SEATTLE BICYCLE SHARE

feasibility study

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Executive Summary

Overview

This report assesses the feasibility of a public use bike-share system for Seattle, Washington. Colloquially referred to as "bike-share" or "bike-sharing," such systems are considered a form of public transportation. Bike-share bicycles are intended for short-term use and are accessible via automated check-out systems. An important benefit of bike-share systems is the flexibility to return rented bicycles to any station within the system, thereby encouraging use for one-way travel and the "final mile" of a trip.

The four major chapters of this report represent the organization of our research and analysis. The topic areas are:

- **Introduction**: Bike-share history and the structure of our study
- **Demand Analysis**: Our analytic and forecast methodologies along with results of their application
- **Policy Framework**: Consideration of governance institutions and their effects on system implementation
- **Bike-Share Program Recommendations**: Summation of our findings and recommendations for how Seattle should proceed

Bike-share bicycles are intended for short-term use, accessible via automated check-out systems.

During our analysis, we looked at demand for bike-share in Seattle. We have concluded that demand is sufficient to support a program. Our final recommendation includes three implementation phases, beginning with the downtown and surrounding neighborhoods.

However, despite anticipation of program demand, there are institutional policy challenges that must be addressed before successful implementation. Prominent among these are:

- The King County helmet law
- City of Seattle sign codes
- Policies that affect station design and use of curbspace

In the case of the latter two, individual neighborhoods and districts may each have their own, unique impacts. Fortunately, Seattle has the flexibility to address these issues, and there are systems in place to overcome these challenges. Once addressed, we recommend the City move forward with implementing a bike-share program.

Despite anticipation of demand for bike-share, there are institutional policy issues that must be addressed before successful implementation.

Bike-Share Through Time

Since inception of the first system in Amsterdam, in the mid-1960s, bike-share has grown and adapted. Originally comprised of painted, free-to-use bicycles, early systems quickly succumbed to theft and vandalism. This shortcoming was later addressed through the introduction of coin-operated locking mechanism, not unlike those of airport luggage carts. However, anonymity of system users, and the minimal investment on their part—in the form of loose change—could not overcome the continued occurrence of theft and vandalism.

Technological advancements in the mid- to late-90s paved the way for the modern bike-share system, also known as "third generation" programs. These consist of bicycle parking stations with kiosks that leverage electric card-reading technology. Whether using a credit card or a membership smartcard, new systems can attribute bicycle rentals to individual users, creating the ability to enforce liability for damaged or stolen equipment. The advent of third generation bike-share programs has led to increasing popularity and widespread implementation. As of 2010, there are approximately 160 bike-share systems throughout the world.

> Bike-share systems increase accessibility by extending traditional transportation systems.

Discussed in more detail within this report, bike-share systems increase accessibility by extending traditional transportation systems. Referred to as the "last mile" of travel, bike-share trips provide convenient access to areas not directly served by transit or areas where bike-share can provide faster or more convenient access.

Bike-Share Riders and System Demand

The Demand Analysis section represents the majority of our work in this report. The goal was to provide a quantitative evaluation of bike-share potential across all areas of the city. Combining the size of our proposed implementation areas with available travel data, we were able to estimate ridership, recommended bicycle stock, and recommended number of check-out stations.

We identified a set of twelve metrics we believe act as indicators of the likelihood of success of a bike-share system. Discussed in greater detail in Chapter 2, these indicators include:

1. Population Density	2. Non-Institutionalized Group Quarter Housing
3. Job Density	4. Retail Job Density
5. Commute Trip Reduction Companies	6. Tourist Attractions
7. Parks/Recreation Areas	8. Topography
9. Regional Transit Stations	10. Bicycle Friendly Streets
11. Streets with Bicycle Lanes	12. Local Transit Stops

Using individualized calculations for each indicator, we divided the entire city into a series of ten meter squares or cells and generated a score for each cell. Following individual scoring we created a combined score for each cell, representing the cumulative potential for bike-share. Appendix A is a collection of maps that illustrate this process. By identifying large, contiguous high-scoring cells, we arrived at our three recommended areas of implementation.

