.1 History of the Bicycle

Albert Pope invented the safety bicycle in the 1890s. It was an affordable, practical, and exciting machine. It afforded people a degree of freedom and independence never before experienced by the masses. People who could not afford a carriage made use of bikes. And women, previously constrained to the home by restrictive clothing and societal norms, found a new freedom of movement in the bicycle that few had previously known. The bicycle "has done more to emancipate women than anything else in the world" declared Susan B. Anthony. While driving was frowned upon, women were allowed to take their bicycles around town to see friends and go about their business. Additionally, the bicycle inspired a reform in women's clothing to accommodate greater range of movement, providing women more control on the bike. However, it also served to give women more freedom and control in their everyday lives.

Bicycles ruled the roads. By 1896, more than 4 million bicycles were in American homes, at a time when the total population had not reached seventy-five million. Manhattan's streets were filled with cyclists at all hours and the bike was a common commuting tool. In 1906, cyclists made up a fifth of the downtown traffic in Minneapolis. Bicycles won several important legal victories guaranteeing their right to the road. In 1887, the New York legislature gave cyclists all the same rights and responsibilities as carriages. By 1900, almost all states defined bicycles as vehicles with the same right to the road as automobiles (Mapes, pp. 6-15).

Pope and his colleagues formed the League of American Wheelmen in 1880 to promote the bicycle. The League of American Wheelmen was prominent in the Good Roads Movement, which lobbied to have roads paved in an attempt to make cycling safer and more comfortable. They financed the first modern asphalt road in Boston, MA. And

eventually changed the face of the country as it came to be defined by its smooth paved road systems. Ironically, in doing so, the League of American Wheelmen and the Good Roads Movement paved the way for the automobile, and with it the end of the era of the bicycle. According to Hiram Maxim, one of the first automobile manufacturers, the bicycle served as a 'consciousness raiser' that led to the car. The bicycle "directed men's minds to the possibilities of independent, long-distance travel over ordinary highway." (Mapes, p.54)

Throughout the first half of the twentieth century, the bicycle enjoyed periodic revivals and it always maintained a certain fan base. The bicycle became well established as an essential part of childhood. Due to the economic privation of the Great Depression, millions of adults took up cycling as an inexpensive means of transportation. Again, during WWII, Americans were encouraged to cycle when gas was rationed and the domestic auto industry was dedicated to the war effort. But in the years following WWII the country underwent a transformation as the modern suburbs were created and the automobile became a way of life.

Cycling culture experienced a revival in the 1970s. Bike sales increased dramatically. Sales jumped from 6.9 million in 1970 to 15.2 million in 1972. Part of this was due to a counter-culture movement critiquing the dominance of the automobile in American society and suburbia. John Dowlin, one of the early grassroots advocates, explained that, "Just as Ghandi saw India producing its own cloth as a way to free itself from British domination, the bicycle could free urban centers from an over-reliance on cars and foreign oil" (Mapes, p. 37). Others pointed to the new sense of environmentalism in the nation epitomized by the first Earth Day or the spike in gas prices in the 1970s as the reason for the sudden rise in the prevalence of cycling.

Whatever the reason, the rebirth of the bicycle movement resulted in the formation of a new wave of advocacy groups. It gave birth to the Bicycle Federation of America, which became a national gathering spot for bike advocacy and remains a leader in the cycling movement today. Cities and government agencies responded by turning their attention to improving bike safety and construction of bike paths. Cities like Washington D.C. began closing parks and parts of highways to cars on the weekends to create recreational opportunity for cyclists. In Oregon, the legislature passed a bill requiring at least 1% of all highways funds to be used to accommodate cyclists on new road projects. However, bike culture all but disappeared during the 1980s and '90s as gas prices dropped and there was a demographic shift away from urban centers. While this movement was short-lived, disappearing almost as quickly as it appeared, it had an important impact on the world of transportation. Many of the advocacy groups and legislation started in the '70s are still pervasive today. Additionally, the plans and policies that did not stand the test of time serve as a blueprint for much of the regulation and planning being implemented today. The '70s were also critical because they highlighted the benefits of cycling and the need for bike friendly communities.

Bicycles have played an important role in American history. They have liberated marginalized populations and given people the freedom of movement. They paved the

way for the automobile and brought a sense of independence to transportation in America. They make a statement about the state of society, and act as a solution to our energy and environmental needs. Most importantly, cyclists have paved the way for themselves. They have gotten the attention of government and citizen groups and carved out a culture and set of rights for themselves. As the bicycle becomes more and more pervasive, this world is expanding as cyclists demand more rights, infrastructure, and support.

2.2 Current State of Cycling

Today, cycling is dominated by a subculture made up of risk-taking, white, middle-class males who thrive on the thrill of dodging through traffic on intermittent bike lanes. In the mainstream, cycling is mainly an instrument for exercise and entertainment among young families and young professionals. It has virtually vanished as a method of transportation, as bike use rarely climbs above 5% in any American city (Mapes, p. 62).

But if a lesson is to be learned from Amsterdam, one of the bike capitals of the world, it is that the bicycle can be easily incorporated into a city's transportation network without changing standards of living. Between 40% and 50% of the city commutes to work on a bike regularly, which in a city of 1.36 million is pretty substantial (Mapes, p. 62). This is due in large part to roads and infrastructure that favor bike use making cycling the preferred method of transportation. Government and private organizations also design programs to educate drivers about when to be aware of cyclists and ensure cyclists are aware of proper bike etiquette. There are also laws and regulations creating incentives to cycle and fines for not abiding by rules of the road. While Americans have learned a lot from cities like Amsterdam, Americans are subjected to a number of challenges which European cities do not face. Suburban sprawl and automobile use are so pervasive in the US that the typical commute often exceeds 30 minutes per day (Mapes, p. 54), a distance that cannot comfortably be covered on a bike. Also, our single car culture and the independence and ease associated with it are difficult obstacles to overcome. But while a bike presence on the level of Amsterdam or Copenhagen may be unlikely, it is not unfeasible to increase ridership above its current level.

City governments all over the United States have optimistically begun developing comprehensive bike plans in an effort to create bike friendly communities and encourage higher bike use. Similar to the methods used in Amsterdam, these plans involve infrastructure, education, and enforcement to increase bikeability.

2.2.1 Infrastructure

Infrastructure implemented in city bike plans in the United States ranges from bikeways to end-of-trip facilities. Bikeways are routes designed to accommodate bicycle use. Bikeways can be as simple as 'Share the Road' signage or widened paved shoulders. However, more intricate bikeways seek to minimize automobile/cyclist interaction. Greenways are paths through parks or along waterways, where automobile access tends to be restricted entirely. Overpasses and underpasses allow cyclists to follow main traffic routes without endangering their safety or interrupting the flow of traffic at major intersections. Paved shoulders and bike lanes offer less protection. They are integrated

with motorways but give cyclists the right of way within their lanes and remind vehicles to be wary. Sharrows (striped sections of the street where the lane narrows and drivers and cyclists must share space) and bike boxes serve to remind drivers they are sharing a lane. End-of-trip facilities primarily refer to improved bike parking for cyclists, especially secure, sheltered parking to protect from theft and poor weather. Other facilities include showers and changing rooms in or near office buildings, and bike stations offering bike rentals, repairs, and storage usually near a form of public transport. Bike Infrastructure is often the most expensive element of a bike plan but it changes the face of a community, often inspiring residents to take up cycling of their own accord. It greatly improves the perception of safety by making drivers and potential cyclists aware that cycling is not only prevalent in the community but also encouraged.

2.2.2 Education

Programmatic interventions aim to increase bicycling through promotional activities, media campaigns, educational events, and other means. One example is Bike-to-Work days. These are promotional events that encourage commuters to try cycling. They often include free breakfasts, giveaways, contests, or other activities. Ciclovias are also popular means of promoting cycling. These are free recreational programs where streets are temporarily closed down to motorized traffic and reserved for non-motorized uses. These events started in San Francisco in the 1960s and gradually spread across the country. Individualized marketing is another common way of encouraging cycling in a community. It encompasses comprehensive marketing programs aimed at individuals in a neighborhood, school, or workplace. Programs usually involve targeted information, events, and incentives, such as transit passes or coupons to bicycle stores. Safe Routes to School is a particularly successful campaign aimed at educating and encouraging students in an effort to increase the safety and number of students walking and biking to school. Education and Incentive programs are effective because they get people on their bikes and allow them to discover for themselves how fun and easy replacing a car with a bike for short trips can be.

2.2.3 Enforcement

Government policy and laws can also be very influential in increasing the bikeability of a community. Helmet laws requiring all cyclists, regardless of age, to wear helmets, increase people's comfort and perception of safety. However, they are shown to reduce ridership as helmets are often clumsy and awkward and difficult to store. Lowering speed limits is another important means of increasing bikeability in a community. Bike Plans reduce speed limits for vehicle traffic to improve safety for cyclists. However, it offers two additional benefits. Lowering speed limits increases environmental quality by decreasing air pollution and noise pollution. Reducing speed limits also increases the speed of bicycling relative to driving. Thus, it reduces the amount of time saved by opting to drive making choosing to cycle more convenient than ever. Trip Reduction Programs are employer-based programs that aim to reduce vehicle travel. They are usually mandated by the government and often include incentives and provisions of facilities. Thus, enforcement programs work in several ways. They can serve to improve perceptions of safety, provide incentives to bike, and decrease the comparative benefits the alternatives.

2.4 State of cycling in St Louis

On paper, the City of St. Louis is an ideal city for cycling. According to the 2010 census report, the City of St. Louis has a population of 350,759 as and a square mileage of 66 including 4 square miles of water. The population density is 5,695 people per square mile. To provide some sort of reference, Manhattan has a population density of 70,951 and Little Rock, Arkansas has a population density of 1,576 people per square mile (US Census Press Releases, 2011). These demographics provide the make up for an ideal bike city. It is not so large that cycling is impractical, nor is it so crowded that cycling is overly risky. Furthermore, the terrain is flat and smooth and the climate is mild creating ideal conditions for bicycling. However, the census report also shows that only 0.10% of residents bike to work.

In 2007, the League of American Bicyclists deemed the City of St. Louis a Bronze Level Bicycle Friendly Community (BFC) for its efforts to actively encourage bicycling in the region. According to the League of American Bicyclists, a BFC welcomes cyclists by providing safe accommodation for cycling and encourages people to bike for transportation and recreation. The St. Louis cycling culture is supported by a small but enthusiastic cycling community. To increase the viability and presence of cycling, both government and nonprofit organizations like Trailnet, Bike St. Louis, Great Rivers Greenway, and the City of St. Louis have made many improvements in accessibility to non-motorized transportation in the City. With very little funding, they have taken a few important steps to improve infrastructure, education, and enforcement within the City. The following sections outline the current infrastructure and initiatives in place in the City of St. Louis according to the Catherine Werner, J.D., the Director of Sustainability for the City of St. Louis and the City's most recent BFC application.

2.4.1 Infrastructure

Many cities require engineers and city planners to include accommodation of cyclists in all new road construction and reconstruction. However, the City of St. Louis has no such policy. Furthermore, City engineers and planners receive no formal instruction regarding bicycle accommodation. These types of policies would be beneficial to the city because they would instigate a shift away from outdated throughways facilitating movement of single passenger vehicles and towards a multimodal system of transportation. As the current system is set up, engineers and city planners are continuing to make outdated and narrow-minded decisions that will have long term effects on the St Louis community.

The City of St. Louis is host to a small but diverse assortment of bike-friendly infrastructure. While the city only has a collective 8 miles of bike lanes, 30% of arterial streets have been designed to accommodate cyclists with either the addition of bike lanes or paved shoulders. Additionally, the City has 38 miles of paved off-road trails that are bicycle friendly. Many of the streets that are dedicated 'bike friendly' due to the presence of a paved shoulder and accompanying signage are very narrow making it difficult for cars to pass cyclists. Furthermore, cars parked along these streets create additional obstacles for cyclists and serve as a safety hazard.

Bike St. Louis, a collaboration between the Great Rivers Greenway District and the City of St. Louis, has created 77 miles of continuous on-street bicycle routes throughout St. Louis and the surrounding county. The most popular route is the 11-mile Riverfront trail along the Mississippi River. The trail offers views of the river, as well as access to adjacent neighborhoods for local residents to enjoy the trail for recreation and commuting. In addition to improving the trail's alignment, new rest stops and water fountains were added to enhance the trail's appearance to make it a regional asset. This trail is excellent for recreational cycling and tourism as the trail provides excellent views of the St. Louis Arch.

Bike St. Louis routes are decorated with an assortment of instructional signage. However, there is a lack of uniformity throughout the region with regard to signage and street markings that can be confusing for drivers and beginner cyclists. The size, lettering, and placement of signs are not consistent with the Manual on Uniform Traffic Control Devices (MUTCD) recommendations established by the Federal Highway Administration. This creates confusion amongst drivers and inexperienced cyclists over the meaning of the signs and who has the right of way.

The City of St. Louis is fortunate to be the host private end-of-trip facilities. Opened in early 2011, the Downtown Bicycle Station offers secure storage, bike racks, showers, and lockers ideal for cyclists commuting to work. Additionally, all libraries and transit stations are equipped with bike racks or bicycle storage units. But while many cities have policies requiring bicycle parking, the City of St. Louis has no such policy. The City has bike racks in front of only some of its public schools and only a few of its government buildings, public spaces, parks, and recreation centers. The result is that safety concerns make people reluctant to cycle and many non-cyclists complain about rogue cyclists who litter the city with their bicycles obstructing sidewalks and causing hazards to pedestrians. However, the City is currently installing 50 new bicycle racks in an attempt to reassure cyclists their bicycles will be secure and improve perceptions of cyclists.

The City of St. Louis has many opportunities for improvement in bike infrastructure. The 2010 Census shows population decreases in both the City of St. Louis and St. Louis County (East-West Gateway). As a result of this population loss and national trends that show a decrease in vehicle miles traveled, many roadways have excess street capacity and could easily incorporate bike lanes. Typically, space in the developed street right-of-way is a scarce urban resource with motor vehicles, transit, parked cars, sidewalks, landscaping, and bicycle facilities often competing against each other for the same space. Many of the streets in the City of St. Louis and elsewhere in St. Louis County do not have this problem. The excess capacity means that street space can be more easily re-allocated, often by simply using paint to channel traffic in ways that create space for on-street bicycle facilities.

Perception of safety is a critical factor in encouraging cycling within the City. Over 700 bicycle accidents have been reported in St. Louis in the past five years (East-West Gateway). Surveys show that intersections are where most bicycle accidents occur, and serve as a major deterrent to cycling in St. Louis. Problematic intersections discourage

bicycling, especially by novice bicyclists who consistently identify fear of unsafe and unlawful motorist behavior as the number one reason for not bicycling more frequently. This obstacle to cycling can be overcome with the addition of bike friendly infrastructure.

Bridges provide an additional obstacle to cycling. In a region where there are multiple rivers and creek systems in addition to many highway and rail corridors, bridges of all sizes provide the connectivity necessary to create a complete, integrated bicycle network that is a truly viable alternative to the automobile. The lack of bicycle facilities on bridges presents a major barrier to increasing bicycle use in the City of St. Louis and surrounding areas. There are currently several bridges that serve as obstacles to cycling in the City of St. Louis including Route 141 over the Meramec River, Route 370 and I-64 over the Missouri River, Manchester Road from Des Peres Road through I-270 interchange and N. Grand Boulevard from Lindell Boulevard through the I-64 interchange (Great Rivers Greenway). These bridges serve to divide communities and serve as obstacles to integrative non-motorized transportation.

The City of St Louis has made an effort to incorporate cycling infrastructure into its transportation plan. However, there are many obstacles to increasing ridership, especially intersections and bridges which can be a safety hazard to cyclists and serve as a barrier to movement within communities. However, road diets provide an opportunity to easily increase bikeability in the region.

2.4.2 Education and Encouragement

In the St. Louis region, the increasing popularity of recreational bicycling is unmistakable as more bicyclists are seen on the streets and the ever-expanding greenway system each year. Several bicycling clubs and groups promote bicycling in and around the St. Louis region. As a means of getting new cyclists on the road, many groups organize group rides and even post their routes publicly on the Internet. Some of the groups also reach out to the community by teaching safe cycling skills and offering tips to adults and children. All of these groups promote recreational riding, as it is their members' presence on the roads and trails that increases the community's awareness of all bicyclists.

The City of St Louis recently launched Open Streets, a semi-annual event that opens normally busy roads exclusively to runners, walkers, cyclists and roller skaters of all ages. Each Open Streets event features a different route and free stations for activities such as yoga, rock-climbing and children's activities. Open Streets encourages denizens to get outside. It provides an incentive to take rusty bikes out of the garage, dust them off, and put air in deflated tires. It serves as a reminder of how easy and how much fun cycling can be. Open Streets is a great way to raise awareness about cycling. However, it seems like the event attracts mainly people who already cycle. Furthermore, there is a concern that it reinforces the idea of cycling as a recreational activity.

Trailnet's Bike to Work Day, seeks to achieve a similar aim. It provides an incentive to get people on their bikes. In 2011, 332 novice cyclists visited the nine refueling stations spread throughout the city, offering cyclists breakfast, coffee, and information about commuter cycling (St. Louis Regional Bike Plan). Bike to Work Day encourages people

to get on their bicycles, navigate their route to work, and see how easy it is to make cycling a part of their regular routine.

Safe Routes to School is a national movement to create safe, convenient, and fun opportunities for children to bicycle and walk to and from schools. The program is designed to reverse the declining trend in children walking and cycling to school. In 2011, about 100 children, 50 parents, neighbors, administrators, and elected officials participated in the event. These one-time events can be powerful in getting new cyclists on the road and raising awareness of the ease of cycling in the city. Throughout the year, Trailnet offers bicycle safety presentations to elementary schools. Bike Works, SWEAT and CAMP offer programs to neighborhood children as well. Helmet giveaways and fittings are offered at Giro della Montagna bike race. Fitting and low cost helmets are offered at numerous public events through local hospitals. These events help instill positive ideas about cycling from an early age. However, they also reinforce the idea that cycling is just for children.

Additionally, Bike St. Louis has developed and distributed a map highlighting the bike friendly aspects of St. Louis transportation to all St Louis households. A public awareness poster campaign focusing on safety, health, and environmental benefits of cycling was also plastered throughout the city. The poster campaign was very successful. It was easily noticeable by people in transit and makes cycling look convenient and fun. In conjunction with the poster campaign, an educational and promotional activity was created and presented to over 30 classes of middle school students. Trailnet also provides Etiquette and Safety tips for riders on their website to improve the perception of cycling safety and driver's attitudes towards cyclists. While these tips are incredibly helpful to new cyclists, it can be assumed that the majority of people who visit the Trailnet site are already experienced cyclists.

The City also educates motorists about proper behavior when passing a cyclist and general guidelines for sharing the road with cyclists. From 2000 to 2005, MoDOT and Trailnet ran radio ads, TV commercials, billboards, distributed posters and brochures, and made PowerPoint presentation to high school driver's education classes, promoting share the road and bike commuting. It can be assumed that the majority of community motorists were exposed to this campaign. However, the campaign ended almost a decade ago and there are now a lot of new drivers on the road who have never heard their message in addition to people who have forgotten the message in the last seven years.

Education and Encouragement programs in St Louis are strong. I think there is a wide awareness of cycling opportunities. However, many of the programs are disorganized and short lived. I think that a combined coordinated campaign by the various groups would be more powerful and have a more lasting impact. Furthermore, many of the programs attract primarily experienced cyclists who need no further encouragement to cycle.

2.4.3 Enforcement and Policy

In designing and rehabilitating local means of transportation, designers are encouraged to take bicyclists and their safety into account. In 2010, Mayor Francis Slay signed the

Complete Streets bill into law, encouraging transportation planners and engineers to keep walkers, cyclists and public transit users in mind, not just drivers. The "Complete Streets" policy sets forth the guiding principles and practices to be considered in public transportation projects, where practicable, economically feasible, and otherwise in accordance with applicable law, so as to encourage walking, bicycling and transit use while promoting safe operations for all users. While the Complete Streets policy does not require certain designs or construction standards, it requires the City to consider elements of Complete Streets in design, construction, and maintenance of public transportation projects. The President of the Board of Public Service shall consider the incorporation of one or more "Complete Streets" elements in each public transportation project to the extent that such is economically and physically feasible (National Complete Streets Coalition). While the introduction of the Complete Streets Policy was hailed by many as the start of a new era for multimodal city planning in the City of St Louis, the policy is greatly diluted by the inclusion of the 'economically and physically feasible' clause. There is concern that this multimodal rhetoric will not be supported by action in the City. When projects are reviewed and funds begin to run out, multimodal considerations are often the first to be cut. Nonetheless, the Complete Streets policy is evidence of an awareness of the importance of liveable and bikeable communities in government.

Missouri also has several policies dedicated to cyclists to ensure their own safety and that they respect the rules of the road. In Missouri, bicycles have the same rights and duties of a motor vehicle. Drivers must maintain a safe distance when overtaking a cyclist, anyone who violates this provision is guilty of an infraction and eligible for a fine. However, this law is rarely enforced. To increase pedestrian safety and improve perception of cyclists, cyclists are required to refrain from riding on sidewalks in business districts. When cycling in busy areas, bicyclists are required to give hand or mechanical signals. Cyclists are also required to ride as near to the right side of the road as is safe, except when making a left turn. While there are only a few policies regarding cyclists, they are very important in maintaining the safety of cyclists and increasing positive perceptions of cyclists on the road. Unfortunately, few cyclists or drivers are aware of these rules. This is because local police rarely enforce them and they are not reviewed in driver's education classes. As a result, many drivers are wary of cyclists on the road because they fear cyclists are lawless and unpredictable.