To estimate demand within the three phases of implementation, we used a combination of trip origin and destination data provided by the Puget Sound Regional Council. Using rates of bike-share trips diverted from other modes, identified by prominent, European bike-share systems, and the geographic extent of the proposed implementation areas, we estimated ranges for the number of bicycles and number of docking stations necessary to support each phase of implementation. Our estimates are:

- Proposed Phase 1: 790 to 980 bicycles and 55 to 65 docking stations
- Proposed Phase 2: An additional 1,115 to 1,235 bicycles and 75 to 85 stations
- Proposed Phase 3: An additional 355 to 375 bicycles and 24 or 25 stations

While we are confident in our analysis and the potential for a successful bike-share program in Seattle, we cannot over-emphasize the recommendation that implementation of proposed Phase 2 and Phase 3 are contingent upon successful implementation of Phase 1. Furthermore, the institutional policy issues mentioned earlier will play an important role in the planning and implementation of bike-share in Seattle.

Moving Forward

Although this report provides an analytical basis for the potential success of a bike-share system, there will be challenges. In short, any proposed program will be subject to a wide variety of governance structures, in addition to those mentioned above, which must be accommodated. In many instances, individual neighborhoods or districts will overlay their own unique mandates for compliance, adding complexity to installation or operation of a system. Success, therefore, will require an active role on the part of the sponsoring agencies to streamline the process to the greatest extent possible.

> Bike-share system providers should make sure the public understands the benefits and feels a personal stake in the success of the system.

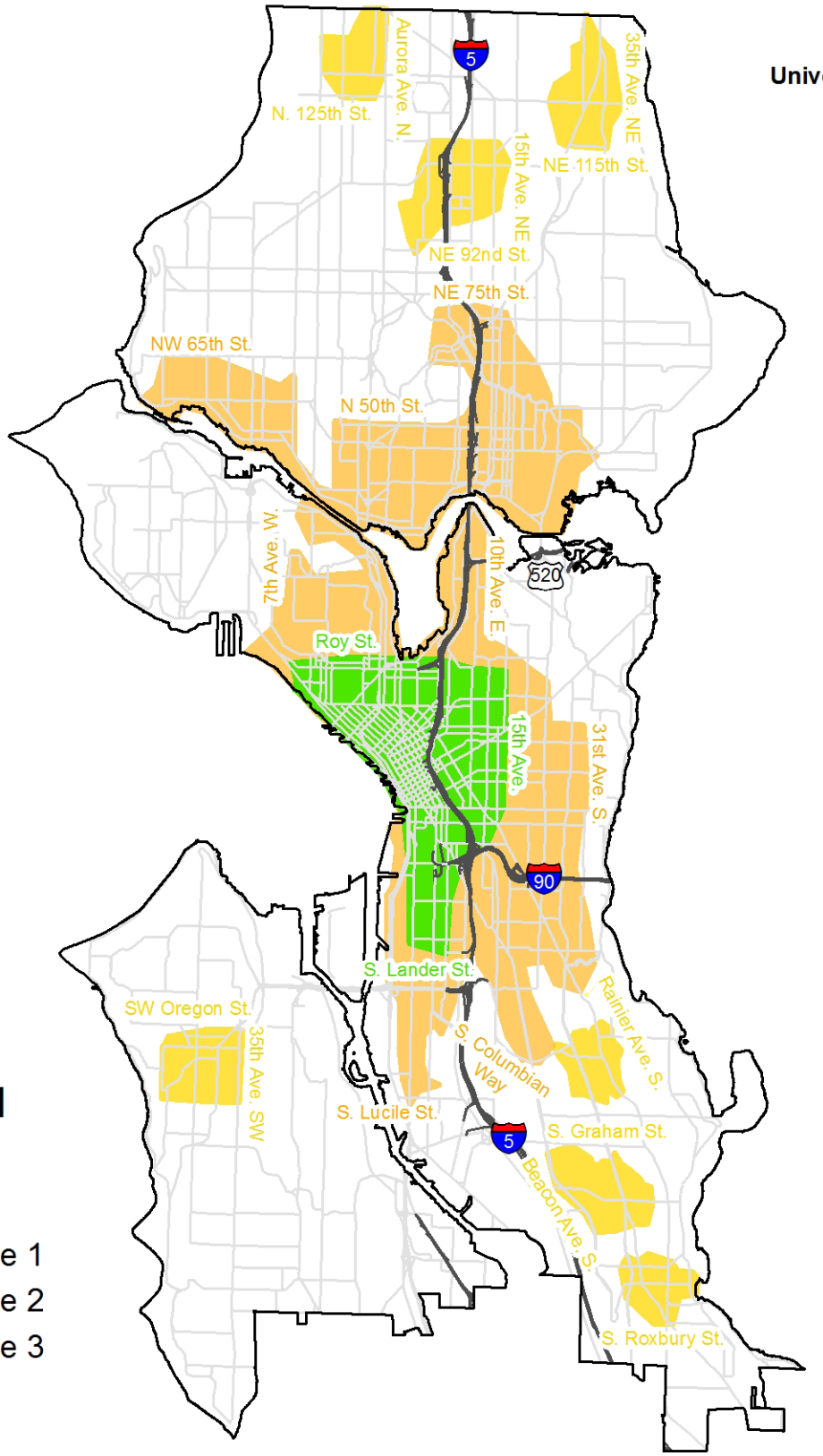
It is also worth mentioning that an active role must be taken not only in clearing logistical hurdles, but also in introducing a new system to the public. As a relatively new concept, outreach and education will play a key role in developing understanding and support. Bike-share will be most successful when the public understands the benefits and feels a personal stake in the system.