Chapter 3: Benefits of Cycling

The benefits of creating a cycling culture in a community are manifold. Cycling serves not only a recreational purpose, but also commuting and other utilitarian purposes. Fitness experts and health professionals advocate cycling for its cardiovascular benefits. Apart from the cost of travel time, cycling is also cheaper than any mode except walking and thus affordable to even to underserved communities. Additionally, the public costs of bicycling are modest, especially compared to motorized transport. Many environmental organizations, community activists and urban planners support cycling because it is an energy-efficient and non-polluting transport mode. Transport planners view space-efficient cycling as a way to reduce roadway congestion. Moreover, bicycling is becoming an important quality of life factor that people and businesses consider when choosing where to locate. Being able to bike from one place to another safely and conveniently can help enhance the quality of a person's holistic experience and quality of life in a community.

3.1 Health

The health community has adopted the view that the only way to get Americans to exercise regularly is to incorporate exercise into their daily lives. We live in an age when the most exercise many Americans get in a day is walking half a mile from one end of the shopping mall to the other in search of a pair of jeans or the perfect mother's day gift. In 2011, less than half of Americans meet the minimum standard of thirty minutes of moderate intensity activity 5 days a week recommended by the Surgeon General (Physical Activity for Adults, Center for Disease Control and Prevention). Thus, there are enormous benefits to getting people out of their cars, even for short trips. Health advocates market cycling as 'active transportation' because it allows people to incorporate physical activity into their daily routine with minimum effort. If you opt to take your bike to the local store to pick up a carton of milk, you are not sacrificing much in the way of time. You spare yourself the time stuck in traffic and looking for parking. Especially when you consider all the stop signs, stop lights, and low speed limits in residential neighborhoods. Plus, with a destination in mind, you focus on your goal rather than the exercise your body is getting. You're focused on navigating the traffic, enjoying the sights, the fresh air, and the thrill of movement.

Political reporter and cycling activist, Jeff Mapes jokes he feels like wearing a sign stating, "Ask me how I lost weight while commuting to work," (p. 10) after he started incorporating his bicycle into his daily commute. The link between cycling and weight loss is less comical when you take American obesity rates into account. According to the CDC, about one-third (33.8%) of adults in the United States are obese, more than any other country in the world. An additional 17% or 12.5 million children and adolescents (aged 2-19 years) are obese, more than triple the childhood obesity rate in 1980 (U.S. Obesity Trends, CDC website).

In a study done in Atlanta, GA by Lawrence Frank, a professor of urban land use at the University of British Columbia, there was a strong link between neighborhood design and physical activity. In walkable, bikeable communities, as defined by areas with

sidewalks, bike lanes, and nearby destinations, twice as many people reported getting moderate amounts of exercise compared to those in far-flung suburbs. Frank also reported that for each additional hour spent in a car each day, the odds of obesity increased by 6% in Atlanta (Frank, 2004). There is irrefutable evidence of the effectiveness of regular physical activity, such as cycling, in the prevention of chronic diseases like obesity. Daily physical activity is also known to be an effective preventative medicine for cardiovascular disease, cancer, hypertension, depression, and osteoporosis (Physical Activity and Health, CDC website). Most analyses have shown a reduction in mortality of at least 50% among highly fit people who engage in physical activity for at least 30 minutes a day compared with low fit sedentary individuals (Myers and George, 2004). Thus, improving bikeability and encouraging residents to get out of their cars and onto their bicycles improves the health of a community.

Skeptics often cite adverse individual health affects such as higher exposure to air pollution and increased risk of collision. However, a cost-benefit analysis of cycling in the Netherlands found that the individual health benefits of cycling greatly outweigh these costs. They quantified the impact in terms of 'all-cause mortality' when 500,000 people made a transition from car to bicycle for short trips on a daily basis. For individuals who shift from car to bicycle, they estimated the beneficial health effects of increased activity to be between 3 and 14 months gained. The potential mortality effect of increased air pollution doses was only between 0.8 and 40 days lost and the increase in traffic accidents resulted in only 5 to 9 days lost (de Hartog, 2010). Thus, when quantified in terms of life years gained or lost, the benefits of cycling are several times greater than the costs.

The societal benefits of cycling are also significant, including a reduction in air pollution, greenhouse gas emissions, and traffic accidents due to fewer vehicles on the roads. Studies have also shown that the more bicycles on the road, the safer biking becomes (Jacobsen, 2003). Vehicles become more comfortable around cyclists and learn to anticipate their presence. Increasing the number of cyclists on the road also creates a cycling culture and cycling norms, causing cyclists to be more aware of and likely to obey cycling laws including signaling, yielding, and cycling in bike appropriate lanes.

3.2 Economic

Improving bikeability of a community promotes economic vitality. Communities that foster a cycling culture have seen considerable economic benefits by attracting businesses, tourism, and active residents. Cycling also has economic impacts that are not as obvious because the costs and benefits are borne and accrued by society rather than just the individual user. The benefits of switching to cycling can be seen in congestion reduction, roadway cost savings, parking cost savings, air pollution reduction, energy conservation, and traffic safety improvements. Victoria Transport Policy Institute's researcher Todd Litman quantified these benefits by estimating the savings per mile of replacing a car trip with a bike trip at \$2.73 per mile. The benefits would be enormous if even a small fraction of the more than 200 billion miles Americans drive each month were replaced by bikes.

Opting to bike instead of drive can open up a host of savings for the individual. The American Automobile Association estimates that the average American spends nearly \$8,000 annually to own and operate a single automobile. Meanwhile, bicyclists typically spend less than \$200 per year (League of American Bicyclists). Cycling can improve the mobility of residents without access to an automobile and allow some households to own one vehicle instead of two. “It’s a good deal for me personally,” explains Jeff Mapes, “I’ve financed a fleet of bikes in my garage, plus an assortment of raingear and other bike paraphernalia out of savings in bus fare and parking.” (p. 59) With rising gas prices, transportation is an increasingly large household expense. Bicycling provides an opportunity for savings that could be allocated towards spending elsewhere.

Additionally, communities that foster a cycling culture benefit from creating an increased demand for cycling products and services. The national bicycling industry contributes an estimated \$133 billion a year to the U.S. economy. It supports over a million jobs and generates \$17.7 billion dollars in taxes (Outdoor Industry Foundation, 2006).

Increasing bikeability also generates business for communities. After introducing policies to encourage bicycling and reduce auto-dependency in Portland, Oregon, the city saw \$90 million in bicycle-related activity in 2008 (Birk and Geller, 2009). Nearly sixty percent of that activity came from retail, rental, and repair, with professional services such as bike messengers and coaching also contributing (Birk and Geller, 2009). Portland residents also save on transportation costs, like gasoline and maintenance, and have more money to spend on things they value.

Improving bikeability in a city is also good for existing business. Along Valencia Street, in San Francisco, two thirds of merchants surveyed four and a half years after the creation of bike lanes reported a positive overall impact on their business (Drammen, 2003). Improving bikeability fosters safe and attractive streets where people are more likely to linger and shop. Additionally, cyclists also positively contribute to the local economy. This theory is supported by a study done on Bloor Street in Toronto, Ontario. People who used non-motorized transportation, such as walking or biking, reported spending more money in the community each month than those who drove there (Clean Air Partnership, 2009). Thus, improving the bikeability of an area helps stimulate the economy and helps local businesses both by encouraging the patronage of cyclists and creating an environment more conducive to shopping.

Cycling to work also provides many benefits to companies and employers. Companies today are often able to choose where they operate based on where they can attract the most talented employees. Improving the bikeability of a community can be a competitive selling point for companies and employees. Additionally, if employees choose to cycle to work, businesses save a great deal in parking. While bicycle parking takes up relatively little space, car parking comes at a significant cost. A simple surface level, paved parking space costs between \$3,000 and \$5,000. A single space in a parking deck costs \$10,000 to \$50,000 (Tougas, 2008). Employers bear these costs in their rent or purchase prices. Congestion also causes employees to lose productive hours in traffic. According to the Texas Transportation Institute, the average commuter spends 40 hours a year in

traffic. However, there is evidence to support the idea that even a small shift from driving to biking results in a large drop in congestion levels. According to the Federal Highway Administration, between 2007 and 2008, there was a 3 percent drop in traffic on urban interstates. This has translated to an almost 30 percent reduction in peak hour congestion. This indicates that shifting to cycling can have major impacts on reducing congestion in a community.

Improving the bikeability of a community also has a positive impact on real estate. Realtors sell not just houses, but communities, and increasing transportation choices increases the livability of an area. By mapping real estate transactions, researchers found that bike facilities have statistically significant positive impacts on home values. A study of the impact of Monon Bike Trail on property values in Indianapolis, Indiana showed that given two identical houses – one within a half mile of the Monon Trail and another further away – the home closer to the Monon Trail would sell for an average of 11 percent more (Lindsey et al., 2011). Bikeability is a quality of life factor that influences both people's and businesses' choice of residence, and improves the economic vitality of a region.

3.3 Environment

Over the course of the past century, transportation activities have resulted in growing levels of motorization and congestion. As a result, the transportation sector is becoming increasingly linked to environmental problems. This has reached a point where transportation activities are a dominant factor behind the emission of most pollutants and thus their impacts on the environment. Unlike most modes of transportation, the bicycle has no significant impacts on the environment. By switching to non-motorized travel, citizens reduce their environmental footprint. As a community, increasing bikeability reduces energy consumption, air pollution, water pollution, road kill, and landfill volume.

By choosing to cycle, citizens reduce their energy consumption. The United States consumes about a quarter of the world's total petroleum production each year. On-road vehicles account for 43% of that consumption (Highway Research & Statistics, EPA 2012). Bicycles do not require external energy inputs. Thus, increasing bikeability is an easy way to decrease this figure.

Automobiles emit a host of air pollutants, including nitrous oxides, volatile organic compounds, carbon monoxide, carbon dioxide, and particulate matter. These gases contribute to smog production, respiratory diseases, damage to plants, and have enormous global warming potential. Meanwhile, bicycling produces virtually no air pollution. Per mile air pollution reductions are especially large because bicycling usually replaces short, cold start vehicular trips. For internal combustion engines, these trips have especially high emission rates. According to a study done by Komanoff and Roelofs, for every 1% of vehicle travel replaced by bicycling decreases motor vehicle air pollution emissions by between 2 and 4%.

Furthermore, automobiles are responsible for a great deal of water pollution. Runoff of motor oil, dirt, deposited vehicle exhaust, road particles, automotive fluids, etc. from

roads collect in and contaminate bodies of water. The EPA estimates the amount of oil and grease runoff from roads on the order of hundreds of thousands of tons annually. Bicycles have smaller wheels, less weight, and travel at lower speeds. Consequently, bicycle trips are less disruptive to the road surface and leave behind fewer particles.

Automobiles also have negative impacts on wildlife. The primary way people kill wildlife is not by hunting or trapping, but with their vehicles. It is estimated that motor vehicles kill over a million animals in collisions daily in the United States (Komanoff and Roelofs, 1993). By choosing to cycle, cyclists travel at a safer, more manageable speed. This allows cyclists an opportunity to react and avoid approaching animals.

Increasing bikeability of a community can also help reduce waste. In 1996, approximately 63 million tires were landfilled, adding to the more than 800 million tires currently in dumps around the country (U.S. EPA Indicator Report, 1996). Tire dumps are classified by the EPA as an 'ongoing environmental hazard.' They serve as breeding grounds for mosquitoes and pose a serious fire hazard. When tires catch fire they emit highly toxic gases into the atmosphere. They are also incredibly difficult to put out and have been known to burn for over a year (U.S. EPA Indicator Report, 1996).

3.4 Solution to the Last Mile Dilemma

The 'Last Mile Dilemma' is a common problem faced by public transportation planners. No matter how extensive a community's system of public transportation, it is rare for commuters to be able to travel from door to door exclusively using public transit. The 'Last Mile Dilemma' refers to the situation in which a person's place of work is located out of convenient walking distance from the closest transit stop. In the face of this inconvenience, it is common for commuters to choose to drive the entire trip, rather than use public transit and walk the 'last mile' to work.

Research suggests that the farthest distance the average American will walk is between 5 and 10 minutes or about a ¼ of a mile. However, transportation planners estimate people will elect to cycle up to 3 miles for a single trip. As a result, many public transit planners encourage users to ride their bikes to the nearest transit stop by allowing riders to take bicycles on train cars and buses. This decreases the commute time for transit users and makes public transit a more viable option for many people. Thus, it follows that increasing the bikeability of an area increases the use of public transportation by making transit to more convenient, and useful to a wider range of people. This increased transit use is beneficial because it deters longer trips in private single passenger vehicles.

3.5 St. Louis Specific Benefits

Cycling clearly offers many benefits to communities across the country. However, different communities benefit differently from improving bikeability. The proposed Regional Bike Plan offers some great health, economic, and environmental benefits specifically to the City of St Louis.

In terms of public health, increasing ridership is important to St Louis because of the activity it encourages. According to the CDC, Missouri is currently the 10th most obese

state in the nation. Over 30% of its populace was classified as obese in 2010 (U.S. Trends, CDC 2011). Within the City of St. Louis, the CDC estimated obesity rates at 32.9% in 2008. The CDC also estimated that 29.0% of St. Louis residents are physically inactive. Thus, it is especially important to provide access to active transportation to help the citizens of St. Louis incorporate physical activity into their daily routines by increasing bikeability.

A large proportion of the St Louis population suffers from restricted access to transportation and would benefit greatly from improvements in the non-motorized transportation network. According to the 2009 U.S. Census American Community Survey, about 33.5 percent of the St. Louis Metropolitan Statistical Area (which includes the City of St. Louis, and St. Louis and St. Charles Counties) is under the age of 19, and just over 13 percent of the population is 65 years or older. For young people, walking and bicycling afford a sense of independence, and for seniors, walking and bicycling are good ways to stay active both physically and socially. In addition, for those who choose not to, or cannot afford to use motor vehicles, bicycling is an inexpensive and effective means of transportation. Finally, the St. Louis region is fortunate to have an enthusiastic and large existing bicycling community who take advantage of Forest Park and the current greenway system. These cyclists will benefit immensely from the security and continuity provided by increasing bike infrastructure and additional cyclists on the road.

Bicycling can also help stimulate the economy by bringing tourist dollars into the region. Active vacations and recreational tourism are one of the fastest growing sectors of the tourist industry (Litman, 2010). As shown in the maps in the appendix, the St. Louis region, with its extensive network of greenways, numerous points of interest, and location at the crossroads of several national bike routes—including the Trans America Bicycle Trail, Katy Trail, Route 66, and Mississippi River Trail—is well-positioned to benefit from further development of its bicycle network. Furthermore, the Regional Bike Plan will incorporate St Louis Landmarks allowing tourists to easily get from to the Arch, City Garden, Busch Stadium, Soulard Market, Anheuser Busch Brewery and numerous other significant landmarks.

Cycling would also be good for property values which are currently among the lowest of any city in the country, with a median of \$119,900 per owner occupied housing unit between 2005 and 2009, according to the US Census Bureau. Thus, the City could greatly benefit from the positive effects of a bikeable community on property values.

Bicycle infrastructure projects, such as installing bicycle lanes and boulevards, have a positive effect on local job creation. This would significantly benefit the city of St Louis which had an unemployment rate hovering around 9% in 2011, according to the Bureau of Labor Statistics. While it is likely that any infrastructure project will generate local construction jobs, it appears that bicycle projects may be more beneficial to the local economy. Based on a study conducted by the University of Massachusetts–Amherst, bicycle and pedestrian infrastructure projects can create more than just road repair and resurfacing jobs. The study evaluated data on infrastructure projects completed in several cities in the United States, including Baltimore, Maryland (Garrett-Peltier, 2011). The

conclusion was that because bicycle and pedestrian projects can be more labor-intensive, more money is spent on labor than on materials.

The City of St. Louis also has problem with air pollution which improving bikeability can ameliorate. Ozone and Particulate Matter create both local and global health and environmental impacts, and areas like the St. Louis region, which are designated as nonattainment areas (for air quality standards) by the Environmental Protection Agency, are required to reduce total emissions. Substituting bicycling trips for short auto trips reduces the amount of pollutants emitted.

Thus, increasing both bikeability and ridership in the City of St Louis benefit the community in terms of physical, economic, and environmental health.

CHAPTER 4: OBSTACLES TO CYCLING CULTURE

Millions of people in the United States love to ride bicycles. They do so for exercise and leisure, to visit friends and run the occasional errand, to attend college classes, go camping in the country, and to explore parks and cities. Bicycling is one of the most popular recreational activities in the United States and becoming a more attractive mode of urban transportation especially among young professionals. Yet the stark reality is that only 1 percent of the total U.S. population rides a bicycle for transportation and barely half as many use bikes to commute to work. When compared with the rest of the industrialized world, these figures are incredibly low. Fewer people ride bicycles in the United States than in almost every country throughout Asia and Europe, with the exception of England, with whom the United States is tied (along with Australia). In contrast, bicycling accounts for 27% of trips made in the Netherlands, 18% in Denmark, and roughly 10% in Germany, Finland, and Sweden (Furness, 2010).

John Pucher, a bicycle transportation expert and urban planning professor, best puts the U.S. figure into perspective by noting that Canadians living in the Yukon bike to work at more than twice the rate of California residents and more than three times that of commuters in Florida. Even the Northwest Territories, just shy of the North Pole, boasts a higher percentage of bike commuters than some of the most bike friendly cities in the United States: Oakland, CA; Honolulu, HI; and Denver, CO (Pucher and Buehler, 2006). This begs the question: how to explain the low levels of bicycling in the United States?

4.1 Perception of Safety

One of the biggest obstacles to the modern bike movement is the perception that riding a bike is unsafe. Cycling is widely considered to be among the riskiest modes of travel. In reality, the likelihood of getting into an automobile accident is much greater than that of getting into an accident while on a bike (Krizek and Roland, 2005). Nonetheless, one of the main reasons many people, especially women and children, chose to drive is because of the perception of safety it provides to themselves and their passengers.

Because women tend to be more risk averse, the proportion of women on the streets is a good indicator of the perception of safety and bikeability of an area. In the United States, women and children are outnumbered 3 to 1 on American streets. Meanwhile in the Netherlands, women make up 55% of all bike commuters (Krizek and Roland, 2005). These statistics show that perception of safety in American cities is low and serves as an impediment to ridership.

How do we combat this? Many cycling advocates, most notably Peter Jacobson, subscribe to a safety in numbers theory. They assert that the only way to make bicycling safer is to put more cyclists on the road. The increased presence of cyclists on the roads will make drivers more aware of cyclists and therefore safer drivers. A study in Portland, Oregon concluded that bike-related accidents are inversely proportional to the number of cyclists on the road (Jacobson et al., 2003). Alternatively, bicycle advocacy groups insist

that the best way to make cycling safer is to limit interaction with cars as much as possible and establish a clear right of way for cyclists.

4.2 Connectivity

A key of good community design is connectivity. Connectivity is defined as the directness or ease of travel between two points that is directly related to characteristics of street design. Connectivity is high when there are few barriers such as dead ends, walls, freeways, etc. Circuitous routes and increased distances discourage walking and biking.

Many people attribute low cycling levels in the United States to the low densities and high degree of suburban sprawl. Cities in Canada and Europe are generally much denser, have more mixed-use development, and less suburban sprawl. These strong centralized cities probably encourage more cycling because trip origins and destinations are less spread out, so that trip distances tend to be shorter, and thus more bikeable.

A major deterrent to cycling is the amount of additional time it takes to reach a destination. While a cyclist simply cannot maintain the speed of a vehicle, circuitous routes and a lack of connectivity exacerbate this problem. In an effort to improve connectivity of bicycle routes, bike friendly resources should be focused around destinations: employment centers, retail areas, transit, schools, etc. Furthermore, the primary focus of developing on-street bicycle facilities should be on arterial and collector roadways, because they typically provide the most direct access to destinations.

Further complicating the problem, the implementation of bicycle infrastructure in the United States tends to be very siloed. Municipalities and individual communities create bicycle plans that end at their boundaries. The result is that regions made up of multiple municipalities, like St Louis, have lots of disjointed pockets of bikeability. This lack of connectivity creates cycling deserts which can be dangerous and confusing and serve as another major impediment to cycling. Many cities with cycling facilities are characterized by discontinuities where the path or lane simply ends abruptly in a ‘dangling node.’ Instances where on-street bicycle lanes end pose considerable risk to many cyclists. These instances force the cyclist to merge with automobile traffic, creating weak links in the system that ultimately affect many people’s decision to cycle. Dangling nodes often occur in high speed or high traffic areas which can be very detrimental to a cyclist’s perceived safety. Furthermore, cycling lanes often end to accommodate parking lanes. The presence of a parking lane after a discontinuity adds to a feeling of “squeeze” perceived by the cyclist. In addition, car parking and car doors opening can also pose a threat. In an effort to resolve ‘dangling nodes’ many regions emphasize interjurisdictional connectivity by building paths between adjacent communities or appointing an individual or governing body to oversee bikeability over the entirety of the region.