Finally, if the City does decide to implement a bike-share system, there are number of specific steps and actions detailed in this report that City staff can take to ensure that bike-share infrastructure is installed in the most effective locations, will function efficiently, and will provide the maximum benefit to Seattle's transportation system.

Proposed Seattle Bike-Share Implementation Phases

SEATTLE BICYCLE SHARE feasibility study

University of Washington
Bike Share Studio



Legend

Seattle

- Phase 1
- Phase 2
- Phase 3

0 0.5 1 2 3 4 Miles

1. Introduction

Purpose of this Report

The City of Seattle Department of Transportation (SDOT) contracted the University of Washington Bike-Share Studio to produce a feasibility study of bike-share programs in Seattle. Over the course of this project, we compiled a summary of the leading edge bike-share programs; conducted demand analyses to identify potential first-, second-, and third-stage implementation areas in Seattle; and estimated the number of trips a program might generate, as well as the number of bicycles and stations necessary to sustain such a program.

In addition, we identified potential system elements for a Seattle bike-share program and reviewed the relevant regulation, policies, and plans that could affect implementation of a bike-share program in Seattle. This report summarizes our findings, provides recommendations for implementing a bike-share program in Seattle, and identifies areas for future study.

Defining Bike-Share

Public use bike-share—shortened for the purposes of this report to "bike-share" or "bike-sharing"—can be defined in a couple of ways. The first definition describes bicycles that are intended for short-term use by the public and that are available for check-out at unattended urban locations. The second and broader definition of bike-share is public transportation via bicycle. These two definitions are not mutually exclusive and are best thought of in combination. Bike-sharing was designed to increase mobility in urban settings by offering the user one-way, short-distance transportation between point A and point B, with little to no stopping in between.

Bike-sharing was designed to increase mobility in urban settings by offering the user one-way transportation between point A and point B, with little to no stopping in between.

The trip begins with a user checking out a bicycle at a station near his/her point of origin. Once the user has reached his/her destination, the bicycle is checked in, or docked, at or near the destination. Though "automated" check out and check in are similar to car-sharing, unlike car-sharing, bike-share bicycles can be returned to any station within the system. Furthermore, the unique pricing structure of bike-share (discussed later) encourages short-term use of 30 minutes or less. This differentiates bike-share from private bicycle rental companies that typically rent bicycles for hours—or even days—at a time.

History

Bike-share experts typically cite three generations of bike-share programs over

the past 45 years.[1] Figure 1 on the following page illustrates each of the three generations of bike-share. The first generation began in Amsterdam in the mid-1960s with the introduction of the White Bike program. White Bikes were ordinary bicycles painted white and left about the city for the public to use free of charge. Within days the program collapsed from overwhelming rates of theft and vandalism.[2] Since Amsterdam's White Bikes, other first-generation programs have been attempted in cities such as Portland, Oregon, and Boulder, Colorado. Regardless of the year of inception, nearly all first-generation programs have met a similar fate: failure resulting from high rates of theft and vandalism.[3]

In 1995, the first large-scale, second-generation bike-share program was launched in Copenhagen, Denmark. Bycyklen ("City Bikes") featured many improvements over the previous generation.[4] The most notable improvement was a check-out method that required a small coin deposit. Unlike Amsterdam's White Bikes, the Copenhagen bicycles were specially designed for intense utilitarian use and could be picked up and returned at designated locations throughout the central city. While more formalized than the previous generation, with stations and a non-profit organization to operate the program, the bicycles still experienced theft attributed to the anonymity of users.[5] Bycyklen is one of the few second-generation programs that still operates today, but it is most well known for the role it played in giving rise to third-generation bike-share.