4.3 Autocentric Culture

In the United States, there is a lot of hostility towards cyclists and devoting resources to accommodate cyclists. Many people attribute this to the fact that we live in an autocentric culture in which alternative forms of transportation are marginalized and misunderstood. More than 120 million people commute via car, of which 105 million commute in single passenger vehicles. In his book, *One Less Car: Bicycling and the Politics of Automobility*, Zack Furness explains that “Driving, and more specifically the act of driving, is not only an integral part of American life, it is one of the most ritualized tasks performed by the largest number of U.S. citizens each day.” Furthermore, William F. Buckley Jr. explains, “The *right* to drive a car is the most cherished right in America” (Furness, 2010: p.27). We live in an autocentric culture. Consequently, it is not surprising that cyclists often find themselves marginalized by an autocentric society and feel their form of transportation becoming obsolete.

The choice to ride a bicycle is often condemned as “cultural elitism.” Other drivers may simply resent cyclists for forcing them to shift out of autopilot as they take care to avoid cyclists on the road. Drivers may also have their opinions colored by experiences with rogue cyclists who don’t obey the rules of the road posing a danger to both themselves and the vehicles around them. Many drivers and pedestrians feel that cyclists are trying to straddle the line between vehicles and pedestrians. Unaware of the actual laws surrounding cycling, many feel that bicyclists choose whichever laws are most convenient at the time. This belief results in uncertainty regarding cyclists’ behavior at intersections and heightens fears of a collision. Regardless of the motivations, many drivers do little to improve the experience of cyclists.

Bicycling is not only a fringe mode of transportation, but also a form of mobility actively discouraged by dominant cultural norms in the United States. The result is that sharing the road with motorists can be a rather unpleasant experience. Streets tend to be hostile environments for cyclists. Drivers can be aggressive, short-tempered, and disrespectful. More importantly, it is not uncommon for male drivers to sexually harass women on bikes and to intimidate, taunt, and occasionally attack male cyclists. Thus, riding a bicycle becomes much less alluring when faced with hostility and resentment.

These problems can be addressed through education and policy. By making cyclists, drivers, and even pedestrians aware of the rules and expectations regarding bicycle travel. By helping people anticipate cyclists’ actions, we can reduce fear of the unknown. Furthermore, circlovias and other promotional events can work wonders to show people that cycling is not a niche activity but easily accessible to everyone. Finally, going back to the ‘safety in numbers theory,’ studies show that the more cyclists on the roads improves perceptions of cyclists and reduces the incidence of harassment improving the quality of cycling for everyone.

4.4 Automobile Subsidies

Many people are less inclined to commute via bicycle because the low costs of owning and operating a car in the United States discourage bicycle use. For the majority of the

last 30 years, the price of petrol has been below that of bottled water. Thanks to extensive subsidies, other aspects of US road transportation are similarly priced artificially low. In Canada and many European cities, the majority of road maintenance budgets are paid for by gasoline taxes. As a result, gasoline prices in Canada have been about 50% higher than in the United States over the entire period 1990-2003 (Furness, 2010). This price differential is due to gasoline taxes that are twice as high in Canada as in the United States. Furthermore, the Canadian and American Automobile Associations estimated the average costs of owning and operating comparable models of cars. Although they used the exact same metrics, the annual cost of owning a Chevrolet Cavalier was 27% higher in Canada. Because the costs of owning a car are so much lower in the United States, there are 41% more cars and light trucks per capita. As a result of these high costs of cars and fuel, people in Canada are more inclined to cycle shorter distances.

Furthermore, liberal car parking policies in the United States encourage vehicular transportation. More restrictive car parking policies in Canadian cities have the indirect affect of encouraging cycling. American cities set minimum parking requirements three times higher than in Canadian cities. In the United States, it is not uncommon for employers to offer their employees free parking worth at least \$1,000 a year nationally. Consequently, Canadian cities were found to have only about two thirds as much parking per 1000 jobs as American cities. Thus, both private and public parking incentives serve to indirectly discourage people from cycling by making driving more appealing.

4.5 Obstacles to Cycling in St. Louis

These obstacles to cycling are prevalent in the St Louis Region. In St. Louis, ridership is especially low. According to the 2010 census, only .01% of the population regularly commutes on a bicycle. This is due in large part to suburban sprawl and lack of connectivity. As is typical in suburban areas, business centers and residential areas tend to be very isolated from one another making it difficult to get from one to the other. Additionally, the majority of the region is not on a grid system, instead culs-de-sac and dead ends abound. Furthermore, there are currently several bridges that serve as obstacles to cycling including Route 141 over the Meramec River, Route 370 and I-64 over the Missouri River, Manchester Road from Des Peres Road through the I-270 interchange and N. Grand Boulevard from Lindell Boulevard through the I-64 interchange. These bridges serve to divide communities and act as obstacles to non-motorized transportation. These gaps in connectivity help explain the reluctance of residents to cycle.

Additionally, many of the streets that are marked as bike routes are incredibly narrow. Bikes are forced onto narrow shoulders that make it difficult for cyclists and drivers to share the road. These roads are also littered with parked cars that force bicycles to weave in and out of dedicated car lanes. This can be very dangerous.

These streets and these communities were not designed for bicycles. This lack of connectivity and narrow routes are due in large part to the autocentric culture of city planners. The streets were designed to accommodate single passenger vehicles. In recent years, city planners have progressed to add bicycle accommodations, but only as

afterthoughts. We are adding these improvements after the fact and the result is that much of our transportation infrastructure cannot be easily altered to incorporate bicycles. For example, major expressways pose challenges to bicycles because of the speed of the passing vehicles. Additionally, the cement walls that line many transportation routes in St Louis do not offer enough shoulder to create a suitable buffer between the cyclist and either passing cars or the cement wall.

Finally, the St Louis region is made up of several small local governments. St Louis County is made up of 90 different municipalities, excluding the City of St Louis. Because cycling plans and cycling infrastructure are left to local governments, the result is 90 different bicycle networks that each end in dangling nodes and fail to connect with one another. Because these municipal lines do not overlap with people's communities completely people experience frequent disconnects in bicycle routes as they travel from one municipality to another.

In conclusion, the St Louis experiences the same obstacles commonly experienced in the United States. There is a lack of connectivity in bicycle routes and a lack of safety. Some of the causes of these discontinuities include siloed local governments, outdated city planning techniques, and an autocratic culture.

CHAPTER 5: PROPOSED ST. LOUIS BIKE PLAN

The St. Louis Gateway Bike Plan provides a long-term vision for coordinating and encouraging bicycling as a viable transportation option. It offers practical action strategies for how to achieve this vision in the next ten years. The Plan is the result of a collaborative effort between the Great Rivers Greenway District, Missouri Department of Transportation, East-West Gateway Council of Governments, Metro, numerous municipalities, St. Louis and St. Charles counties, the City of St. Louis and Trailnet. The Plan was completed in August 2011 and covers St. Louis County, City of St. Louis, and the urbanized communities of St. Charles County.

In short, the St Louis Bike Plan can be summarized in a few goals. The overall mission is to increase the number of people using bicycles for transportation while reducing the rate of bicycle crashes by 50% by 2020. The Bike Plan also seeks to increase the 77-mile existing St. Louis bike network to approximately 1,014 miles of bike facilities over the next ten years. The Plan strives to improve and unify the existing bike network. In order to accomplish these goals, the Bike Plan will improve accessibility and safety around intersections and bridges, concentrate bike infrastructure near destinations, and increase the presence of signage and end of trip facilities.

Admittedly, it seems unlikely, that the region has the initiative, funding, or collaborative abilities to accomplish these tasks. Many municipalities do not consider multimodal transportation a priority, according to Kevin Neill, the Community Planning Manager at Trailnet who works with municipalities all over Missouri to create Bike Plans. Even with clearly stated goals and timelines, many of these plans are largely ignored by public officials. The public officials are too busy pushing their own agendas. Additionally, the majority of these municipalities are low-density suburbs. As a result, officials feel that creating a bikeable community is an unrealistic goal and their energy is better focused elsewhere. They are unable to appreciate the effects of small changes. The result is that many bike plans never come to fruition.

Additionally, while these projects are shown to generate savings in the long run, they require investment in the short term. This begs the question, where does this initial funding come from? Nationally, only 1.6% of FHWA funding goes towards nonmotorized transportation and Neill predicts that nonmotorized transportation in St Louis receives maybe half that amount. Without funding to support these projects, the idea of a 1,000-mile bike network seems laughable. Furthermore, one of the main goals of the plan is to increase connectivity. This requires that the different municipalities and different levels of government work in tandem to accomplish shared goals. Many of these small government entities are known for competing with one another and are reluctant to work on joint projects. Neill described the dynamic between the smaller municipalities and the county as tense and the efforts of East West Gateway as slow moving due to the diversity of interests represented. Consequently, a voluntary collaborative effort seems unlikely and a single unified trail network seems like a pipe dream.

However, the creators of the plan remain optimistic. In speaking with Ann Mack, the executive director of Trailnet, about the ambitious nature of expanding a trail network from 77 miles to over 1000 interconnected miles, Mack explained that the plan was simply outlining the possible ways to improve the trail network and to show public officials the potential their community holds to be bike friendly. By providing a truly comprehensive bicycle plan with lofty goals, Mack hopes raise awareness of the need for a multimodal transportation system and make it a priority for public officials. By presenting all the options, the plan encourages public officials to pick the low hanging fruit. Even if only 10% of the infrastructure suggested in the bike plan is implemented, the St Louis bike network will still grow almost 200%. “We don’t measure success in miles of bike lane painted, but in changes in transportation culture,” Mack explains.

5.1 Infrastructure Initiatives in the City of St. Louis

One of the main goals of the Gateway Bike Plan is to create a fully interconnected, seamless, and safe bicycle facility network that connects areas within St. Charles County, St. Louis County, and the City of St. Louis. The Bike Plan hopes to implement bicycle facilities that encourage the use of bicycles for transportation. In order to accomplish this goal, the Plan outlines a set of recommendations and actions to create an integrated bicycle facility network making St. Louis a great place for bicycling.

The goal of creating an integrated bike network is to provide a prioritized system of routes that are contiguous and connected to other on- and off-road facilities. The Plan seeks to improve accessibility and safety for bikes along on-street routes. On-street routes will help connect people to jobs, shopping, transit, schools, parks, and other destinations, as well as tie together the region’s ever-growing system of greenways and off-road trails. The Bike Plan seeks to accomplish this goal via three unique actions:

- Integrate on-street bicycle facilities into appropriate planning documents at the state, county, and local planning level.
- Prioritize on-street bicycle facilities that make critical links to and among major destinations and address barriers that create significant impediments to safe and efficient bicycling.
- Implement on-street bicycle facilities identified in the Plan to improve accessibility and safety for bicyclists whenever major road projects are undertaken.

More specifically, the Plan seeks to improve accessibility and safety for bikes around barriers like intersections and rivers. These barriers impede accessibility and create unsafe bicycling conditions. The Plan outlines actions to accomplish this task:

- Integrate identified barriers into appropriate state, county and local planning documents. These barriers include bridge crossings, complicated intersections, railway crossings, or corridors with other particular challenges identified in the Gateway Bike Plan should be integrated into the transportation plans and work programs.
- Prioritize identified barriers in terms of how significant they are for making critical links in the transportation network and improving safety.

- Include appropriate bicycle facilities in all future bridge projects and major rehabilitation of existing bridges.

The City of St. Louis and the surrounding areas have a number of planned and existing bicycle facilities in place. These facilities will be incorporated into the regional bicycle network and retrofitted as needed to improve the safety. The Plan lays out three steps to accomplish this goal:

- Conduct safety audits for existing facilities to identify design deficiencies and maintenance needs.
- Work with appropriate agencies to adopt maintenance programs to routinely maintain and upgrade existing facilities. Ensure that bicycle facilities that are part of the roadway network are included in the regularly scheduled maintenance of the roadway network, such as lane sweeping, pothole repair, removal of obstacles, standard restriping and resurfacing.
- Identify and focus resources on spot maintenance problems where bicycle crashes occur. Roadway features that cause minor discomfort to motorists, such as potholes, seams between roadway sections, faded or unclear roadway striping, and improper drain grates, can cause serious problems for cyclists because of their small lightweight tires. Government agencies should establish spot maintenance and improvement programs with dedicated resources to address discrete problems and construct low cost improvements to enhance bicycle safety and convenience.

The bicycle crash rate (number of reported crashes divided by number of cyclists) is a key indicator of the safety of on-street facilities, the acceptance of bicyclists on the roadway, and good roadway behavior on the part of both motorists and bicyclists. One of the objectives of the Bike Plan is to reduce the crash rate by fifty percent by 2021, while increasing ridership. The Plan identifies a number of implementation actions aimed at accomplishing this objective:

- Identify spot locations, corridors and neighborhoods where bicycle crashes are occurring through regular on-the-ground assessments.
- Focus resources on spot locations, corridors, and neighborhoods where bicycle crashes are occurring.
- Develop a Web site where users can interactively report crashes, bad pavement, road conditions, etc. Data should be compiled and distributed to the entities involved in plan implementation and roadway maintenance.

The Plan asserts that installing way-finding signage and end-of-trip facilities will help bicyclists feel more comfortable and confident using the Bicycle Facility Network. Signage provides directional information to major destinations, helps identify trail connections, and assists bicyclists through complicated and confusing portions of the network. End-of-trip facilities, such as secure bike parking/storage at destinations, and amenities, such as changing areas and showers, are also important for attracting ridership and making bicycle transportation more convenient. Thus, the Bike Plan is committed to promoting cycling through route signage and end of trip facilities, suggesting:

- Install a Signed Bicycle Route System with uniform signage to create a cohesive network. A comprehensive set of bicycle route wayfinding signs should be developed to connect destinations in the St. Louis region and indicate bike friendly routes.
- Require and install end-of-trip facilities. All public facilities, (parks, community centers, libraries, city halls, schools, etc.) should have sufficient bicycle parking to meet demand. Incentives or requirements should be put in place for new commercial and multi-family residential developments to provide on-site bicycle parking and/or storage.
- Encourage area gyms and fitness facilities to work with the public agencies to create bicycle commuter memberships. Showers and changing facilities can help make bicycling a feasible choice for getting to work by providing a place to freshen up after the ride.

Finally, the Bike Plan seeks to improve safety for all modes of transportation through careful design and implementation of bicycle facilities. Specifically, the Bike Plan attempts to improve safety by designing all bicycle facilities to the latest American Association of State Highway Transportation Officials (AASHTO) bicycle guidelines and 2009 Manual on Uniform Traffic Control Devices (MUTCD) Standards. Following these guidelines allows local agencies to move forward with confidence that what they are doing is consistent with the latest thinking and ensures uniformity among amenities. The Bike Plan intends to accomplish this goal via four straightforward initiatives:

- Ensure latest AASHTO bike guidelines and MUTCD are adopted by the appropriate agencies.
- Adopt additional guidance for installing bicycle facilities that builds on AASHTO guidelines and 2009 MUTCD Standards.
- Ensure consistent application of bicycle facility guidelines and standards through field checks to insure compliance to AASHTO guidelines and 2009 MUTCD Standards.
- Identify creative solutions to unique issues that may be outside of standard design guidance. There will always be situations in which adopted guidelines and standards do not adequately address existing right-of-way constraints or the safety needs of the bicycle network users. In such situations, an agency must be able to use professional engineering judgment to identify creative solutions that still fall within the intent of standard design guidance.

In summary, the St Louis Bike Plan hopes to expand the regional bike network and increase ridership while decreasing the crash rate. To accomplish these goals, the plan proposes prioritizing on-road bike lanes, ameliorating barriers to connectivity, retrofitting existing bike facilities, installing signage and end-of-trip facilities, and abiding by AASHTO and MUTCD standards. The infrastructure section of the plan is probably the most expensive to implement. As illustrated in the next section, road projects carry large price tags and it is often difficult to justify their costs. However, if implemented correctly bike infrastructure may be the most beneficial in accomplishing the bike plan's stated goals. Identifying dangerous spots and intersections could work wonders to improve the safety of bicycle travel. Furthermore, bike lanes and bike signage not only provide a safe

route but also raise awareness about the ease of cycling in the region and have been shown to increase ridership.

5.2 Education and Encouragement Initiatives in the St Louis Bike Plan

Engineering and construction of the bicycle network are critical, but it is equally important to discuss how the Plan incorporates programs designed to raise awareness and educate citizens about available cycling infrastructure and the benefits of cycling. From motorists to delivery truck drivers to bicyclists and pedestrians on the sidewalk or crossing streets, all users of a public roadway must understand how to safely travel and interact with the various transportation modes. The regulations that govern all users, including bicyclists, can be taught through various education programs, training classes, marketing and awareness campaigns. Additionally, encouragement programs can play an integral role in increasing ridership. By providing recognition, incentives, and awareness the Regional Bike Plan can help bicycling be viewed as a more convenient transportation choice.

Throughout the St. Louis region, several existing programs combine components of education and encouragement. The Bike Plan seeks to create a more comprehensive approach and coordinate these initiatives within a regional framework. Many of the actions identified can be easily accomplished simply because they are already underway by different agencies and organizations.

One of the primary goals of the St Louis Bike Plan is to improve safety for all modes of transportation through the implementation of educational and enforcement programs. Expanding and developing education and enforcement programs through partnerships with community organizations can reduce the number of crashes involving bicycles. Efforts must be made to encourage a culture of respect and shared usage that welcomes new riders to the region's roads and trails. The education and enforcement programs recommended are intended to help grow the number of bicyclists while also increasing safe and appropriate behavior by bicyclists and all other roadway users. The Plan outlines five initiatives to accomplish this goal:

- Expand and support existing and new bicycling education programs for bicyclists and motorists through partnerships with community organizations and appropriate law enforcement agencies.
- Encourage children to walk and bicycle to school at the elementary, middle, and high school levels by expanding safe routes to school programs, including curriculum and safety education programs. Safe Routes to School programs use education and incentives to show students how much fun walking and biking can be. It garners parents' support by teaching bicycle safety.
- Work with Missouri Department of Transportation (MoDOT) to develop and update educational materials regarding motor vehicles and bicyclists. Encourage MoDOT to continue and expand its efforts to educate motorists and bicyclists through its Web site, print, digital, and social media and the publication and dissemination of materials such as state bicycle maps and road maps.
- Identify agencies and not-for-profit groups that will collaborate on developing educational, promotional, and marketing materials for bicyclists, motorists.

- Classes and promotional materials are provided by a number of organizations and agencies in the State and region, including Trailnet, Missouri Bicycle and Pedestrian Federation, MoDOT, Great Rivers Greenway, and local jurisdictions. Close coordination may allow each to play to their strengths, such as providing volunteers, funding, technical capacity, or staffing, etc., while promoting consistent and effective messaging.
- Encourage local police agencies to participate in outreach activities such as bicycle rodeos and school assemblies. Because police officers are seen as authority figures and respected by children, their involvement in programs and activities that promote safe cycling can help foster responsible riding for a lifetime while reducing the likelihood of injury. Local police agencies help by being present at community bicycling events, developing bicycle and pedestrian safety messages for morning announcements, and being present on the street near schools during the morning and afternoon when kids are coming and leaving school.

Additionally, successful implementation of the plan is contingent upon well informed departments and staff members who have influence over how roadways are planned, designed, constructed, and how laws are enforced. The Bike Plan aims to educate these parties about the Plan, the facilities and actions it recommends, and the latest standards and guidelines that inform the Plan's recommendations. The Plan outlines six initiatives to accomplish this goal:

- Implement semiannual training programs on AASHTO guidelines and MUTCD standards for educating planners, engineers, maintenance staff, the public, and others organizations.
- Identify creative, low-cost ways to deliver education programs for planners and engineers. Programs should provide continuing education credits to encourage participation. This might be feasible because webinars and courses are offered through Great Rivers Greenway, Trailnet, MoDOT, as well as several national organizations.
- Identify a training program champion to administer, publicize, and seek funding for training. The program champion should coordinate with the East West Gateway Council to incorporate training into the long-range transportation plan. Program champion should oversee implementation of the Plan and coordination of training workshops. The workshops should cover all the priorities highlighted throughout this Plan—bicycle planning, facility design, maintenance, education, enforcement, safe routes to school, and Complete Streets.
- Establish a communication system to promote education opportunities to municipalities, agency staff, crews, and law enforcement.
- Improve consistency in enforcing traffic laws for motorists and bicyclists through training workshops for law enforcement officers. Review current laws and behaviors by motorists and bicyclists that lead to bicycle crashes. As bicycling in the region increases, it is important for all patrol officers to be prepared for potential conflicts and incorrect behavior. Due to the relatively low levels of on-road bicycle use, many officers are not as familiar with laws that pertain to bicycles as those related to vehicles. As a result, unsafe behavior by bicyclists and

motorists goes uncorrected. To emphasize the importance of bicycle safety law enforcement, regular trainings on bicycle safety laws should be offered to law enforcement officials.

- Offer specialized training to high-level officials. Educating decision makers and other high level officials on the latest approaches to roadway design and accommodation of bicycles helps to establish a common level of understanding of crucial policy decisions affecting the Plan's implementation. While it can be difficult to entice high-level officials to attend 1- or 2-day workshops, they can often be encouraged to attend short, 1 or 2 hour presentations on facility design and other topics related to bicycling.

Finally, the Plan establishes encouragement programs to expand the public's view that bicycles are a viable and acceptable mode of transportation. Education and encouragement programs help to build acceptance that bicycles belong as legitimate users of the roadway, thus improving bicycle safety and people's willingness to bike. The Plan outlines five encouragement initiatives:

- Facilitate and support existing and new bicycling promotion events through partnerships with community organizations, municipalities, and schools. Closer coordination among these organizations and agencies may achieve greater impact by allowing each to play to their strengths.
- Encourage people to bike to community events by providing bicycle parking. Providing sufficient bicycle parking, and where possible, locating the parking so that it provides extra convenience to those arriving on bicycle can be an effective encouragement strategy.
- Challenge city to do one bike event per year. Partnerships between government agencies, not-for-profit advocacy organizations, and bicycle gear manufacturers and retailers could be leveraged to organize, staff, and fund such events. In the City of St. Louis, a series of Open Streets festivities are held during the year and feature car-free street events that draw thousands of residents.
- Revise, develop, provide, and maintain regional and local bicycle network maps. Bike St. Louis has produced a paper map for the initial network and will revise it every 2 years as the network expands. The map includes additional educational information on effective cycling and network route types, including bike lanes and shared lane markings.
- Develop an interactive, Internet-based bicycle route way-finding program. An online bicycle route wayfinding program should be developed as a coordinated effort between EWGCOG, Trailnet, and Great Rivers Greenway, with support from partner governments and organizations, to help bicyclists determine preferred routes to destinations throughout the region. Such a program would allow bicyclists to enter their origin and destination and generate an optimal route to follow, give their experience level, time limits, preferred type of bicycle facility (bike lane or trail only), or other factors. It is likely that online tools already in existence, such as Google Maps or Community Walk, could be used and modified as needed to create a customized wayfinding program.

The education and encouragement component of the bike plan is comprised of three parts. The Plan encourages local agencies and nonprofits to collaborate and support one another in their various educational and outreach programs. This poses a challenge as most of these groups are accustomed to working alone. Many groups see collaboration posing more challenges than support due to communication issues and differing ideologies. Secondly, the Plan strives to keep public officials and other influential parties informed about the bike plan and the newest standards and guidelines in multimodal transportation. Lastly, the plan encourages local groups and municipalities to reach out to their residents and actively promote cycling with events and multimodal maps.

Of the three sections of the bike plan, education and encouragement is the most conservative. The plan focuses on reinforcing and collaborating on education and encouragement activities. The majority of the programs suggested are already underway. Bike St. Louis regularly updates its multimodal map of the St. Louis Region and sends it to residents of the St. Louis Region. The City already supports a series of successful circlovias. East-West Gateway already offers regular trainings on the most up-to-date AASHTO guidelines and MUTCD standards for educating planners, engineers, maintenance staff, the public, and others organizations. And Safe Routes to School is already present in nearly half of local elementary schools. The trouble with many of these programs, however, is that they reach only a very small portion of the population. Attendance at East-West Gateway trainings, for example, is always very low and always attended by the same people. While Open Streets draws a larger crowd, it appeals mainly to people who would spend their Saturdays outside with their bicycles and their families regardless. With regards to education and encouragement, the real challenge the region faces is reaching new groups of officials and residents. Unfortunately, this is not something the plan emphasizes.

5.3 Policy and Enforcement Initiatives in the City of St. Louis

A primary goal of the Bike Plan is to increase the commitment of public officials to bicycling in all levels of government. The Plan seeks to accomplish this objective by increasing intergovernmental cooperation on bicycle policy and projects. Given the number of agencies with influence over the roadway network within the planning area, intergovernmental cooperation on bicycle policy and projects is critical for successful implementation of the Plan. Cities and regions that are successful in implementing regional bicycle networks work together to solve problems and tackle issues that extend beyond their own boundaries. For the Gateway Bike Plan to be successful, bicycling must be valued by the various government agencies and not-for-profit organizations responsible for its implementation. Further, it must be instituted into their planning, policies, missions, and corporate cultures.

Ensuring citizens, in addition to Policy Makers, are aware of and abide by bicycle codes is also critical is improving the perception of bicycle safety and ameliorating the relationship between cyclists and their automotive neighbors on the road. Reducing bicycle-related crashes hinges upon addressing the behavioral causes. Enforcement that targets certain behaviors of each road user group is also important for establishing correct behaviors. Coordination among local and state law enforcement agencies, transportation

agencies and bicycle advocacy organizations to enforce laws and reduce bicycle-related crashes is critically important. Proper reporting and monitoring of bicycle crashes and ultimately reducing the number of crashes through better bicycle facilities and/or awareness and enforcement of state law is a critical part of the Bike Plan.

Moreover, many federal-aid funding opportunities require cooperation among local and regional entities in developing and implementing regional goals. Partnering among agencies and organizations can allow funding resources to be used more efficiently, and so numerous jurisdictions in the St. Louis region must be plugged into the Plan's implementation process. Furthermore, public agencies often have their hands tied when it comes to advocating bicycling, which is why the involvement of advocacy groups is important. The Plan proposes 8 initiatives to increase cooperation:

- Identify and designate a regional entity to oversee collaboration between groups to promote continued planning. An organization with a regional reach, like East West Gateway or Great Rivers Greenway, can play a critical role in promoting bicycle planning and overseeing collaboration between jurisdictions.
- Designate a citizen committee within the selected agency to support intergovernmental cooperation and review plans. Furthermore, a citizen oversight committee could provide initial review of major roadway projects to ensure that Plan recommendations are being considered and incorporated. The committee could track and measure implementation of the plan and be responsible for issuing an annual report card that summarizes achievements and milestones.
- Identify key personnel and contacts in appropriate state, county, and local governments. Assigning responsibility for the Plan to people in the right positions at each level of government will create a sense of ownership. These champions of the Plan will help the Bicycle Program Coordinator ensure that no opportunities for creating the Regional Bicycle Network are missed in the Plan.
- Identify processes or steps for transportation agencies to take to modify standard plans for on-street facilities. Include all appropriate agencies to ensure uniformity of design practices. Update transportation plans and specification manuals systematically to include the latest AASHTO guidelines, MUTCD standards, and best practices as they relate to bicycle planning and design. This can be done either by providing training workshops on the latest guidelines and best practices in bicycle facility design or developing a checklist that can be used by local agencies to identify needed changes.
- Review local plans to identify planned facilities that do not connect to other jurisdictions. Once identified, collaborate to change plans to create an interconnected system. This will ensure the development of a contiguous, interconnected regional bicycle network, and efficient use of resources.
- Identify process to make sure bicycle facility projects and elements of projects are implemented as planned. Having a system in place that ensures Plan recommendations are being incorporated at the project planning and development phase is critical to implementation. One suggested process is a checklist to identify which elements are needed to accomplish the Plan's objectives.
- Adopt Complete Streets ordinances or similar policies at local, regional, and state levels.

- Collaborate to preserve and develop rail corridors for multi-purpose trails. Rail corridors, whether in use or abandoned, provide opportunities for rails-to-trails or rails-and-trails projects that provide regional connections and recreational opportunities.

Additionally, the Plan seeks to establish funding sources for implementation and ongoing maintenance of the various initiatives. The Plan seeks to establish funding via 8 policy related initiatives:

- Review and revise prioritization criteria by state, regional, county, and local transportation agencies to ensure that good bicycle projects receive priority ranking for existing funds. Local jurisdictions should be encouraged to prioritize projects based on their existing capital improvement programs.
- Review and revise application forms and scoring criteria used by state, regional, and local transportation agencies to ensure that good bicycle projects (those that encourage use and improve safety) receive priority ranking for existing funds.
- Install bicycle facilities as part of routine accommodations or normal public and private projects, development, and programs. Routine road projects, such as resurfacing and striping, should incorporate bicycle facilities according to the Plan's recommendations, where feasible.
- Identify local, county, or state dedicated funding sources for implementation of on-street bicycle facilities. For example, a certain percentage of capital improvements could be set aside for bicycle facilities, or regional agencies could offer grant programs for improved bicycle facilities. Much like resurfacing and bridge projects in the St. Louis region, dedicated funding sources are needed to fund on-street bicycle facilities that otherwise would not be funded through routine accommodation.
- Encourage local municipalities to fund a bicycle/pedestrian program coordinator, or, at a minimum, dedicate responsibility for bicycle/pedestrian facility planning, implementation, and programming to an existing position. The Bicycle Program Coordinator could help to maintain momentum for Plan implementation at the local level by serving as a liaison among organizations and keep a close eye on funding and partnership opportunities.
- Create public/private partnerships to develop bicycle facilities. For example, a project may include developing end-of-trip facilities such as the Downtown Bicycle Station.
- Encourage multi-agency applications for funding projects. Interagency cooperation should receive added emphasis because inter-agency project development is often a criterion for receiving grant funds.
- Encourage municipalities or units of government to enact impact fees for new developments or redevelopments and require the installation of bicycle facilities. Impact fees will require contribution to a fund that can be used to make bicycle infrastructure improvements on area roadways, in addition to traffic improvements.

Ensuring citizens, in addition to Policy Makers, are aware of and abide by bicycle codes is also critical to improving the perception of bicycle safety and ameliorating the

relationship between cyclists and their automotive neighbors on the road. The Missouri Revised Statute establishes bicycles as having the same rights and duties of a motor vehicle. The statute also imposes some regulations and restrictions on bicycle use to protect the safety of the cyclist and maintain order on the roads. Enforcement of the Statute is rather relaxed which has resulted in a general ignorance of the rules it sets forth. The Bike Plan proposes several initiatives to correct this:

- Add stronger language to the Missouri Driver Guide related to motorist-cyclist behavior and incorporate bicycle friendly training into driver's education. The Guide should the State Statute which defines the rules and penalties associated with not maintaining the proper distance when passing a bicyclist.
- Increase enforcement of motorists and bicyclists behavior to reduce bicycle- and motor-vehicle-related crashes. In addition to or instead of a citation and a fine, cities throughout the country often require offenders (both drivers and bicyclists) to take a course on specific laws that pertain to pedestrian and vehicular safety.
- Introduce a progressive ticketing program. Issuing tickets is the strongest form of enforcement. There are three main steps to effective progressive ticketing. The first revolves around education. Raising awareness about the problem will change some behaviors and create public support for the enforcement efforts to follow. The second step could be considered a warning. Announce what action will be taken and why. Fliers, signs, newspaper stories, and official warnings from officers can all serve as reminders. Finally, hold a press conference announcing when and where the police operations will occur. If offenders continue their unsafe behaviors, officers issue tickets.
- Follow up by compiling and reviewing statistics on where and why citations are issued to assess their consistency and focus.

In summary, the policy section of the plan is probably the most realistic. It addresses many of the usual obstacles to implementation of a multimodal transportation project. The plan identifies new and creative ways to fund multimodal transportation projects, which is critical to implementation of the infrastructure and educational components of the plan. The policy section also identifies ways to remain a priority in the eyes of public officials. It seeks to create a sense of ownership of the plan by identifying important individuals within each government agency or organization to take responsibility for keeping the plan top of mind when drafting new transportation projects. Furthermore, the plan seeks to stay relevant by creating a checklist for organizations so that groups know what is being asked of them and exercise follow through. Additionally, the policy section focuses largely on increasing interagency cooperation. This is accomplished by the appointment of an agency to oversee the implementation of the plan, an individual within that agency to coordinate cooperation and ensure implementation, and creation of a citizen oversight committee to track and measure implementation. These initiatives will be critical to the success of the bike plan. However, they are also the most difficult to accomplish and will probably face the most resistance.

The majority of the policy section focuses on projects that facilitate the implementation of infrastructure and education programs. Because so many of the plans and policies identified in the policy section of the Regional Bike Plan are intimately tied with the

success of the education and infrastructure sections, I was unable to further analyze the costs or effectiveness of these initiatives in the next section. As a result, I combined enforcement initiatives with the education section. I think it can be assumed that if implemented successfully, the funding initiatives identified in this section would increase the proportion of initiatives implemented in the other two sections. Furthermore, successful implementation of the collaborative initiatives would increase the effectiveness of the other initiatives identified in the infrastructure and education sections of the bike plan.

CHAPTER 6: COST EFFECTIVENESS OF INFRASTRUCTURE INITIATIVES

In 2006, the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) commissioned a study on the effects of comprehensive packages of bicycle-friendly interventions on ridership. The Nonmotorized Transportation Pilot Program (NMTTP), which will be discussed in depth in the next chapter), gave four communities \$25 million to implement comprehensive bicycling plans. The results support an extensive and rapidly growing body of evidence that suggests the need to facilitate cycling through appropriate infrastructure, traffic calming, training and education programs, and other supportive measures. Counties and cities with high levels of bicycling and good safety rates tend to have extensive infrastructure and pro-cycling policies. Those with low bicycling rates and poor safety records generally have done much less. While such aggregate comparisons across cities and countries support the general importance of policies for encouraging bicycling and improving safety. It is not clear which measures are the most effective and should be given priority in designing and implementing a bicycle plan.

The St. Louis Regional Bike Plan is modeled after the NMTTP. However, without a \$25 million grant to implement these initiatives, the St Louis Region does not have the resources to implement such a comprehensive plan. The following section examines different types of infrastructure the St. Louis Bike Plan considers and evaluates their costs and effectiveness. This will help the Region prioritize individual initiatives so as to maximize the effectiveness of the plan.

6.1 Infrastructure Policies

Complete Streets

The Complete Streets Concept asserts that streets are not just for vehicles but also for all potential users, including pedestrians, cyclists, transit users, wheelchair users, shopkeepers, and residents. Complete Streets policies, taking many different forms, establish the complete streets concept as the guiding design principle for new and rebuilt streets. Complete Streets policies have been adopted by 314 jurisdictions, including 25 states, the Commonwealth of Puerto Rico, and the District of Columbia. Additionally, the US Congress is considering a federal Complete Streets Policy.

- **Impact:** While no data was found regarding the effect of Complete Streets on ridership, there is a multitude of studies looking at cities implementing comprehensive bike initiatives. However, these studies have shown mixed results. The Nonmotorized Transportation Pilot Program did not reveal any statistically significant changes in ridership after the implementation of a comprehensive bike program (McGinnis et al., 2011). However, this may be attributable to the short evaluation period (three years) and the limited resources allocated to data collection. In Boulder, CO, the share of workers commuting by bicycle rose from 3.8% in 1980 to 6.9% in 2000 and 8.8% in 2006 in response to an aggressive program of bikeway expansion and pro-bicycle measures (Roskowski et al., 2008). In contrast, the share of workers commuting by bicycle in Davis, California fell from 28% in 1980 to 14% in 2000, in spite of extensive bike

infrastructure development (Buehler and Handy, 2008). However, the decline in cycling in Davis is mainly attributable to a sharp increase in long distance commuting to jobs in other cities in the Sacramento and San Francisco areas. Thus, the results of comprehensive bicycle studies are mixed. However, it is widely believed that this is due to errors in sampling and comprehensive bicycle plans have an overwhelmingly positive impact on ridership. In reality, most Complete Policies do not result in comprehensive bike initiatives. In fact, often once the policy is passed it is largely forgotten about and the region sees no investment in bikeability what-so-ever.

- **Cost:** The cost of implementing a Complete Streets Program can vary widely depending on the amount of infrastructure already in place and each regions level of commitment to multimodal transportation. In 2005, the Nonmotorized Transportation Pilot Program (NMTTP) awarded \$25 million dollars to four communities for the purpose of improving their nonmotorized transit networks (McGinnis et al., 2011). These communities were four very diverse communities. Thus, it can be assumed that comprehensive bicycle plans can be implemented for about \$25 million.

As discussed in an earlier chapter, there is some concern that Complete Streets Policies contain empty rhetoric. They espouse multimodal communities, but in many cities this is not be supported by action. When projects are reviewed and funds begin to run out, multimodal considerations are often the first to be cut. Nonetheless, the Complete Streets policy is evidence of an awareness of the importance of liveable and bikeable communities in government. A Complete Streets policy could be helpful is keeping bikeability on the agenda and keeping cycling initiatives in the front of people's minds. However, it is important that people view Complete Streets Policies not as an end but as a means. They should not be viewed as evidence of bikeability in a community, but instead as a tool cycling advocates can use to implement other cycling initiatives outlined in the Bike Plan.

6.2 On-Street Facilities

Bicycle Lanes

In the United States, bicycle lanes are usually designated by a white stripe, a bicycle icon on the pavement, and signage. The lanes are on each side of the road, to the right of the motor vehicle lanes. AASHTO recommends that lanes be at least 5 feet wide.

- **Impact:** Overwhelmingly, data shows that implementation of bicycle lanes increases ridership in American cities. A Cross-Sectional study of 43 large cities in the United States revealed a positive correlation between the presence of bike paths and levels of bicycle commuting (Dill and Carr, 2003). Additionally, several stated preference surveys show a preference for bike lanes over no facilities and that bike lanes encourage more cycling (Cervero et al., 2009). Before-and-after ridership counts in several North American Cities also show an increase in the number of cyclists after the bike lanes were installed. In 2003, a bike lane was striped on Fell Street in San Francisco as part of a six-month trial. At the end of

six months, the number of cyclists on Fell Street showed an 18% increase (City of San Francisco, 2004). In Toronto, the average increase in cycling two years after installation of a bike lane was found to be 23% (City of Toronto, 2001). In Vancouver, the before and after bicycle count data is also positive. Bicycle use increased within the city, particularly along established Bike Paths. It is likely that this increase in use is due both to existing cyclists migrating to the bike routes and to new ridership from those who did not cycle before the bike lanes were established (City of Vancouver, 1999). Finally, a study of Davis, California also found a significant increase in ridership after a bicycle lane was painted onto Anderson Road. Significantly, the increase in ridership was observed not only on Anderson, but also on the surrounding streets (Federal Highway Administration, 1994).

- **Cost:** According to the Regional Bike Plan, the costs to design and install bicycle lanes will vary from \$25,000 to \$30,000 per mile. Costs will be on the higher end if installation requires grinding out old paint lines; they will be on the lower end if no grinding is required.

Buffered Bicycle Lanes

In some locations, buffers may be added to bicycle lanes to provide horizontal separation from moving or parked cars. A buffered bicycle lane is a cycle track that lies with the roadway and is separated from motor vehicle traffic by a stripe painted beyond its outer edge that indicates the beginning of the motor vehicle lane or parking area. The space that is created between the bike lane and the motor vehicle lane (which is often filled with a series of diagonal stripes) is not intended for travel by any mode, but rather exists as a buffer creating greater separation between bicycles and autos. Ideal candidates for buffered bicycle lanes are roadways with high vehicle speeds, excess capacity, and few curb cuts or turning movements.

- **Impact:** A study of Portland, Oregon showed a dramatic increase in ridership one year following the installation of buffered bike lanes. Nearly 65% of survey respondents indicated they choose to ride on the buffered bike lanes more often. Observational studies found that counts increased 77% on one street and 271% on another. Furthermore, the 77% is assumed to be understated because the locations of the before-and-after counts were not the same. Cyclists overwhelmingly agree that the addition of buffered bike lanes makes streets safer, easier and contributes to a better cycling environment. Cyclists indicated they feel lower risks of being 'doored' in the buffered bike lanes, and nearly nine in ten cyclists preferred a buffered bike lane over a standard bike lane. Two out of three motorists also agreed that they like the additional separation between cars and bicycles. However, motorists also felt that buffered bike lanes have make driving more challenging. 61% of motorists indicated that driving on these streets is less convenient, and 56% found parking more difficult (Monsere et al., 2011).
- **Cost:** The price of a buffered bike lane varies depending on the type of buffering treatments used. According to the Regional Bike Plan, a buffered bike lane consisting of a 4 foot buffer area but no flex bollards may cost approximately

\$18,000 per mile, while a buffered bike lane that utilizes flex post bollards and two feet of diagonal striping may cost approximately \$45,000 per mile. Bollards look like rigid, structural impediments, but are made of hollow plastic and bend up to 90 degrees when impacted by a vehicle, and bounce back to the upright position once pressure is removed.

Wide Shoulders

Wide, striped, and bikeable shoulders are another facility that can be considered for roads in the Plan area with higher traffic volumes and speeds. To be considered bikeable, shoulders should be at least 4 feet wide on roadways with open drainage and 5 feet wide on roadways with curb and gutter. There are two types of bikeable shoulders identified in the Plan; the difference between the two is in whether parking is allowed on the shoulder. In rural areas, no parking is allowed and shoulders should be provided as discussed above. In some areas within the City of St. Louis and other parts of the Plan area, shoulders may also function as a parking lane.

- **Impact:** While no empirical studies regarding wide shoulders were located, several stated preference surveys show that people feel safer on wide shoulders than they do when sharing vehicular lanes. Beginning cyclists in particular expressed a preference for bicycle lanes over wide shoulders. Moreover, all cyclists preferred paved to unpaved shoulders and said that the presence of pavement factored into their route choice and decision to cycle (Benekohal et al., 1997 p.139-145).
- **Costs:** The cost of paved shoulders will vary depending on whether the paved shoulder area already exists or additional pavement is required to provide the shoulder. Costs associated with enhancing an existing paved shoulder may include adding signage indicating a bicycle route and restriping. This would be similar to the costs of adding a bike lane, between \$25,000 and \$30,000 per mile. However, if the shoulder is to be added to the roadway, the cost is approximately \$2.3 million per mile, assuming earthwork, base course, pavement, landscaping, traffic maintenance, utility adjustments, and striping.

Shared Lane Markings

Shared lane markings or sharrows are street markings placed in the center of a lane to indicate that a bicyclist may use the full lane. They are typically designated by a picture of a bike under two forward facing arrows. Sharrows are generally used where there is not enough space for separate bicycle lanes and cyclists are encouraged to use the full traffic lane. These are often bus-only lanes, usually in downtown environments that also allow bicycle travel. When bus/bike-only lanes are developed, it is desirable for the lanes to be wide enough (at least 15 feet) for buses and bicyclists to pass each other comfortably in the lane.