Building upon the innovation of coin-deposit locking mechanisms, third-generation programs gained worldwide popularity by incorporating advanced technologies for bicycle reservations, pick-up, drop-off, and information tracking.[6] The earliest identified third-generation bike-share program was Bikeabout, created in 1996 at Portsmouth University in England.[7] This program allowed students to use a magnetic stripe card to rent a bike.

Bike-sharing grew slowly in the following years, with one or two third-generation programs launching annually. These include 1998's Vélo à la Carte in Rennes, Frances, and 2005's Velo'v, launched by JCDecaux in Lyon, France. With a fleet of 1,500 bicycles, this was the largest third-generation bike-share program to date and grabbed the attention of other European cities.

Two years after the launch of Lyon's ground-breaking program, Paris launched its own bike-share program, Vélib', with approximately 7,000 bicycles. Vélib' has since expanded to 20,600 bicycles, quickly becoming one of the largest and most publicized bike-share programs. However, the publicity was partially the result of extremely high rates of theft and

1 Paul DeMaio, "Bike-sharing: Its History, Models of Provision, and Future," in Velo-City Conference (Brussels, 2009).
2 Ibid.
3 Susan Shaheen, Stacey Guzman and Hua Zhang, "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future," in Transportation Research Board Annual Meeting (Washington, D.C., 2010).
4 Paul DeMaio, "Bike-sharing: Its History, Models of Provision, and Future," in Velo-City Conference (Brussels, 2009).
5 Ibid.
6 Susan Shaheen, Stacey Guzman and Hua Zhang, "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future," in Transportation Research Board Annual Meeting (Washington, D.C., 2010).
7 Paul DeMaio, "Bike-sharing: Its History, Models of Provision, and Future," in Velo-City Conference (Brussels, 2009).

Figure 1: Photos of 1st, 2nd and 3rd Generation Bike-Share

1st Generation Bike-Share Photo
http://www.happyhotelier.com

1st Generation Bike-Share Photo
http://wanderlustandlipstick.com

2nd Generation Bike-Share Photo
http://umebike.wordpress.com

3rd Generation Bike-Share Photo
Max Hepp-Buchanan, 2009

3rd Generation Bike-Share Photo
Max Hepp-Buchanan, 2009

3rd Generation Bike-Share Photo
Max Hepp-Buchanan, 2009

vandalism. Since the inception of Vélib' in July 2007, nearly 80 percent of the program's initial fleet of bicycles has been either stolen or damaged beyond repair.[8]

The four main components of third-generation bike-share programs are summarized as follows:

1. Distinguishable bicycles (either by color, special design, or advertisement)
2. Docking stations
3. Kiosk or user interface technology for check-in and checkout
4. Advanced technology (e.g., mobile phone, magnetic strip card, smartcards)[9]

Furthermore, each rental is often accompanied by a large monetary deposit secured by the user's credit card.

Incorporation of third-generation information technology was meant to help deter bicycle theft, which was a major concern of second-generation coin-deposit systems. Clearly, third-generation technology is not entirely successful at preventing theft and vandalism. Despite this continued problem, however, 92 programs, large and small, operated across the globe at the end of 2008. By the end of 2009, that number was approximately 160, an increase of 74 percent.[10]

Table 1 is a reference guide to the bike-share programs that we commonly refer to throughout this report.

Table 1: Bike-Share Programs

Program Name	City	Generation	Year Created	Operator	# of Bikes	# of Stations
White Bikes	Amsterdam	First	1965	Public	Unknown	None
Bycyklen	Copenhagen	Second	1995	City of Copenhagen	2,000	110
Vélo à la Carte	Rennes	Third	1998	Clear Channel	200	25
Velo'v	Lyon	Third	2005	JC Decaux	4,000	340
Vélib'	Paris	Third	2007	JC Decaux	20,600	1,425
Bicing	Barcelona	Third	2007	Clear Channel	6,000	400
SmartBike DC	Washington, D.C.	Third	2008	Clear Channel	120	10
Bixi	Montréal	Third	2009	Public Bike System Co.	5,000	370

The availability of technology and the emergence of many competitors is leading to a marketplace in which incremental advances quickly spread throughout the industry.[11] In fact, some experts assert that bike-share is already seeing the emergence of fourth-generation

8 Steven Erlanger, "French Ideal of Bicycle-Sharing Meets Reality," The New York Times, October 30, 2009, New York Edition ed.: A1.
9 Susan Shaheen, Stacey Guzman and Hua Zhang, "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future," in Transportation Research Board Annual Meeting (Washington, D.C., 2010).
10 Paul DeMaio, "Bike-sharing: Its History, Models of Provision, and Future," in Velo-City Conference (Brussels, 2009).
11 Ibid.

systems. Since the introduction of the first third-generation programs, advancements have been made in methods of check-out and check-in, ease of use, flexibility of station placement, tracking of bicycles and mileage, bicycle and station design, powering of supply stations, incorporation into other modes of transport, distribution, business models, and theft deterrence.

As an example, the Bixi program in Montréal uses "modular," solar-powered stations that are not installed into the street infrastructure. Bixi stations are dropped into place and secured by their weight. Subsequent adjustments to station size or location based on actual demand and use patterns are easier to make than changes to models that require street installation or hardwiring to existing infrastructure.

Status of Bike-Share in the United States Today

The first bike-share program to exist in the U.S. was Smartbike DC, initiated in 2008. Clear Channel operates the program with 120 bicycles and 10 stations as part of an outdoor advertising contract with Washington, D.C. Denver also has a small bike-share program called B-Cycle, which started with 30 bicycles for city employees. Through the summer of 2009 B-Cycle expanded significantly. Its goal is to have 1,000 bicycles and 70 stations on the street by the summer of 2010.[12]

Minneapolis appears to be the next city to host a bike-share program. NiceRide is scheduled to launch in spring 2010 and will be operated by Public Bike System Company, the same non-profit that operates the Bixi program in Montréal. The program is planning to start with 1,000 bicycles. The system will be seasonal; bicycles will be removed during the winter because of heavy annual snowfall.[13]

Boston released an extensive and detailed request for proposal (RFP) for a bike-share vendor and operator in spring of 2009.[14] That summer, the Metropolitan Area Planning Council announced that it had also selected Public Bike System Company to operate its program. Like Minneapolis, Boston expects to launch in spring of 2010, but with a slightly larger fleet—1,500 bicycles and 150 stations.[15]

The most recent city in the U.S. to show interest in bike-share is Philadelphia. In late 2009 a paper was released that discusses the methods and findings of a two-phased project to identify a primary geographic market area for a bike-share program. The paper endeavored to estimate daily bike-share trips in the city's prima-

12 DeMaio, Paul. The Bike-sharing Blog. January 14, 2009. http://bike-sharing.blogspot.com/2009/01/denver-is-mile-high-on-bike-sharing.html (accessed March 5, 2010).
13 JzTI and Bonnette Consulting. Philadelphia Bikeshare Concept Study. Philadelphia: Delaware Valley Regional Planning Commission, 2010.
14 Metropolitan Area Planning Council. Request for Proposals - Bicycle Sharing System. RFP, Boston: Metropolitan Area Planning Council, 2009.
15 City of Boston. "Mayor Menino, Boston Bikes Announce Request for Proposals for Bike Share Program." City of Boston.gov. March 3, 2009. http://www.cityofboston.gov/news/default.aspx?id=4122 (accessed March 5, 2010).

ry market area.[16] The methodology discussed in the Philadelphia paper informed the methodology presented in this report. A more detailed consultant report on the bike-share feasibility study for the City of Philadelphia was released in February 2010.[17]

Bike-sharing provides a low-cost geographical expansion of existing transportation services, providing a means to complete the "final mile" of one's commute.

Benefits

Transportation planners and bike-share experts generally agree about the benefits of bike-sharing in urban settings.[18] These benefits can be separated into two general categories: 1) benefits to the city/region and 2) benefits to the user/society (with some overlap).

Transportation benefits to the city/region include the following:

- Does not create pollution, or contribute to global warming
- Does not add to congestion
- Is less expensive to purchase and maintain than other modes (rail, bus, auto)
- Requires less infrastructure investment than other modes
- Allows low-cost expansion of existing transportation services
- Promotes greater transit use through modal integration

Transportation benefits to the user/society include the following:

- Provides low-cost, on-demand transportation (typically offered 24 hours a day, seven days a week)
- Serves as the "final mile" of commute
- More bicycles on the road increases the safety of other cyclists
- Offers physical exercise for the user
- Makes a city more livable and neighborly

The introduction of Velo'v in Lyon offers a good case study of some of the benefits of bike-sharing in urban settings. In a relatively short timeframe Velo'v drastically changed the