- **Impact:** Shared Lane markings are rare in the United States, but their use is expected to increase. As a result, there were no American studies found that measured levels of cycling. However, a study in the United Kingdom found that shared bus/bike lanes were popular amongst cyclists. For a quarter of cyclists

surveyed, the lane influenced their route choice and few delays due to buses were observed (Reid and Guthrie, 2004).

- Cost: The Regional Bike Plan estimates the costs to design and install shared lane markings will vary from \$15,000 to \$20,000 per mile. Costs will be higher if the installation requires grinding out old paint lines; they will be lower if no grinding is required.

Signed Bicycle Route

Signed routes are used to form essential links in a connected bicycle network. They can be installed on arterial and local streets with relatively low traffic volumes and/or low speeds that do not need special bicycle accommodations in order to be bicycle-friendly. They can also be installed in conjunction with special bicycle facilities such as bicycle lanes and shared lane markings. Bicycle signage typically provides information on direction, destination and distance.

- Impact: No studies were found that measured change in ridership along signed bicycle routes. However, a stated preference survey from Calgary, Alberta shows that signed routes are seen as having only a small value over and above an unsigned route on the same type of facility. This survey suggests that a well-designed bicycle route that guides cyclists quickly to or along desirable facilities will have high value, but that a poorly designed bicycle route that is little more than signs and a line on a map will have low value (Abraham et al., 2002). Additionally, a survey of Texas cyclists revealed a positive correlation between cyclists' perception of the facility and the presence of signed roadways. However, the correlation was not nearly as strong as that with bike lanes (Sener et al., 2009). While the presence of bike signage does not seem to affect the revealed preference of cyclists, it is possible that a ridership count might show different results. It would take into account new cyclists who became aware of the presence of the cycling network to the presence of signage. Furthermore, strategically placed bicycle signage can be helpful in linking one bicycle route to another increasing connectivity of a bicycle network.
- Costs: Fabrication and installation of 'Share the Road' signage and markings is estimated to cost \$1,000 per mile assuming two signs per mile on each side of the road, according to the Regional Bike Plan.

St. Louis is fortunate to have noticeably wider roads than many regions on the east coast or in larger cities. As a result, lane widths are much wider than AASHTO guidelines recommend. With the implementation of road diets, the region could easily accommodate bicycle lanes. A road diet is a technique to reduce either the number of lanes or width of lanes on a road. If properly designed, traffic does not divert to other streets or cause congestion, because the road previously provided excess capacity. Road diets increase safety by decreasing incidents of speeding. Most importantly, the freed-up space allows the introduction of on-street bicycling facilities. Thus, existing road infrastructure in the St Louis region offers an opportunity to increase connectivity and safety of the bike network.

Overall, on-street bike facilities appear to be pretty effective in increasing ridership and perception of safety. Specifically, bike lanes really appeal to new and beginner cyclists. They like the security of the lines and tend to be apprehensive about sharing lanes with vehicles. Convincing new cyclists to continue cycling or cycle more regularly is the easiest way to increase ridership. Thus, bike lanes appear to be very effective in increasing ridership. Buffered bicycle lanes were received similarly and appear to cause a greater increase in ridership. However buffered bike lanes are also the most expensive on-street facilities to implement and require a lot of additional space on the road. The additional cost did not seem to justify significantly the possible increase in ridership, making buffered bicycle lanes less cost-effective than regular bicycle lanes. Looking at the studies of unmarked shoulders, it appears that if they are not very well received by beginner cyclists. If they already exist, they should be left alone or converted into bike lanes. However, shoulders shouldn't be constructed if they do not already exist. Finally, shared lane markings and signed bicycle routes seemed to be effective in instances where bicycle lanes would not be feasible. These small gestures seems to reassure cyclists. However, signed bicycle routes are much less expensive to implement than shared lanes. Perhaps, signed bicycle routes should be encouraged when bicycle lanes are not feasible.

6.3 Off Road Facilities (Physically Separated Bicycle Facilities)

Shared-Use Paths

These off-street paths are paved and separated from motor vehicle traffic. They usually accommodate two-direction bicycle traffic. According to AASHTO guidelines, the minimum recommended width is ten feet. The term trail is sometimes used for this type of facility. Shared use paths are open to multiple forms of nonmotorized transportation, including pedestrians, rollerbladers, etc. in addition to cyclists.

- **Impact:** A stated preference survey in San Diego reveals that less confident cyclists prefer separate paths to bike lanes (Jackson and Ruehr, 1998). This indicates that an off-street path might be helpful in encouraging new cyclists to get on the road. However, before-and-after counts proved to have mixed results. While one study showed a dramatic improvement in ridership following the installation of a bike path, the other was less successful. According to one study, the creation of the Orange Line Bike Path in Los Angeles in 2005 resulted in a 38% increase in the number of people cycling and using other forms of active transport both on the Bike Path and in the surrounding neighborhoods (Cohen et al., 2008). On the other hand, the installation of a bike path in Utah did not correlate with an increase in ridership. A sample of suburban residents in West Valley City was surveyed both before and after the construction of a multipurpose trail in their neighborhood using a preliminary household survey, individual activity diaries, new resident surveys, and a trail user's intercept survey. The results show that trail neighborhood residents did not use the facility after it was built nor did new residents move to the neighborhood because of the trail. In fact, the users of the trail were actually recreational cyclists who had previously cycled elsewhere and often drove to the beginning of the trail (Burbidge and Goulias, 2009).

- **Costs:** The Regional Bike Network offers a wide range of costs of the implementation of shared use paths. The Plan estimates \$86,592 per mile to rehabilitate existing paths that have fallen into disuse and \$989,875 per mile to construct new paths.

Cycle Track

Cycle tracks create a physically separated and buffered space for directional bicycle travel. They are different from shared-use paths in that they are for the exclusive use of bicyclists and are operationally related to the overall roadway. The physical separation from other vehicles on the roadway can consist of curbs, striping, bollards, flexible posts, landscaping strips, or parked vehicles. The cycle track can be at the same grade as the adjacent roadway or raised to the level of an adjacent landscaping buffer or sidewalk.

- **Impact:** Cycle tracks are common in European Cities on major streets with higher volumes of motor vehicle traffic. However, they are rare in the United States. A before-and-after study of ridership in Copenhagen showed a 20% increase in bicycle and moped traffic and a 10% decrease in vehicle traffic (Jensen, 2008a). But the study does not indicate whether the change was due to change in route choice or an actual shift by users in mode of transportation. Similarly, another study of a cycle track in London showed a 58% increase in the number of cyclists on the roadway in 3.5 years (Transport for London, 2004a).
- **Costs:** Costs for cycle tracks may vary considerably depending on whether drainage work or new signal heads are required. The cost of a one-way cycle track on both sides of the street is approximately \$670,000 per mile.

Off-Road facilities do seem to show an increase in ridership. However, off-road facilities are targeted primarily at recreational cyclists and are extremely expensive to implement. While they certainly add value to a community, they should not be considered a priority in the St. Louis Bike Plan. The costs of constructing such a path are several orders of magnitude larger than that those of building a bike lane. This enormous cost is not justifiable in the case of St. Louis.

6.4 SPOT IMPROVEMENT CONSIDERATIONS

Intersection Improvements

Intersections are the most dangerous places for cyclists. A comprehensive review of bicycle crash types in the early 1990s showed that 58% of crashes involving motor vehicles and bicycles occurred when they were crossing paths at intersections (Hunter et al., 1997). Consequently, improvements are being implemented in many cities to make intersections safer and easier for bicycles to navigate.

- **Impact:** Most intersection improvements are implemented in conjunction with the retrofitting of an existing roadway with other multimodal improvements or in the

construction of an entirely new road. As a result, it is difficult to isolate the impact of improving intersections on safety or ridership. But, while no studies were found regarding bicycle-friendly intersections, it can be assumed that they improve perception of safety and ease of cycling.

- **Cost:** The costs of designating bike lanes around intersections in the manner that aligns with MUTCD standards ranges from \$1,750 to \$7,500 per intersection according to Great Rivers Greenway. The range in price is dependant on the complexity and traffic at the intersection.

Climbing Lanes

A climbing lane is a hybrid bicycle facility that includes a 5-foot bicycle lane on the uphill direction of a roadway and a shared lane marking on the other side. This type of facility allows slower-moving, uphill bicyclists to have a designated bicycle lane while climbing, and allows motor vehicles room to pass easily. It also allows faster-moving, downhill bicyclists to have a shared lane marking, which alerts motorists to expect faster moving bicyclists in the travel lane.

- **Impact:** While no studies were found regarding bicycle-friendly intersections, it can be assumed that they improve perception of safety and increase the ease of cycling.
- **Costs:** The climbing lane is a focused directed tool, meaning that it will only be implemented in short bursts. Nonetheless, the costs to design and install bicycle lanes will vary from \$25,000 to \$30,000 per mile. If a shared lane accompanies the bike lane, this could increase the price by \$15,000 to \$20,000 per mile.

Bridge Infrastructure

Bridges help to weave regions together, providing critical links between neighborhoods and commercial centers. Oftentimes, bridges were not built to incorporate multimodal transportation and serve to as a major obstacle to connectivity. The difficulty of crossing such a bridge and the risks to safety prevent many novice cyclists from biking at all. Thus, many cities are incorporating multimodal accommodations in new and retrofitted bridges.

- **Impact:** Incorporation of bike friendly accommodations on bridges significantly increases ridership within communities by increasing regional connectivity. Annual bicycle counts on Portland's central city bridges, which connect residential neighborhoods to the city's primary commercial and employment center, show a 210% increase in bicycle trips between 1991 and 2004 (Birk et al., 2005). This dramatic increase in bicycling occurred primarily in those corridors where the city has made significant investment to: improve bicycling condition on the bridges; create connected bicycle facilities leading to the bridges; and mitigate traffic designs that are not bike friendly. The corridors where the quality of bicycle infrastructure is highest experienced the greatest growth in bicycle trips. Birk et al. believed that the city's investments in the downtown bridges have been the primary impetus behind the citywide increase in bicycle use.

- **Cost:** Due to the high costs of retrofitting bridges, the Regional Bike Plan does not estimate a price to retrofit bridges in the area. However, looking at the price of the Portland project, the city invested hundreds of thousands of dollars to retrofit each bridge.

While bridge improvements would be very helpful, they do not seem economically feasible. On the other hand, steep gradients and tricky intersections appear to be major obstacles to beginner cyclists. It would be relatively inexpensive for the region to invest in climbing lanes and spot improvements and increase the perception of safety. These spot improvements should be a top priority for the plan, because they will go a long way to increase bikeability with very little investment.

6.5 END OF TRIP FACILITIES

Bike Parking

1.5 million bicycles are reported stolen each year in the United States, and fear of bicycle theft is recognized as a significant deterrent to bicycle use. The availability of safe and convenient parking is critical to cyclists. Bike parking comes in many forms including common bike racks, sheltered racks which protect from extreme weather conditions, guarded or monitored, and bike lockers.

- **Impact:** A stated preference survey in Edmonton, Alberta showed that the provision of secure parking at a destination has a very large and significant positive effect on the attractiveness of cycling, equivalent to a reduction of 26.5 minutes cycling in mixed traffic. (Hunt and Abraham, 2007) Noland and Kunreuther (1995) also demonstrated that availability of safe bike parking at work significantly raised perception of bicycling convenience and likelihood of cycling to work. Additionally, a multivariate analysis of the UK National Travel survey in 2007 also revealed that availability of bicycle parking had significant impacts on bicycling to work. (Wardman et al., 2007) However, while outdoor bicycle parking increased ridership 5.8%, covered parking was shown to increase ridership by 6.3% and indoor parking resulted in an increase of 6.6%. Thus, improving the quality of bicycle parking only marginally affects the change in ridership.
- **Costs:** The costs of installing bike parking infrastructure vary enormously. It costs approximately \$300 to install a basic bike rack that can accommodate two bicycles. The costs of purchasing and installing bike lockers ranges from \$1000 to \$4000 for every two bicycles stored. However, the costs to provide car parking space are estimated around \$2200 to provide parking in a surface lot and \$12,500 to accommodate parking in a garage.

Showers at Workplaces

In both public and private workplaces a combination of showers, clothes storage, and/or change facilities can often be found. These facilities are usually in conjunction with bike parking facilities.

- **Impact:** The Hunt and Abraham study revealed that the provision of showers at the destination has a more modest but still significant positive effect on the attractiveness of cycling, equivalent to a reduction of 3.6 minutes cycling in mixed traffic.
- **Costs:** The costs of such a project vary widely depending on the type of facility and building in which the shower will be located. As a result, the Regional Bike Plan does not begin to estimate the costs of such a project. However, in the case do the Downtown Bicycle Station, the costs of creating a bathroom with three showers and a changing room was approximately \$12,000, according to Mike Sondag, the Senior Director of Finance and Administration of the Downtown St. Louis Partnership.

Bicycle Stations

Bicycle stations are full-service facilities offering secured, sheltered bike parking in addition to bicycle rentals, bicycle repairs, showers, accessories, bicycle washes, bicycle touring advice, etc.

- **Impact:** No studies were found that measured change in ridership following the establishment of Bicycle Stations. However, the impacts are presumably positive, because such bike stations are generally well utilized due to security, convenience, and the wide range of services offered. However, the increase in ridership probably comes from already experienced riders because use of a bicycle station typically requires a membership which new cyclists would be less likely to invest in.
- **Costs:** While the Regional Bike Plan does not estimate the costs of such a project, the Downtown St. Louis Partnership was able to give me an estimate of the costs of upkeep of the Downtown Bicycle Station, the first Bicycle Station the region. Monthly the bicycle station costs \$26,217.42 to operate. The Station estimates that it has invested \$131,000 over the course of its first year in operating costs. It is important to remember that this does not include the start-up costs of building and opening the bike station. This is a huge investment on the part of local governments, nonprofits, and private interests. To date, the station has 90 members who pay \$150 for a yearly membership. While the members benefit enormously from this service, it is still unclear how the greater St. Louis community, especially beginning or infrequent cyclists benefit from this service.

The most cost efficient form of end-of-trip facility appears to be conventional bicycle parking. More advanced forms of parking and bicycle storage may be more effective, but not so much as to justify the cost increase. Bicycle stations and showers are expensive to implement and they do not cater to new cyclists, instead to a select group of experienced cyclists. I would argue that simple bicycle racks are the most effective in increasing

ridership because they are inexpensive and easy to implement. Additionally, they can be implemented all over the region increasing access to bike parking for people everywhere regardless of how often or where they decide to cycle.

CHAPTER 7: COST EFFECTIVENESS OF EDUCATION & ENCOURAGEMENT PROGRAMS

While infrastructure programs are largely designed to get cyclists to keep cycling and to cycle more frequently, education and encouragement initiatives are designed to reach out to people who would not be otherwise be cycling. In the following section I examine studies that showed the impact of education, encouragement, and enforcement initiatives on ridership and bikeability. Unfortunately, I was unable to isolate the costs of the various initiatives. The Regional Bike Plan does not include proposed cost estimates for any of the initiatives listed below. Furthermore, it is impossible to extrapolate the projected costs of education, encouragement, or policy initiatives from other cities because they vary dramatically based on available resources, demographics, and the scope of the project desired. However, by comparing different education/encouragement plans in different cities, it is possible to compare relative costs and changes in ridership.

7.1 Education

Safe Routes to School (SR2S)

Safe Routes to School includes education, encouragement, and enforcement programs aimed at increasing the safety and number of students walking and bicycling to and from school. SR2S began in Denmark in the 1970s. Programs in the Unites States have dramatically increased in number since the early 1990s. SR2S is now funded at the federal level with nearly 45,000 schools participating by the end of 2008.

- Impact: Before-and-after studies of SR2S are rare considering the programs popularity. Existing studies show mixed results. A study in Marin County, CA found a 114% increase in the number of students bicycling to school (Staunton et al., 2003). Another study of ten California Schools observed no effects of SR2S on bicycling. However, nine of the SR2S programs focused primarily on pedestrian-specific education, and saw significant increases in foot traffic (Boarnet et al., 2005). In 2007, another study of California SR2S programs was completed. Of the four schools examined, only one showed a noticeable increase in the number of students cycling to and from school, from 23 before the project to 39 after (Orenstein et al., 2007).

Classes

This incorporates a variety of programs designed to increase bicycling skills and knowledge of bicycling laws. In the United States, the League of American Bicyclists certifies trainers for six different cycling related courses. Local governments and community organizations also offer training and education programs designed to teach both motorists and cyclists how to coexist on the roadway.

- Impact: There are few rigorous evaluations of bicycle-centric transportation classes because their impacts are difficult to measure. However, evidence shows an increase in both skills and confidence levels of cyclists. The classes are also shown to also increase perception of safety and tolerance by motorists. An evaluation of a program run by the Central Sydney Area Health Service in

Australia showed that 56% of participants were bicycling regularly more than two months after completion of the course (Telfer et al., 2006). However, it is important to keep in mind that people who take these classes do so voluntarily, meaning they were probably already planning on relying on cycling more as a means of commute.

Bicycle Maps/ Interactive Wayfinding Program

Bicycle Maps highlight the most bike friendly routes a potential cyclist can use to navigate the region. Maps can be distributed in paper form and posted online as a downloadable or printable document. Maps also serve to educate citizens about the ease of cycling and the extent of bicycle friendly infrastructure available to them.

- **Impact:** No data was available on the effectiveness of distributing multimodal maps on increasing ridership. However, it can be assumed that these maps help raise awareness of the opportunities for cycling in a community by reaching out to a broader cross section of the community. On the other hand, it is also possible that due to the vast number of advertisements presented to people each day, residents experience flyer blindness and these maps go largely ignored.

These educational programs reach a wide variety of audiences: children, people interested in cycling, and the general public. While, the classes appear to show the greatest increase in ridership, I would argue that SR2S has the greatest impact, because it reaches a more susceptible audience. People who are willing to take the time to take a class about bicycling are probably already taking the time to cycle regularly. SR2S, on the other hand, exposes people who may not have otherwise thought of using a bicycle as a means of transportation. SR2S fosters a bikeable environment from a young age when there is less of a stigma to cycling and more people are willing to bike. Furthermore, parents feel more comfortable themselves when they are confident their children know the rules of the road. They are more inclined to allow their children to cycle to nearby destinations rather than chauffeuring their kids from place to place.

7.2 Encouragement

TravelSmart

TravelSmart is a comprehensive marketing program aimed at individuals in a neighborhood, school, or worksite. Programs usually involve targeted information, events, and incentives. TravelSmart programs have been implemented throughout Australia and are increasingly prevalent in American cities. In the St. Louis Region, Trailnet has implemented a similar TravelGreen program, which promotes commuter bicycling and increases awareness of bicycling safety.

- **Impact:** Many TravelSmart programs show larger increases in walking and transit use than cycling, which are also targets of the marketing. However, all evaluations of programs in US cities found increases in the share of all daily trips made on bicycle. Washington State's King County Metro Transit's In Motion program used a comprehensive marketing approach to reduce the use of single passenger cars and encourage other forms of transportation. Program participants

in each neighborhood report increased transit ridership and use of other non-single-occupant vehicle modes, such as carpooling, biking, and walking. The pre- and post-participant reported mode shares for each In Motion program indicate a 24% to >50% decrease in driving alone and a 20% to almost 50% increase in transit use (Cooper, 2007). Additionally, SmartTrips Southeast, Portland's unique TravelSmart program, saved over 19 million vehicle miles traveled in 2007 and reduced drive alone trips by 9.4%. This is equivalent to shifting about one trip per week, per person from driving alone to another way to go such as walking, bicycling, riding transit and carpooling (Portland Office of Transportation, 2007).

Travel Awareness Programs

Travel awareness programs encompass a wide variety of programs designed to reduce driving and increase use of transit, walking, and cycling. These programs are usually implemented by local governments or community organizations.

- **Impact:** Evaluations of media campaigns tend to focus on marketing-style outcomes rather than changes in travel behavior. For example, media studies often focus on how many people have noticed a campaign or what they remember from it. Awareness of travel behavior campaigns range from 17% to 76%, but tends to concentrate between 20% and 40% (Cairns et al., 2004). Although these numbers appear significant, it is important to keep in mind that the majority of people who are aware of a campaign do not respond to it or alter their behavior accordingly. These statistics simply demonstrate awareness that a sponsoring organization believes multimodal transportation is a valuable alternative to single passenger vehicles. Only a small fraction of this number actually shifts their transportation habits in response to the campaign. Thus, the impact of travel awareness travel awareness programs on ridership appears negligible.

Bike to Work Days

Bike to Work Days (BWDs) are very popular in metropolitan areas in the United States. BWDs are promotional events that encourage commuters to try bicycling. Events usually take place over the course of a day and include free breakfasts, giveaways, contests, and other activities.

- **Impact:** Evidence shows that BWDs increase bicycling beyond the event. The number of first time riders has increased in many programs. In Seattle, the program attracted 845 new riders in 2004 and 2,474 new riders in 2008. Similarly, 433 new riders came out for Portland's BWD in 2002 and 2,869 new riders participated in the 2008 event. In San Francisco in 2008, bicycle counts at a central point doubled on BWD and remained 25% higher several weeks after the event (LAB, 2008). In Victoria, Australia, 27% of first time riders on BWD were still commuting by bicycle five months later (Rose and Marfurt, 2007). This shows that repetition of BWDs are important because the programs take time to gain traction. Furthermore, BWDs are sustainable, after a one day event, people continue to cycle on their own without added incentives.

Ciclovias

These bike events are aimed at encouraging new cyclists to rediscover the ease and fun of nonmotorized transport. Ciclovias are free mass recreational programs where streets are temporarily closed to vehicular traffic and reserved for use by rollerbladers, runners, pedestrians, and cyclists. More than 38 cities in the United States currently host such events.

- **Impact:** While ciclovias tend to be quite popular, no studies were found that separated bicycles from other forms of nonmotorized transportation. One study in Bogota, Columbia found an association between recreational riding on ciclovias and increased utilitarian cycling (Gomez et al., 2005). However, Bogota has the largest ciclovía in the world, with 123 km of streets closed to cars and over 1 million participants. This scale makes it an exceptional case. Additionally, it is possible that people who use their bicycles for utilitarian purposes are the ones who participate in the ciclovias, rather than the ciclovias encouraging utilitarian riding.

Trip Reduction Programs

Trip Reduction Programs are employer-based programs that aim to reduce vehicle travel, usually by shifting commute mode to transit, walking, or bicycling. These programs are common in the United States in metropolitan areas with high levels of congestion or problems with air quality. Programs are often mandated by law and may include promotions, financial incentives, and/or provision of facilities.

- **Impact:** Evaluations of trip reduction programs tend to focus on reductions in vehicle travel rather than increases in bicycling. However, a few studies in the United Kingdom take changes in bicycling behavior into account. When Manchester Airport implemented a Trip Reduction Program, with parking charges and improved bicycle access and facilities, the number of weekly bicycle trips to work more than tripled between 1996 and 2000 (Rye, 2002). However, a stated preference study in 2006 showed that a financial incentive greater than £2 per day was needed to significantly increase the number of bicycle commuters (Ryley, 2006). This shows that trip reduction programs can be very effective. However, they require a great deal of investment from sponsoring organizations.

Overall, encouragement programs seem to be very effective in increasing ridership. Encouragement programs are especially good at bringing new cyclists onto the road. The only exceptions to this trend are travel awareness programs, which have no measured results but are assumed to have a negligible impact. Trip Reduction Plans appear to be the most successful in increasing ridership. However, they are also presumably the most expensive to implement and require a real commitment from private companies. Ciclovias and BWDs appeared to be the most cost effective initiatives. They only require a one time investment but draw in a host of first time cyclists who continue to cycle regular months after the event. Furthermore, would presumably be even more effective if implemented together as one appeals to commuters and the other appeals to recreational cyclists.

7.3 Policy

Enforcement

Many communities use targeted enforcement to encourage motorists and cyclists to share the road safely. Enforcement increases the perception of safety in an area and spreads awareness of proper etiquette for sharing the road.

- Impact: While no data was found regarding the impact of targeted enforcement on share the road regulations, there is a wide array of studies relating enforcement and safety of bicyclists. A 2006 study shows that increases in citations issued to drivers exceeding the speed limit result in a marked decrease in both the severity and frequency of motor accidents in Fresno, California (Davis et al., 2006). A meta-analysis of 119 road safety studies also found a statistically significant decrease in traffic related injuries (Phillips et al., 2011). Thus, it follows that an increase in share-the-road regulation enforcement would result in an increased perception of cycling safety and an increase in ridership.

Helmet Laws

Helmet Laws require cyclists of all ages or of specified ages (i.e. under 18 years old) to wear helmets. In the United States helmet laws were first adopted by state and local governments as early as 1985. As of 2009, there were 22 states and at least 192 local helmet laws in the United States (Bicycle Helmet Safety Institute, 2009).

- Impact: Mandatory Helmet Laws are the subject of much debate. They have been shown to increase helmet use but also to reduce bicycling. That they can save lives and decrease the severity of bike injuries is undeniable. About two-thirds of the deaths and one-third of bike injuries involve the head and face. What is heavily contested is whether or not helmet-use decreases the number of accidents, or whether it increases them. Helmet Laws have been found to have a negative impact on public perception of safety. They serve as an inconvenience to many riders, and may actually cause an increase in collision rates (LeBlanc et al., 2002). This is because collision rates decline with increases in the numbers of people walking or bicycling because motorists appear to adjust their behavior in the presence of people walking and bicycling (Jacobsen, 2003). With fewer cyclists on the road due to restrictive helmet laws, drivers are less accustomed to accommodating multimodal transportation users and the incidence of collisions increases. Studies in Australia support this theory. They found declines in bicycle counts one year after the implementation of a helmet law of 36% in Melbourne, 36% in New South Wales, and 20% in Perth (Clarke, 2006; Robinson, 2006).

Speed Limits

Reduced speed limits for vehicle traffic are used to improve safety for cyclists and pedestrians and to improve environmental quality (e.g. reduce noise).

- Impact: Reduced speed limits for vehicles potentially increases bicycling in two ways: by increasing the speed of bicycling relative to the speed of driving, and by increasing the safety of bicycling. While no data on speed limits and ridership in

the United States was found, studies in Europe support this hypothesis. In Graz, Austria a general 30km/hr speed limit reduced bicyclist accidents by 4% (Sammer, 1997). Widespread vehicle speed limits in Hilden, Germany led to significant increases in bicycling (Bauman et al., 2008). Stated Preference Studies in the United Kingdom also show an increase in willingness of residents to bicycle in 20 mph zones (Babtie Group, 2001).

The outcome of policy initiatives has been mixed. Enforcement initiatives have been successful in creating a safe and respectful environment, which improves the cycling experience for many riders and may cause cyclists to cycle more. Helmet laws have been less successful in ameliorating the cycling experience. While they do increase the proportion of cyclists wearing helmets, the overall result is a decrease in safety and ridership. Lowering speed limits seems to be the most successful in terms of increasing ridership. However, this is rarely feasible and often met with a great deal of opposition. It is seen as a direct attack on the single passenger car, which policy makers are very reluctant to support. In the case of St Louis, enforcement should be the priority because it is shown have a positive impact and it is the most feasible to implement.

7.4 Costs of Education and Encouragement Initiatives: NMTPP Case Study

St Louis County, St Louis City, Great Rivers Greenway, and Trailnet do not have proposed cost estimates for any of the initiatives listed above. Costs of implementing education and encouragement initiatives vary dramatically based on the resources already in place, population size, size of the region, and the scope of the project desired. However, St Louis is fortunate to have a number of these initiatives already in place (See Section 2.3). It is impossible to extrapolate the projected costs of education, encouragement, or policy initiatives from other cities due to these factors. However, by comparing different education/encouragement plans in different cities, it is possible to compare relative costs and changes in ridership.

In 2005, the Nonmotorized Transportation Pilot Program (NMTPP), as part of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU), awarded \$25 million dollars to four communities: Columbia, MO; Sheboygan County, WI; Minneapolis, MN; and Marin County, CA. To evaluate the impact of the program, two community-wide surveys were conducted before (2006) and after (2010) in each of the four experimental communities. The surveys were also administered in Spokane, WA, which served as a control community. Each of the four pilot programs experienced increases in their nonmotorized mode shares. Ridership counts began in 2007 and the following table reflects the changes in bicycle use after one year in each of the pilot communities.

	Education Spending	Annual Change in Ridership
Columbia	\$3,475,080	71%
Sheboygan County	\$730,000	54%
Minneapolis	\$800,300	29.2%

Marin County	\$1,000,000	29.1%
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Cumulatively, the four cities spent approximately \$6 million on education, outreach, and marketing similar to the initiatives in the St Louis Regional Bike Plan. This is about 6% of the funds they were allocated.

Columbia, has designed the most extensive education campaign of all four pilot programs. It invested the most of their allocated funding towards educational efforts. Over the course of the 5-year implementation period, Columbia spent \$3,475,080 on educational and promotional programs. Meanwhile, Marin County, who invested the second most in marketing and education, allocated only \$1 million. Columbia saw the greatest increase in ridership. Within 1 year of the program’s implementation, 75% of survey respondents said they were aware of GetAbout Columbia’s programs. This is significant considering the bulk of proposed infrastructure projects were still in their infancy. This suggests that education and encouragement programs contribute largely to increases in mode shift.

However, it is difficult to make comparisons across these communities because they were all very different to begin with. Sheboygan and Columbia started with the least multimodal infrastructure, so it makes sense that they saw the most benefit from implementation of the plan. It is also possible that Columbia experienced a greater increase than Sheboygan because Columbia implemented more of its infrastructural projects during that first year, including 7 miles of painted bike lanes, sharrows, and three intersection improvements. These confounding factors do not altogether negate the positive correlation between investment in education/encouragement and increased ridership. The increase in mode shift indicated by the ridership counts demonstrate that more people are hearing about the benefits of the nonmotorized transit system and taking advantage of it.

Thus, there is a lot of value to investing in education/encouragement programs. It helps spread awareness of the benefits of nonmotorized transportation and the different options available to community members. Furthermore, these programs can be implemented for a fraction of the cost of infrastructure costs. The community that invested in the most comprehensive education/encouragement program spent less than a quarter of their grant on their these initiatives. Meanwhile, infrastructure initiatives were not even covered by the \$25 million grant.

CHAPTER 8: ANALYSIS

8.1 General Findings

The estimated cost of the St Louis Regional Bicycle Plan is \$75 million. This is three times the amount of funding awarded to the NMTTPP communities and it does not even take into account costs of maintaining existing infrastructure, education, or encouragement programs. Furthermore, this \$75 million figure is assumed to be a gross underestimate of the actual cost of the project. It does not take into account proposed educational or encouragement programs. Nor does it take into the costs of enormous infrastructure projects such as modifying bridges to accommodate bicycles, because it assumes these costs will be absorbed into impending retrofit projects.

The last two chapters summarized available evidence on the impacts of a wide variety of bicycling initiatives around the country, and the world. The findings were mixed and there was considerable variation in estimated impacts. A common objective of synthesizing evidence is to pool results and derive generalisable estimates of effect size. This is not feasible in this instance because the methods and conditions surrounding the studies were so heterogeneous. This poses problems for policy makers who ultimately need to know whether a particular project will lead to an increase in bicycling in order to justify the \$75 million price tag. These weak and inconclusive findings may raise some questions as to the validity of such a project.

But on the whole, the studies suggest positive impacts of interventions on bicycling levels. As noted by Ogilvie et al. (2004) in their review of pedestrian and bicycle interventions, “It is difficult to change longstanding and complex patterns of behavior, so evidence that some interventions have achieved any measurable shift is encouraging.” It is important to point out that not detecting an impact is not equivalent to lack of impact. Many of the studies measured changes in behavior after only one year. This does not leave enough time for interventions to “mature” and have an impact. Shifting transportation mode is a gradual process, and such long-term projects require some time to induce changes in travel behavior and for usage to build up. Seeing any improvement after one year is impressive and indicative of future improvement. Furthermore, many interventions were ineffective in terms of increasing bicycle ridership and safety, but successful in other terms, such as promoting public transport or walking. Thus, these results are not as discouraging as they might seem. There are many reasons why studies found negligible impacts on bicycle ridership that have more to do with a lack of substantive data and the quality of the study than an actual failure of the intervention.

8.2 Limitations

Historically, collecting transportation data has been difficult and fraught with uncertainty. Despite their increasingly recognized potential as a solution to several pressing problems, walking and cycling remain the most understudied modes of travel. This study reveals considerable variation in estimated impacts which make it difficult to generalize about the effectiveness of individual interventions or even of interventions as a whole.

8.2.1 Quantity of Available Data

The largest problem is a paucity of available data. Impacts of nonmotorized transportation interventions are difficult to demonstrate scientifically unless adequate means, resources, and time are allocated. Typically, very limited resources are allocated to data collection and evaluation of nonmotorized transportation, which is detrimental to successful scientific evaluation. Many hypothesize that this is due in part to the low levels of bicycle use. Additionally, it could be a result of a lack of awareness by policy makers of the importance and amount of funding necessary to collect useful scientific data.

As a result, I was forced to expand my search beyond peer-reviewed articles to include government-funded studies. I broadened my search to include cities outside of the United States and studies that began as much as 20 years ago, in 1992. Due to the lack of ridership counts, I was also forced to include a variety of study methodologies, including ridership counts, both stated and revealed preference, and individual- and aggregate level analyses. Despite widening my search parameters, no relevant studies were found to describe the impact of a number of educational programs and infrastructural improvements. The resulting lack of uniformity between studies makes it difficult to compare results and draw conclusions.

8.2.2 Quality

The overall quality of the studies considered varies considerably. Many of studies reviewed were not published in peer review outlets. Among other issues, this suggests that these studies have not been prepared to meet the levels of research quality expected in peer reviewed journals. Furthermore, many of the studies have a tone of advocacy to their analysis and findings. Other sources included: census data, metropolitan travel surveys, facility specific surveys and counts, and national surveys by the Bureau of Transportation Statistics.

Moreover, many studies lump together walking and bicycling under the heading nonmotorized transportation. This thesis focuses primarily on bike-use, and uses bike-specific data where available. Pedestrian studies confound data significantly because all trips require some pedestrian travel considering they all begin and end with a walking trip. As a result, a majority of the population identifies as pedestrians, whereas cyclists tend to comprise a much smaller portion of the population.

Furthermore, while ridership counts are helpful because of their widespread use, relying solely on ridership counts as a measure of the effectiveness of a bicycle facility may lead to inaccurate conclusions. A facility may see increased use overall, but this may not reflect whether those riders are new riders who would not have biked without the facility, or whether those riders are riders who would have used another route in the facilities absence. It is therefore ideal to use ridership counts in conjunction with stated preference surveys.

8.2.3 Search Parameters

The search was expanded to include cities from all over the world. These cities were of varying sizes, geography, populations, and existing infrastructure. This heterogeneity makes it impossible to make comparisons due to the presence of so many confounding factors. This is especially apparent in the NMTTP study. In cities like Columbia, MO which had negligible amounts of cycling Infrastructure and nonmotorized transportation use prior to the implementation of GetAbout Columbia, experienced monumental increases in ridership. Minneapolis, on the other hand, experienced the lowest increases in ridership. This could be attributed to the significant amount of bike friendly infrastructure already in place and the fact that Minneapolis experienced the highest share of non-vehicular commuting, prior to the implementation of the NMTTP. Because all cities have different cycling cultures and levels of bike friendly infrastructure, it is difficult to compare impacts of bike friendly programs in different cities. This is especially true of foreign cities where attitudes are much more receptive to cycling as an accepted mode of transportation.

Geography and population density also play a role. It is difficult to compare ridership in a hilly city like San Francisco with a relatively flat one like Minneapolis. Similarly, comparing a city with a dense population like Minneapolis where everything is within biking distance with Sheboygan County, WI where people are much more widely dispersed, and therefore dependant on their cars, can be complicated.

Finally, timing plays a critical role affecting ridership statistics. An increase in ridership that correlates with the implementation of bike friendly programs does not necessarily imply causation. Because studies were examined from relatively wide period of 20 years, external factors may have also affected nonmotorized transit use, like changing gas prices, an ever-changing economy, congestion, concern over global warming and other environmental issues, etc. If any of these factors changed between baseline and bookend surveys, they could influence changes in ridership.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

9.1 The Importance of Momentum

The purpose of this thesis was to discuss strategies of increasing “bikeability” in terms of the St Louis Regional Bike Plan. The number one obstacle to the implementation of most bicycle plans is that the plans never gain momentum and policy makers lose interest in the projects. After looking at the St Louis Bike Plan, I have identified 4 methods of maintaining momentum.

The first is to propose ambitious goals. As discussed in Chapter 5, the regional bike plan sets out incredibly lofty goals. The plan strives to build a 1,000 mile bicycle network, cut the bicycle crash rate in half, and increase ridership. These ambitious goals show policy makers how much potential their communities have, and how bike plans represent a real opportunity to make a significant, noticeable change in their community. This is incredibly attractive to policy makers because they can cite their support of these plans in election years or when vying for a promotion.

It is important to establish quick wins in implementing the plan in order to demonstrate immediate progress and build momentum. These wins will be the ‘low hanging fruit’, or the most cost-effective, easy to implement initiatives. These can be accomplished both by relying on opportunities in the community and by implementing initiatives that help overcome common obstacles to cycling.

Third, policy plays a critical, and often undervalued, role in maintaining momentum of bicycling plans. It is critical for accruing funding, encouraging collaboration, and ensuring follow through.

Finally, the single most significant finding in this thesis is the need for better bicycling studies. It is critical that bicycle plans devote sufficient resources to evaluation of initiatives and changes in ridership over the course of project.

9.2 Obstacles to Cycling

Based on the major obstacles to cycling discussed in Chapter 4, I recommend an emphasis on connectivity, safety, and education about the alternatives to automobility in prioritizing bike initiatives.

Connectivity

It is important that bike facilities that connect people to popular destinations be favored. On-Street facilities should be implemented on roads that will improve access to employment centers, retail centers, transit, schools, and parks. Furthermore, the primary focus should be on arterials and collector roadways, which tend to provide the most direct access to destinations.

Many dangerous intersections in the Regional Bike Plan serve to divide existing and planned bicycle routes. Spot improvements at these intersections will greatly improve the continuity of the regional bike network. These spots should be prioritized, especially if

they are in close proximity to major cycling destinations. Additionally, these spot improvements will go a long way to improve the safety of the bicycle network.

Spot improvements on bridges and interjurisdictional connectivity are also very effective in improving bikeability. However, they are too difficult to implement and thus do not qualify as ‘low hanging fruit’. But if their implementation ever became feasible, the opportunity should be seized.

Spot improvements on bridges can be incredibly expensive, often times involving bicycle tracks separate from the motor vehicle traffic which is expensive in and of itself. Many of the regions bridges were build more than fifty years ago and are due to be rehabilitated or replaced. This will provide an inexpensive opportunity to improve and expand bicycle access to and across bridges and improve regional continuity.

Many points of the bicycle facility network connect dangling nodes by connecting adjacent communities and municipalities. This would be especially beneficial in the completing Great River Greenway’s River Ring Trail and creating one long connected trail throughout the region. However, these are difficult to implement because it requires coordination between the different municipalities.

Safety

Bicycle lanes and intersections will also go a long way to increase the perception of safety in the region. This is especially true if these facilities reflect existing roadway traffic conditions, including traffic volume, speed, and roadway capacity.

Traffic calming may also be considered as a way to improve the bicycling environment by reducing motorized vehicle speeds. This entails lowering speed limits, speed bumps, or narrowing vehicle lanes. However, these methods are often met with resistance because they are seen as an attack on the automobile and our autocratic culture.

Education

Education is a powerful tool in helping people escape their autocratic culture. It shows people that cycling is a viable alternative and highlights all of the infrastructure improvements available to them. It removes the stigma to cycling by creating a culture of cyclists who know the rules of the road and drivers with a better understanding of cyclists. Furthermore, the St Louis Region is already host to a number of education programs. Thus, the costs of enhancing and expanding them will be minimal.

9.3 Opportunity

The City of St Louis is also very fortunate to have certain unique opportunities to enhance bikeability in the region. It is important to emphasize these opportunities in prioritizing initiatives in the Regional Bike Plan.

Road Diets

Typically, space is a scarce urban resource with motor vehicles, transit, parked cars, sidewalks, landscaping, and bicycle facilities competing against one another. Fortunately,

many of the streets in the St. Louis Region do not have this problem. The 2010 Census shows population decreases in the region as well as a decrease in vehicle miles traveled nationally. The result is that many roadways have excess roadway capacity. The result is arguably the most significant opportunity for increasing bikeability in the region. This excess space can more easily be reallocated to on-road facilities, like bike lanes.

A typical road diet technique is to reduce the number of lanes on a roadway cross-section. If properly designed, traffic does not divert to other streets road after a road diet, because the road previously provided excessive capacity. However, St. Louis roads are so wide that often all that is required is narrowing of the existing lanes. Proponents of road diets generally believe key benefits include lower vehicular speeds, reduced crash rates, and improved pedestrian and cyclist safety. Other benefits of road diets include promoting better land use, promoting greater driving attentiveness, and of course, increased bikeability through the addition of bicycle lanes.

9.4 Role of Policy

Without underlying policy measures, the majority of the plan would be impossible to implement. Policy initiatives overcome many of the main obstacles to bikeability, particularly funding and collaboration. The Regional Bike Plan identifies new and creative ways to fund multimodal transportation projects. Additionally, policy initiatives focus largely on increasing interagency cooperation. This is accomplished by the appointment of a Great Rivers Greenway to oversee the implementation of the plan and encourage collaboration between groups. The Plan also appoints an individual within Great Rivers Greenway to coordinate cooperation and ensure implementation of the plan. This creates a sense of ownership in the responsible parties and ensures that the plan always has an advocate and remains a priority.

The policy section also identifies ways to remain a priority in the eyes of public officials. It seeks to create a sense of ownership of the plan by identifying important individuals within each government agency or organization to take responsibility for keeping the plan top of mind when drafting new transportation projects. Furthermore, the plan seeks to stay relevant by creating a checklist for organizations so that groups know what is being asked of them and exercise follow through. Thus, a strong emphasis on policy initiatives is critical to the success of the rest of the plan.

9.5 Need for Adequate Data Collection

The single most significant finding in this thesis is the need for better bicycling studies. The effectiveness of bicycling interventions is difficult to measure scientifically unless adequate means, resources, and time are allocated. Studies on the effectiveness of different interventions are inconsistent and often unclear. We lack good evidence on which interventions are likely to be effective in promoting an increase in bicycle use.