16 Krykewycz, Gregory R. et al. "Defining a Primary Market Area and Estimating Demand for a Large-Scale Bicycle Sharing Program in Philadelphia." TRB 2010 Annual Meeting. Washington, D.C., 2009.
17 JzTI and Bonnette Consulting. Philadelphia Bikeshare Concept Study. Philadelphia: Delaware Valley Regional Planning Commission, 2010.
18 Eric Britton, "Public Bikes in Latin American Cities: Great idea but what next?" (Cuernavaca: World Streets, July 2, 2009).

image of cycling in Lyon, which had never been known as a bike-friendly city. For many years, the mode share for bicycles was 0.6 percent, but in 2006, 1.8 percent of all trips were made by bike. In only one year, Velo'v riders had essentially tripled the share of trips made by bicycle. Even more significant is the fact that Velo'v has proved that traveling by bicycle in Lyon is credible.[19] Traffic crossings at intersections have increased by 80 percent for bicycles, one-fourth to one-third of which are Velo'v users. The increased number has also changed the behavior of drivers, who have no choice but to accept the presence of cyclists.[20]

These increases raise the question, "Who are bike-share users?" As a general rule, bike-share should be aimed at residents and tourists alike. Bike-share can be targeted toward both men and women, regardless of race, class, or age (though, for liability reasons, they may need to be 18 or over). Unfortunately, bike-share may not be right for those who are somehow mobility-impaired or handicapped.

Some new bike-share users will likely substitute bike-share trips for trips they would have otherwise made on foot or by bus. Ideally, however, people will recognize that between bike-share and local/regional transit (most likely a combination of both), many car trips can be replaced by these alternative and sustainable modes of travel.

Structure of the Seattle Bike-Share Feasibility Study

Chapter 2 outlines the methodology and findings of our demand analysis. This includes proposed Phase 1, Phase 2, and Phase 3 implementation areas, as well as estimates for the number of bicycles and stations for each phase. Chapter 3 is our policy framework, which discusses potential system elements for a bike-share program in Seattle. Chapter 3 also identifies and analyzes city/regional plans and policies that may have an impact on bike-share planning and implementation in the city. Chapter 4 condenses the discussion in chapters 2 and 3 into a bulleted list of our key findings and recommendations for the City of Seattle. It concludes with a summary discussion of how the demand analysis findings and the policy implications relate to each other, if at all.

Throughout the report, key findings and recommendations will be made, although all of them can be found in one location in Chapter 4. As you read, please note:

- ❖ All recommendations can be identified by use of a diamond-shaped bullet.
- • All other points (key findings, etc.) will use a simple black dot bullet.

19 Keroum Slimani, interview by Max Hepp-Buchanan, Lyon and Velo'v, (September 3, 2009).
20 Ibid.

2. Demand Analysis

Introduction

The objective of the demand analysis was to provide a quantitative evaluation of a bike-share system in Seattle. By incorporating best practices from recent bike-share feasibility studies in North America, our methods were designed to identify market areas where bike-sharing has the highest potential. The analysis also forecasts demand for bike-sharing in those areas.

The Demand Analysis has three sections:

- **Indicators** - This section provides background information and justification for the twelve indicators used to identify bike-share market areas.
- **Analytical Methods** - The Analytical Methods section describes the methodology used in our demand analysis, which consisted of a geographic information systems (GIS) analysis based on our indicators. This analysis identified geographic areas, which led to a recommendation of phased implementation. This in turn supported estimation of trip-level demand for a bike-share system in Seattle.
- **Results** - This section introduces our findings, including three proposed phases of bike-share implementation and their demand projections. Included is the Impacts of Climate and Culture section, which compares Seattle to peer European cities with bike-share systems.

Modeling Methods Review

During our literature review, we evaluated methodologies that have been used in European and North American cities with successfully implemented bike-share programs to find best practices in the industry. While the practice of assessing bike-share demand is relatively new and relevant data are scarce, some lessons learned were useful.

The first large-scale, third generation bike-share program in Lyon, France, determined that population and employment densities, along with compact station density, are critical for ensuring ease of access for customers. To meet its density criteria, Lyon's modeling consisted of laying a 300-meter grid over density maps to identify potential high-use areas. Planners then used the grid to appropriately space stations throughout the high-use area.

Planners in Paris, France, added indicators for retail-based and facility-based trips to Lyon's existing density indicators and developed a "cumulative-trip" demand for the entire city. Paris applied a similar 300-meter grid to identify varying trip thresholds that predicted levels of bike-share demand within each square. This resulted in three categories of demand—low, medium, and high—for which varying numbers of bicycles were supplied to meet the demand. However, Parisian planners significantly underestimated the number of bicycles needed by about 11,000 bicycles.

Montréal, Canada, estimated its bike-share demand by defining the service area on the

basis of population density statistics similar to those found in Lyon. Once the service area had been determined, Montréal applied the density and ratio of bicycles used in the Lyon study. In addition to this rather basic approach, Montréal funded a market study to supplement its demand estimates and to produce pricing and revenue projections.

Representing what we think is the most advanced methodology to date for estimating bike-share demand, the Delaware Valley Regional Planning Commission (DVRPC), Philadelphia's metropolitan planning organization, used a much more thorough, data-rich, and fine-grained analysis. Its analysis had ten indicators and used a GIS-weighted sum raster analysis to identify two market area phases. Once the market areas had been determined, a sketch-planning method was developed to estimate trip-level demand for bike-sharing on the basis of the demand for existing modes and diversion rates observed from European systems.[21] This methodology benefited from combining local data with observed industry standards from successful European programs. It not only supported a fine-grained analysis with additional indicators representing transportation network and facility factors, but it also provided a flexible range of demand projections. We think this approach represents the best available science in the industry for determining bike-share feasibility. Our demand analysis relied on the methodology developed by the DVRPC.

Analysis Summary

Our demand analysis addressed two primary questions: 1) where in Seattle is bike-sharing most suitable, and 2) what are the anticipated demand levels within those areas? To determine where bike-sharing would be most successful, we used a weighted sum raster analysis in GIS to identify proposed phases for bike-share implementation. Using these proposed implementation areas, we applied European diversion rates to local trip-level data.

In summary, our demand analysis utilized the following steps:

1. Identify 12 indicators favorable to bike-share use.
2. Convert the indicators into GIS raster data to ensure "apples to apples" comparison.
3. Aggregate the indicators into a composite bike-share score by using a weighted sum raster analysis.
4. Map the composite score data to identify contiguous, high-scoring areas and draw boundaries to represent proposed bike-share implementation areas.
5. Calculate the demand for existing transportation modes within the

21 JzTI and Bonnette Consulting with the Delaware Valley Regional Planning Commission. (2010). Philadelphia Bikeshare Concept Study.

proposed implementation phases.

6. Apply diversion rates to existing Seattle trips to determine demand for bike-share.
7. Apply industry standards to estimate the number of bicycles and stations needed.

Indicators

Our indicators measured the suitability of an area for supporting bike-sharing. Each indicator related to particular characteristics. Our twelve indicators are listed in Table 2. Ten were used in the Philadelphia analysis, and two were added to capture unique features of Seattle. Topography was not included in the Philadelphia study but was included in this analysis. Knowing that flatter terrain is more favorable to cycling in general, the highly variable topography in Seattle is expected to affect bike-share use and is an appropriate indicator for a Seattle study. The Commute Trip reduction variable was also another variable relevant to bike-share ridership that was not present in the Philadelphia analysis. The indicators are discussed in further detail in the next section.

Table 2: Indicators

	Indicator	Scale	Metric	Buffer	Weight	Data Source
	Population Density	TAZ	Population per acre	n/a	1	2008 PSRC Population and Housing Estimates
	Non-Institutionalized Group Quarter Population Density	TAZ	Group quarter population per acre	n/a	0.5	2008 PSRC Population and Housing Estimates
	Job Density	TAZ	Jobs per acre	n/a	1	2008 PSRC Covered Employment Estimates
	Retail Job Density	TAZ	Retail jobs per acre	n/a	1	2008 PSRC Covered Employment Estimates
	Commute Trip Reduction (CTR) Companies	10 meter cell size	Point density	n/a	1	King County Metro
	Tourist Attractions	10 meter cell size	Point density	1000 meters	1	Seattle Department of Planning and Development
	Parks/Recreation Areas	10 meter cell size	Proximity distance	1000 meters	0.5	WAGDA (Seattle Parks Layer)
	Topography	10 meter cell size	Slope angle	n/a	1	WAGDA (WA Digital Elevation Model)
	Regional Transit Stations	10 meter cell size	Proximity distance	1000 meters	1	WAGDA (ST Link. ST Sounder, Amtrak, Ferry, ST Express)
	Bicycle Friendly Streets (including streets with bicycle lanes)	10 meter cell size	Proximity distance	1000 meters	1	WAGDA (SDOT bicycle layer)
	Streets with Bicycle Lanes	10 meter cell size	Proximity distance	1000 meters	1	WAGDA (SDOT bicycle layer)
	Local Transit Stops	10 meter cell size	Point density	1000 meters	1	WAGDA (Metro stops, Street Car)

Residential Population Density

Residential density supports bike-share demand by providing a pool of potential users. Even the simplest bike-share analyses have included this indicator. Higher density improves accessibility, which reduces travel distances and makes non-motorized travel more feasible.[22]

Residential density also indicates the number of off-peak trips that might be taken. In particular, personal business and social/recreational trips can be estimated on the basis of residential population density. Off-peak use increases demand for a bike-share system through the day, with the added benefit of helping to balance bicycle inventories across the city.