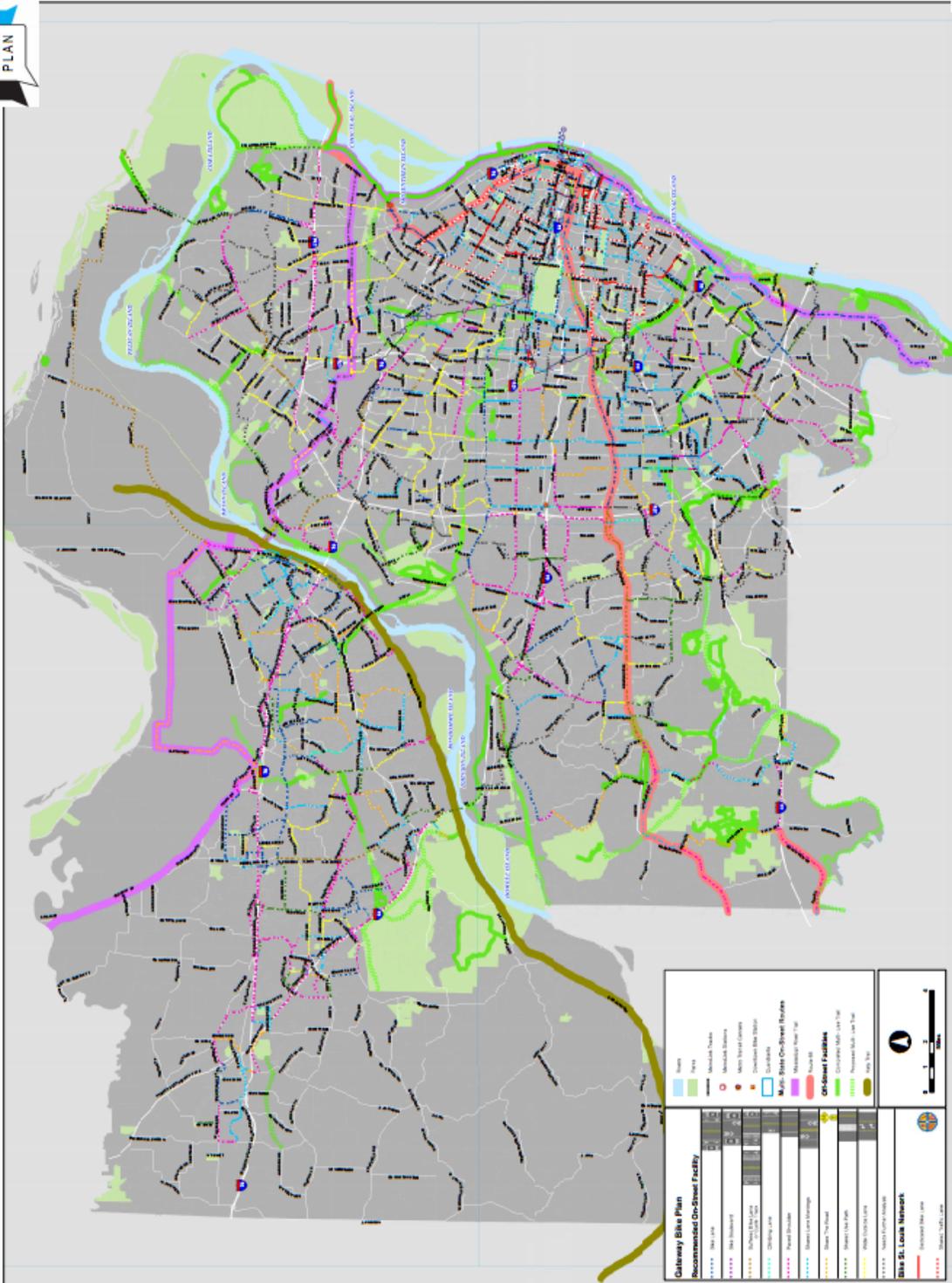
This is because many of the studies lack an ideal research design for evaluating interventions. This would involve before-and-after measurements of a treatment and a control group. This would address the question of causality, such as whether bicycling infrastructure actually led to increased levels of bicycling. Without a similar experimental

design, it is difficult to control for other relevant factors like cost and convenience of car use, income levels, city planning, and any other factors that might affect bicycling levels other than pro-bicycle policies.

Unfortunately, political and administrative considerations in the planning stage of a bicycle plan rarely underscore the importance of scientific evaluation. In the case of St. Louis, the bike plan is still in its infancy, and a robust comprehensive evaluation can still be incorporated. This should be a top priority for the bicycle plan because a properly conducted study has the potential to increase ridership in communities across the country when they learn from the successes and failures of the St. Louis bike plan.

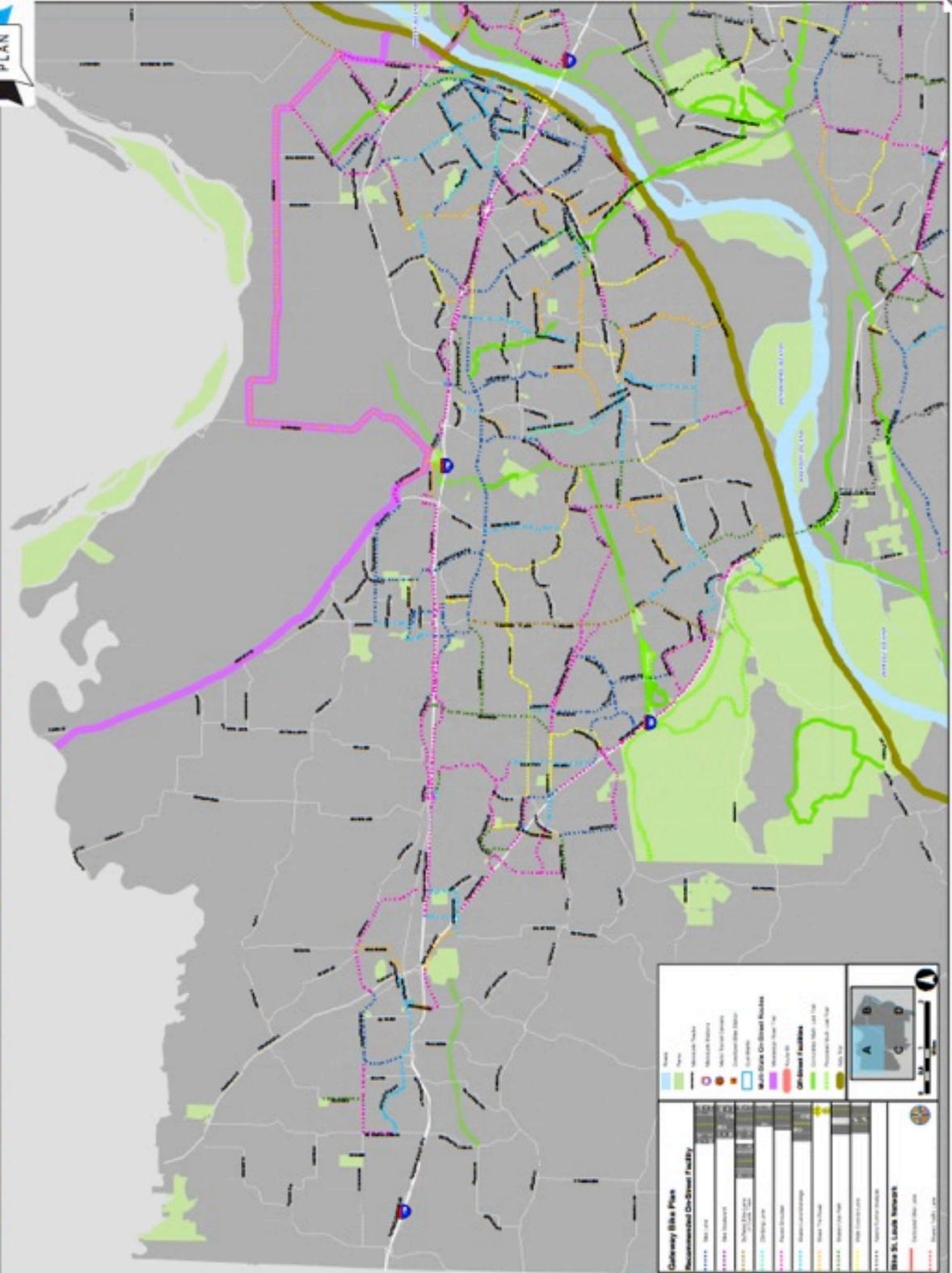
APPENDIX: MAPS OF REGIONAL BIKE NETWORK

CONNECTING COMMUNITIES ACROSS THE ST. LOUIS REGION



MAP 1: OVERALL NETWORK

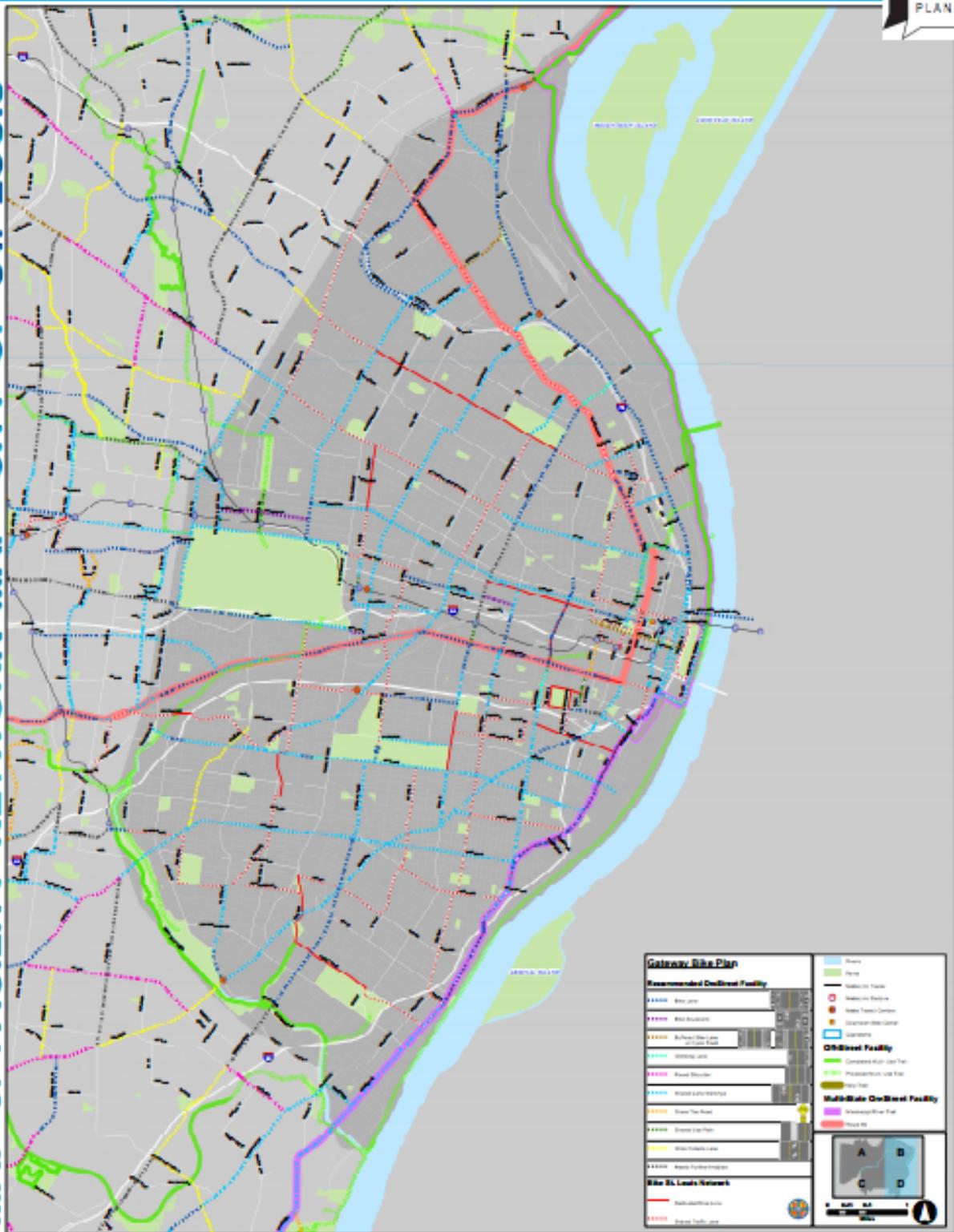
CONNECTING COMMUNITIES ACROSS THE ST. LOUIS REGION



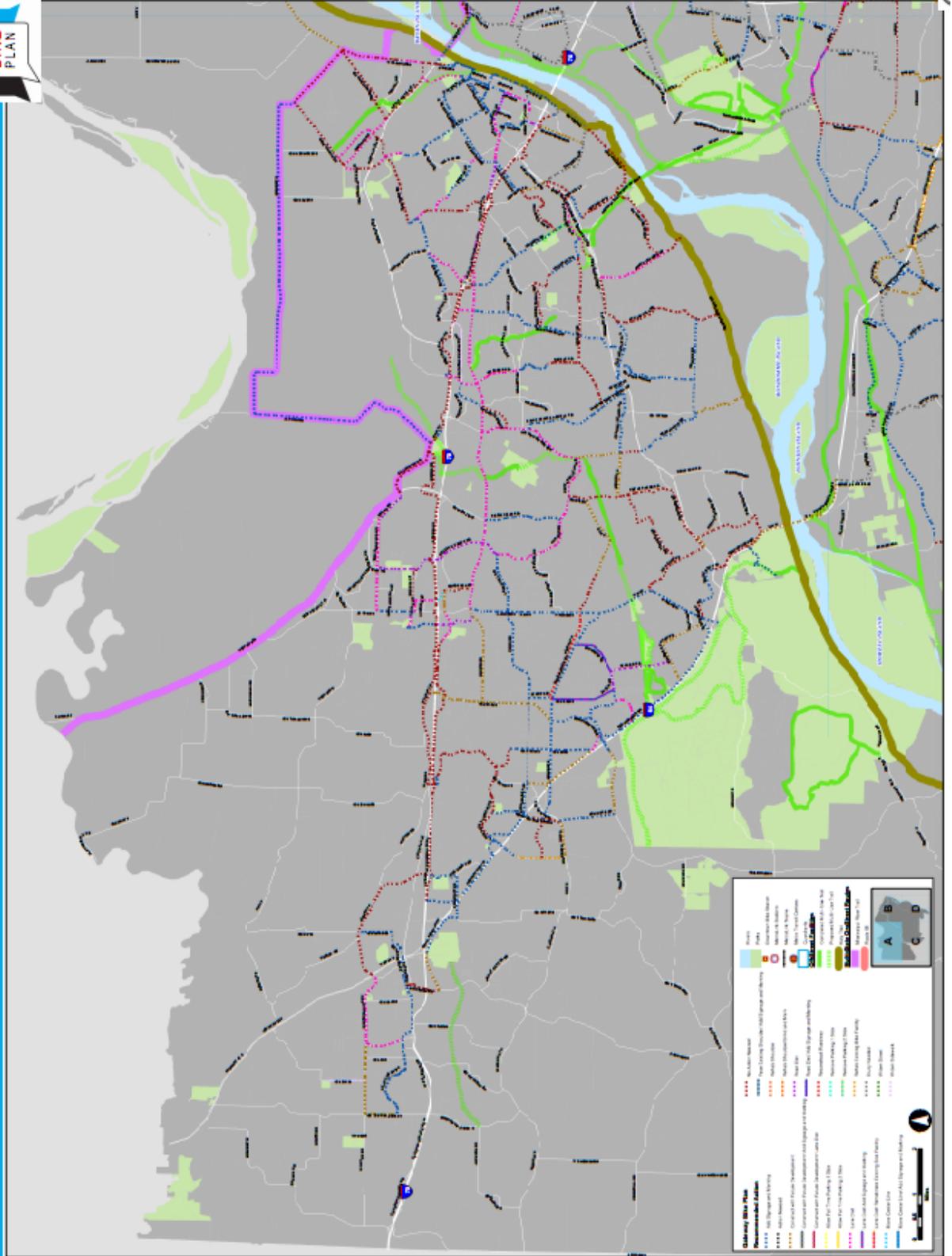
MAP 2: FACILITY NETWORK MAP AREA A

Greater Bike Plan	
Recommended On-Street Facility	2015-2020
2015-2020	2020-2025
2025-2030	2030-2035
2035-2040	2040-2045
2045-2050	2050-2055
2055-2060	2060-2065
2065-2070	2070-2075
2075-2080	2080-2085
2085-2090	2090-2095
2095-2100	2100-2105
2105-2110	2110-2115
2115-2120	2120-2125
2125-2130	2130-2135
2135-2140	2140-2145
2145-2150	2150-2155
2155-2160	2160-2165
2165-2170	2170-2175
2175-2180	2180-2185
2185-2190	2190-2195
2195-2200	2200-2205
2205-2210	2210-2215
2215-2220	2220-2225
2225-2230	2230-2235
2235-2240	2240-2245
2245-2250	2250-2255
2255-2260	2260-2265
2265-2270	2270-2275
2275-2280	2280-2285
2285-2290	2290-2295
2295-2300	2300-2305
2305-2310	2310-2315
2315-2320	2320-2325
2325-2330	2330-2335
2335-2340	2340-2345
2345-2350	2350-2355
2355-2360	2360-2365
2365-2370	2370-2375
2375-2380	2380-2385
2385-2390	2390-2395
2395-2400	2400-2405
2405-2410	2410-2415
2415-2420	2420-2425
2425-2430	2430-2435
2435-2440	2440-2445
2445-2450	2450-2455
2455-2460	2460-2465
2465-2470	2470-2475
2475-2480	2480-2485
2485-2490	2490-2495
2495-2500	2500-2505
2505-2510	2510-2515
2515-2520	2520-2525
2525-2530	2530-2535
2535-2540	2540-2545
2545-2550	2550-2555
2555-2560	2560-2565
2565-2570	2570-2575
2575-2580	2580-2585
2585-2590	2590-2595
2595-2600	2600-2605
2605-2610	2610-2615
2615-2620	2620-2625
2625-2630	2630-2635
2635-2640	2640-2645
2645-2650	2650-2655
2655-2660	2660-2665
2665-2670	2670-2675
2675-2680	2680-2685
2685-2690	2690-2695
2695-2700	2700-2705
2705-2710	2710-2715
2715-2720	2720-2725
2725-2730	2730-2735
2735-2740	2740-2745
2745-2750	2750-2755
2755-2760	2760-2765
2765-2770	2770-2775
2775-2780	2780-2785
2785-2790	2790-2795
2795-2800	2800-2805
2805-2810	2810-2815
2815-2820	2820-2825
2825-2830	2830-2835
2835-2840	2840-2845
2845-2850	2850-2855
2855-2860	2860-2865
2865-2870	2870-2875
2875-2880	2880-2885
2885-2890	2890-2895
2895-2900	2900-2905
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2945-2950	2950-2955
2955-2960	2960-2965
2965-2970	2970-2975
2975-2980	2980-2985
2985-2990	2990-2995
2995-3000	3000-3005
3005-3010	3010-3015
3015-3020	3020-3025
3025-3030	3030-3035
3035-3040	3040-3045
3045-3050	3050-3055
3055-3060	3060-3065
3065-3070	3070-3075
3075-3080	3080-3085
3085-3090	3090-3095
3095-3100	3100-3105
3105-3110	3110-3115
3115-3120	3120-3125
3125-3130	3130-3135
3135-3140	3140-3145
3145-3150	3150-3155
3155-3160	3160-3165
3165-3170	3170-3175
3175-3180	3180-3185
3185-3190	3190-3195
3195-3200	3200-3205
3205-3210	3210-3215
3215-3220	3220-3225
3225-3230	3230-3235
3235-3240	3240-3245
3245-3250	3250-3255
3255-3260	3260-3265
3265-3270	3270-3275
3275-3280	3280-3285
3285-3290	3290-3295
3295-3300	3300-3305
3305-3310	3310-3315
3315-3320	3320-3325
3325-3330	3330-3335
3335-3340	3340-3345
3345-3350	3350-3355
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3365-3370	3370-3375
3375-3380	3380-3385
3385-3390	3390-3395
3395-3400	3400-3405
3405-3410	3410-3415
3415-3420	3420-3425
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3595-3600	3600-3605
3605-3610	3610-3615
3615-3620	3620-3625
3625-3630	3630-3635
3635-3640	3640-3645
3645-3650	3650-3655
3655-3660	3660-3665
3665-3670	3670-3675
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3935-3940	3940-3945
3945-3950	3950-3955
3955-3960	3960-3965
3965-3970	3970-3975
3975-3980	3980-3985
3985-3990	3990-3995
3995-4000	4000-4005

MAP 6: FACILITY NETWORK MAP- CITY OF ST. LOUIS

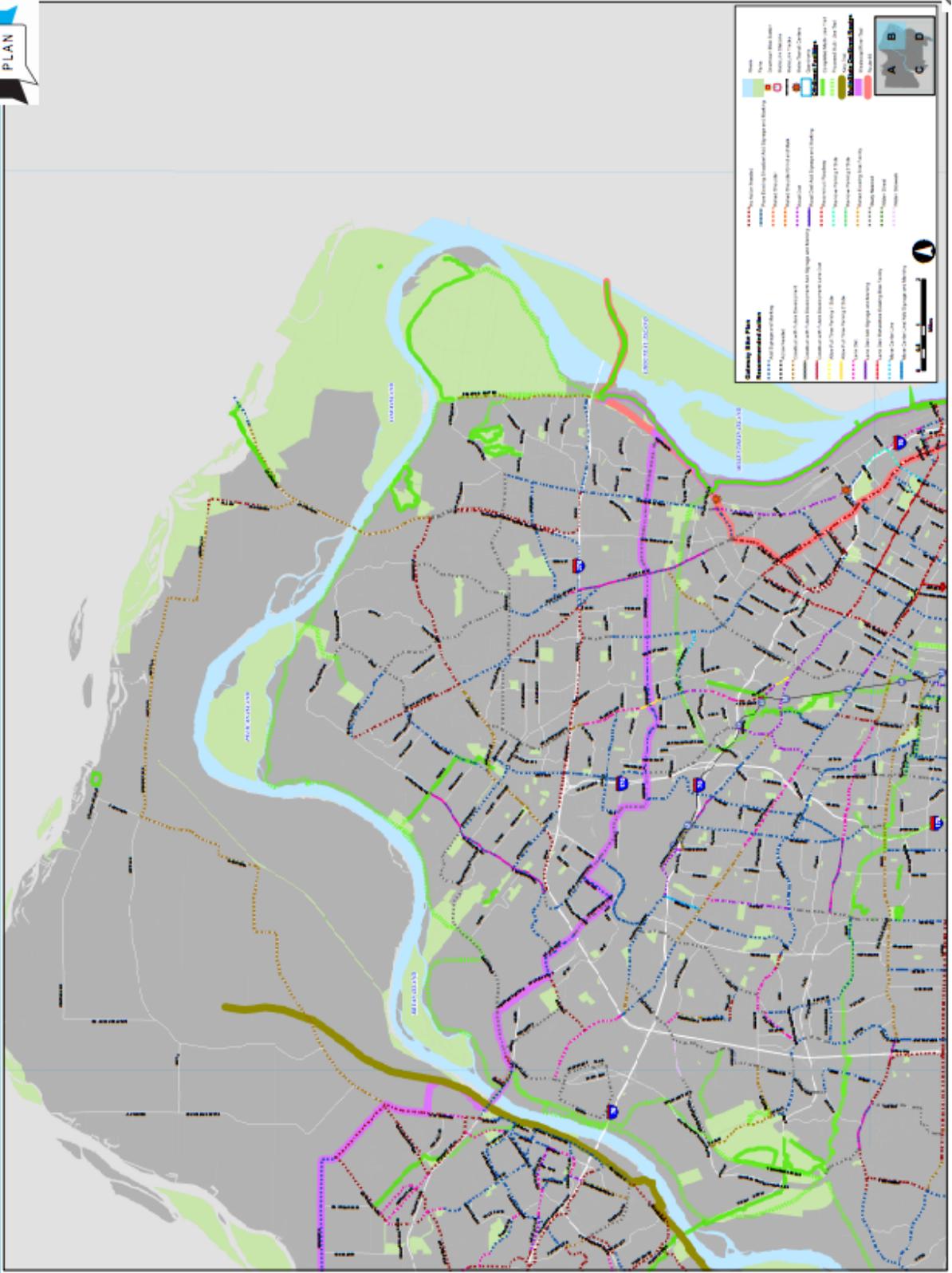


CONNECTING COMMUNITIES ACROSS THE ST. LOUIS REGION



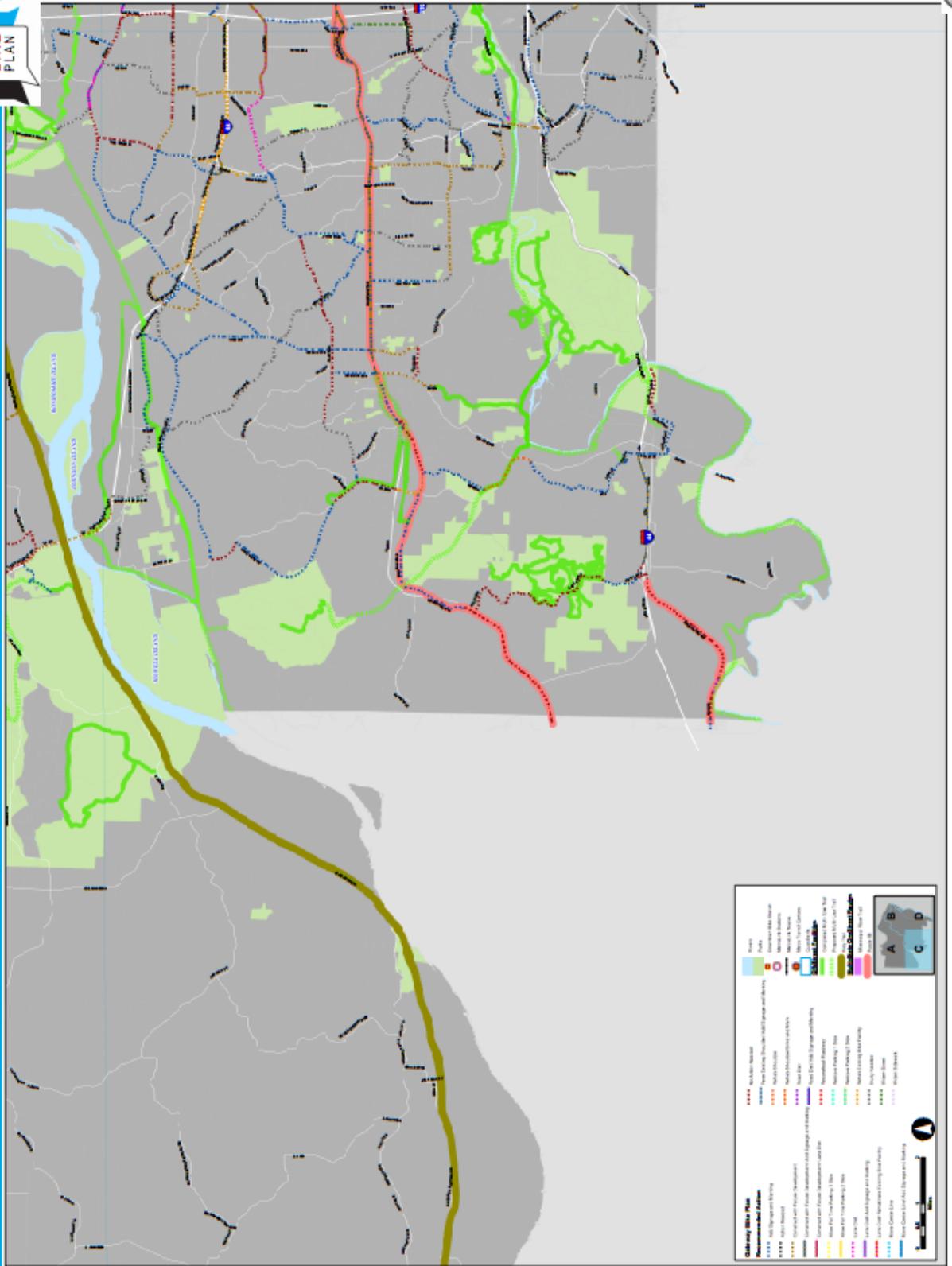
MAP 7: IMPLEMENTATION MAP A

CONNECTING COMMUNITIES ACROSS THE ST. LOUIS REGION



MAP 8: IMPLEMENTATION ACTION MAP B

CONNECTING COMMUNITIES ACROSS THE ST. LOUIS REGION



MAP 9: IMPLEMENTATION MAP C

Works Cited and Selected Bibliography

- Abraham, John E et al. "Investigation of Cycling Sensitivities Authors." *Transportation Research Board Annual Conference* (2002): 2-12.
<http://people.ucalgary.ca/~jabraham/Papers/calgarybike/CalgaryBike.pdf>
- Babtie Group, 2001. Urban Street Activity in 20 mph Zones: Final report. Department for Transport, Local Government and the Regions, London.
- Bauman, A., Rissel, C., Garrard, J., Kerr, I., Speidel, R., Fishman, E., 2008. Getting Australia moving: Barriers, facilitators and interventions to get more Australians physically. Australian Transport Research Forum. S122.
- Benekohal, R F, American Society of Civil Engineers. Urban Transportation Division, and American Society of Civil Engineers. Highway Division. 1997. Traffic Congestion and Traffic Safety in the 21st Century: challenges, innovations, and opportunities, Chicago Illinois, June 8-11, 1997: proceedings of the conference sponsored by Urban Transportation Division, ASCE, Highway Division, ASCE. In New York, N.Y.: American Society of Civil Engineers.
- Buehler, T., Handy, S., 2008. Fifty years of bicycle policy in Davis, CA. *Transportation Research Record*. 2074, 52–57.
- Birk, Mia, Roger, Geller. "Bridging the Gaps: How the Quality and Quantity of a Connected Bikeway Network Correlates with Bike Use." *Alta Planning + Design* 503 (2005): n. pag.
- Boarnet, Marlon G, Craig L Anderson, Kristen Day, Tracy McMillan, and Mariela Alfonso. 2005. "Evaluation of the California Safe Routes to School legislation: urban form changes and children's active transportation to school." *American journal of preventive medicine* 28 (2 Suppl 2) (March): 134-40.
<http://www.ncbi.nlm.nih.gov/pubmed/15694521>.
- Burbidge, S.K., Goulias, K.G., 2009, in press. Evaluating the impact of neighborhood trail development on active trail behavior and overall physical activity among suburban residents. *Transportation Research Record*.
- Brownson, R. C., J. J. Chang, A. A. Eyler, B. E. Ainsworth, K. A. Kirtland, B. E. Saelens, and J. F. Sallis. 2004. "Measuring the Environment for Friendliness Toward Physical Activity: A Comparison of the Reliability of 3 Questionnaires." *American Journal of Public Health* 94 (3) (March 1): 473-483.
<http://ajph.aphapublications.org/cgi/content/full/94/3/473>.
- Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A., Goodwin, P., 2004. Smarter choices – Changing the way we travel. UCL, Transport for Quality of Life, The Robert Gordon University and Eco-Logica. Final report to the Department for Transport, London, UK.
- Census Bureau Home Page. 30 Mar. 2005. Web. 26 Feb. 2011.
<http://www.census.gov/PressRelease/www/releases/archives/american_community_survey_acs/004489.html>.
- Cervero, Robert et al. "Influences of Built Environments on Walking and Cycling: Lessons from Bogotá." *International Journal of Sustainable Transportation* 3 (2009): 203-226.
- City of San Francisco, 2004. Fell Street Bike Lane (Scott to Baker) and Tow-Away Zone Proposal. City of San Francisco, San Francisco, CA. Accessible at:

- http://www.sfmta.com/cms/uploadedfiles/dpt/bike/rewrite%20of%20memo%20for%20website%2011_22_04.pdf
- City of Toronto, 2001. City of Toronto bike plan: Shifting gears. Toronto, Ontario
- City of Vancouver, 1999. 1999 bicycle plan: Reviewing the past, planning the future. City of Vancouver, Engineering Services, Vancouver, BC.
- Clarke, C., 2006. The case against bicycle helmets and legislation. *World Transport Policy and Practice*. 12 (2), 6–16.
- Clean Air Partnership, “Bike Lanes, On-Street Parking and Business: A study of Bloor Street in Toronto’s Annex Neighborhood,” February 2009.
<http://www.cleanairpartnership.org/pdf/bike-lanesparking.pdf>
- Cohen, D., Sehgal, A., Williamson, S., et al., 2008. Impact of a new bicycle path on physical activity. *Prev. Med.* 46, 80–81.
- Cooper, C., 2007. Successfully changing individual travel behavior: Applying community-based social marketing to travel choice. 86th Annual Meeting of the Transportation Research Board. Transportation Research Board, Washington, DC.
- Davis, James W, Lynn D Bennink, David R Pepper, Steven N Parks, Deborah M Lemaster, and Ricard N Townsend. 2006. “Aggressive Traffic Enforcement: A Simple and Effective Injury Prevention Program.” *The Journal of Trauma and Acute Care Surgery* 60 (5).
http://journals.lww.com/jtrauma/Fulltext/2006/05000/Aggressive_Traffic_Enforcement_A_Simple_and.7.aspx.
- de Hartog JJ, Boogaard H, Nijland H, Hoek G, 2010 Do the Health Benefits of Cycling Outweigh the Risks?. *Environmental Health Perspectives* 118(8)
- Dill, Jennifer, Carr, T. 2003. “Bicycle commuting and facilities in major US cities: If you build them, commuters will use them.” *Transportation Research Record* (1828)
- Drammen, Emily, “Economic Effects of Traffic Calming on Urban Small Businesses,” Department of Public Administration, San Francisco State University, December, 2003
- Environmental Protection Agency, “Highway Research & Statistics.” 2012
<http://www.epa.gov/airscience/quick-finder/roadway.htm>
- Federal Highway Administration, 1994. A compendium of available bicycle and pedestrian trip generation data in the United States. US Department of Transportation, Washington, DC.
- Frank, Lawrence, Martin Andresen, and Thomas Schmid. “Obesity Relationships with Community Design, Physical Activity, and Time Spent in Cars.” *American Journal of Preventative Medicine*. 2004.
- Furness, Zack. 2010. *One less car: bicycling and the politics of automobility*. Philadelphia: Temple University.
- "Gateway Bike Plan." *Gateway Bike Plan*. Great Rivers Greenway, Sept. 2011. Web. 8 Jan. 2012. <<http://stlbikeplan.com/>>.
- Garrett-peltier, Heidi, and Heidi Garrett-peltier. 2011. “Pedestrian and Bicycle Infrastructure: A National Study of Employment Impacts.” Political Economy Research Institute.
- Gomez, L., Sarmiento, O., Lucimi, D., Espinosa, G., Forero, R., Bauman, A., 2005. Prevalence and factors associated with walking and bicycling for transport among

- young adults in two low-income localities of Bogotá, Colombia. *Journal of Physical Activity and Health*. 2, 445–449.
- Great Rivers Greenway and City of St. Louis. 2008. “Bike St Louis”. *Studio 2108 LLC*. <http://www.bikestlouis.org/>.
- Hunt, J.D., Abraham, J.E., 2007. Influences on bicycle use. *Transportation* 34, 453–470
- Hunter, W.W., W.E. Pein, and J.C. Stutts. *Bicycle Crash Types: A 1990’s Informational Guide*, FHWA-RD-96-104, Federal Highway Administration, Washington, DC, April 1997.
- INRIX, “National Traffic Scorecard.” 2012
<http://scorecard.inrix.com/scorecard/summary.asp>
- Jackson, M.E., Ruehr, E.O., 1998. Let the people be heard: San Diego County bicycle use and attitude survey. *Transportation Research Record*. 1636, 8–12
- Jacobsen, P L. 2003. “Safety in numbers: more walkers and bicyclists, safer walking and bicycling.” *Injury Prevention* 9: 205-209.
- Jensen, S.U., 2008a. Bicycle tracks and lanes: A before-after study. 87th Annual Meeting of the Transportation Research Board. Transportation Research Board, Washington, DC.
- Komanoff, Charles and Roelofs, Cora, *The Environmental Benefits of Bicycling and Walking*, National Bicycling and Walking Study Case Study No. 15, USDOT, January 1993, FHWA-PD-93-015
- Krizek, Kevin J, Susan Handy, and Ann Forsyth. “Explaining changes in walking and bicycling behavior: challenges for transportation research.” *Environment and Planning* 36 (2009): 725-741.
- Krizek, Kevin J, and Rio, Roland W. 2005. “What is at the end of the road? Understanding discontinuities of on-street bicycle lanes in urban settings.” *Design* 10: 55-68.
- League of American Bicyclists. “Bicycle Friendly Community.” Web. 15 Nov. 2011.
<<http://www.bikeleague.org/programs/bicyclefriendlyamerica/communities/>>
- League of American Bicyclists, 2008. *Bike to Work events in selected US Cities*. League of American Bicyclists. Washington, DC.
- LeBlanc JC, Beattie TL, Culligan C 2002 Effect of legislation on the use of bicycle helmets. *Canadian Medical Association Journal* 166:592–595
- Lindsey et al, “Property Values, Recreation Values, and Urban Greenways,” *Journal of Park and Recreation Administration*, V22(3) pp.69-90.
<http://www.sagamorepub.com/ebooks/jprabackissues/jpra223555/Article5.pdf>
- Litman, Todd. *Whose Roads? Defining Bicyclists’ and Pedestrians’ Right to Use Public Roadways* (Victoria, BC: VTPI, November 2004), p. 6. Print.
- Litman, Todd. 2010. “Quantifying the Benefits of Nonmotorized Transportation For Achieving Mobility Management Objectives by.” *Transportation Research Record*: 134-140.
- Mapes, Jeff. *Pedaling Revolution*. 2nd ed. Corvallis, OR: Oregon State University Press, 2009. Print.
- Mcginnis, Laurie, Kevin J Krizek, Thomas Götschi, and Jan Lucke. 2011. “Nonmotorized Transportation Pilot Program Evaluation Study.” *Security* (May).

- Monsere, Christopher, Nathan Mcneil, and Jennifer Dill. *Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes*. City of Portland, 2011.
- Myers J, Kaykha A, George S, et al. Fitness versus physical activity patterns in predicting mortality in men. *Am J Med* 2004;117:912-8.
- National Complete Streets Coalition. "Complete Streets Policy." 2011. Web. 12 Nov. 2011. <http://www.completestreets.org/>
- Noland, R., Kunreuther, H., 1995. Short-run and long-run policies for increasing bicycle transportation for daily commuter trips. *Transportation Policy* 2 (1), 67–79.
- Ogilvie, David et al. "Promoting walking and cycling as an alternative to using cars: systematic review." *British Medical Journal* 329 (2004): n. pag.
- Orenstein, M.R., Gutierrez, N., Rice, T.M., Cooper, J.F., Ragland, D.R., 2007. Safe Routes to School safety and mobility analysis. Traffic Safety Center, University of California at Berkeley.
- Outdoor Industry Foundation, "The Active Outdoor Recreation Economy," 2006. http://www.imba.com/resources/science/outdoor_industry_bike.pdf
- Overview, Study. 2011. "Nonmotorized Transportation Pilot Program Community-Wide Evaluation Study." *October*.
- "Overweight and Obesity Trends." Center for Disease Control and Prevention. Web. 15 Nov. 2011. <http://www.cdc.gov/obesity/data/trends.html>
- Phillips, Ross O, Pål Ulleberg, and Truls Vaa. "Meta-analysis of the effect of road safety campaigns on accidents." *Accident Analysis and Prevention* 43.3 (2011): 1204-1218.
- Physical Activity for Adults*. Center for Disease Control and Prevention, 30 Mar. 2011. Web. 8 Feb. 2012. <http://www.cdc.gov/physicalactivity/everyone/guidelines/index.html>.
- Portland Office of Transportation, 2007. SmartTrips Southeast Final Report. City of Portland, Portland, OR
- Pucher, John and Buehler, Ralph. 2006. "Why Canadians cycle more than Americans: A comparative analysis of bicycling trends and policies." *Transport Policy* 13: 265-279.
- Pucher, John, Jennifer Dill, and Susan Handy. "Infrastructure, programs , and policies to increase bicycling: An international review." *Preventive Medicine* 50 (2010): S106-S125.
- Reid, S., Guthrie, N., 2004. Report 610: Cycling in bus lanes. Transport Research Laboratory, London.
- Robinson, D.L., 2006. No clear evidence from countries that have enforced the wearing of helmets. *British Medical Journal* 332, 722–725.
- Rollin, Stanley (Director of Planning & Urban Design). 2007. *City of St. Louis's Bicycle Friendly Community application*. Administrator.
- Rose, G., Marfurt, H., 2007. Travel behaviour change impacts of a major ride to work day event. *Transportation Record Part A* 41, 351–364.
- Roskowski, M., Ratzel, M., 2008. How to be like Boulder. The Bike/Ped Professional Newsletter of the Association of Pedestrian and Bicycle Professionals 2, 4–5
Accessible at: http://www.apbp.org/resource/resmgr/newsletter/2008_issue_2.pdf.
- Rye, T., 2002. Travel plans: Do they work? *Transport Policy* 9 (4), 287–298.
- Ryley, T.J., 2006. Estimating cycling demand for the journey to work or study in West

- Edinburgh, Scotland. *Transp. Res. Rec.* 1982, 187–193.
- Sammer, G., 1997. A general 30 km/H speed limit in the city: A model project in Graz, Austria. In: Tolley, R. (Ed.), *The greening of urban transport: Planning for walking and cycling in western cities*. John Wiley & Sons Ltd., Chichester, U.K., pp. 385–390
- Sener, Ipek N, Naveen Eluru, and Chandra R Bhat. 2009. An analysis of bicycle route choice preferences in Texas, US. *Transportation* 36, no. 5: 511-539.
<http://www.springerlink.com/index/10.1007/s11116-009-9201-4>.
- Staunton, C.E., Hubsmith, D., Kallins, W., 2003. Promoting safe walking and biking to school: The Marin County success story. *American Journal of Public Health* 93, 1431–1434.
- Telfer, B., Rissel, C., Bindon, J., Bosch, T., 2006. Encouraging cycling through a pilot cycling proficiency training program among adults in central Sidney. *Journal of Sports Science and Medicine*. 9, 151–156.
- Texas Transportation Institute. “Traffic Congestion and Urban Mobility.” September 2011. http://tti.tamu.edu/infofor/media/topics/congestion_mobility.htm"xf."
- Transport for London, 2004a. Business case for cycling in London (Draft). Transport for London Street Management, London. Accessible at:
<http://www.tfl.gov.uk/assets/downloads/businessandpartners/business-case-for-cycling.pdf>.
- United States Environmental Protection Agency. “Indicators of the Environmental Impacts of Transportation.” *Policy, Planning, and Evaluation* (1996): n. pag. Print.
- U.S. Obesity Trends*. Center for Disease Control and Prevention, 21 July 2011. Web. 8 Feb. 2012. <<http://www.cdc.gov/obesity/data/trends.html>>.
- Wardman, M., Tight, M., Page, M., 2007. Factors influencing the propensity to cycle to work. *Transportation Research. Part A* 41, 339–350.