Higher population densities also correlate with less automobile dependence and higher use of alternative transportation choices.[23]

Non-Institutionalized Group Quarter Population Density (University Housing)

University housing was included with general residential population density, but we also chose to include it as a second factor to increase its weight as an indicator. Student populations are a likely market for bike-sharing because of their average age and large transit mode share. In addition, the structure is in place for education about bike-share and transportation choices because students regularly use the same spaces, and colleges already have systems in place to market programs and share information. These marketing systems are similar to Commute Trip Reduction companies, discussed in further detail below.

This indicator captured housing at the University of Washington, Seattle Pacific University, and Seattle University. Any group housing, whether on campus or not, was also included. It did not include institutionalized or incarcerated housing.

While college students' ages vary, 76 percent of students are between 18 and 29.[24] According to surveys, university students fit the profile of bike-share users, who are most likely to be "18-34 years in age [with a] high level of education."[25] This makes university housing density a good indicator because university students offer a great market for new bike-share users.

Another factor is that at Seattle's universities, transit mode-share is high, meaning that a large number of the population ends their trips with the last mile not accommodated by transit. Bike-sharing offers a transportation choice for these

22 Litman, T., & Steele, R. (2008). Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior. Vancouver, British Columbia: Victoria Transport Policy Institute.
23 Ibid.
24 U.S. Census Bureau. (2008, October). Social and Economic Characteristics of Students: October 2008. Retrieved February 3, 2010, from School Enrollment: http://www.census.gov/population/www/socdemo/school/cps2008.html
25 CityRyde. (2009). CityRyde Bike-sharing Informational Webinar. Philadelphia.

students. In fact, at the University of Washington, the Climate Action Plan reported that 79 percent of students choose alternative transportation (see Table 3). These students are potential users of bike-share.

At the University of Washington, the Climate Action Plan reported that 79 percent of students choose alternate transportation. These students are potential users of bike-share. Bike-share can serve the 60% of student population who live within five miles but are not already biking or walking.

Table 3: Mode Share at University of Washington Seattle Campus[26]

Mode	Percentage
Single occupancy vehicle	21
Ride share	5
Transit	39
Walk	25
Bicycle	8

In addition, institutional commitment at the universities to alternative transportation should help generate bike-share riders. One of the strategies in the University of Washington's Climate Action Plan is to support bicycling and walking. "Almost 60 percent of the Seattle campus population lives within five miles of campus, and today there are many people that bike or walk occasionally, but do not make those options their primary commute choices."[27] Bike-sharing can potentially support this strategy by reaching the 60 percent of the student population who live within five miles but are not already biking or walking.

Finally, universities are frequently surrounded by mixed-use development, as well as pedestrian and bicycle friendly environments that are conducive to bike-share usage.

According to surveys, university students fit the profile of bike-share users, who are most likely to be "18-34 years in age [with a] high level of education."

Because these populations were also counted within the Population Density indicator, accounting for them with group housing would count them a second time. However, we thought that double-counting students in dormitories would give too large a weighting to these populations. Therefore, we applied a half weighting to this indicator.

Job Density

At a basic level, job density measurements indicate where people are during the day. As with most transportation infrastructure, higher density yields greater efficiency in service provision.

26 University of Washington. (2009). Climate Action Plan. Retrieved February 3, 2010, from http://f2.washington.edu/oess/sites/default/files/file/UW%20Climate%20Action%20Plan%20091509.pdf
27 Ibid.

Employment density measures the intensity of morning commute attractors and midday trip origins.[28] Previous research has indicated that employment density is one of the primary predictors of bicycle use. For example, Frank and Pivo found that job density has a greater impact on commute mode choice than residential density, particularly when workplace density reaches 50 to 75 employees per acre.[29]

Retail Job Density

Retail density was included in the demand analysis because of its function as a trip attractor.

In addition to being a way for commuters to travel "the last mile" from their transit endpoint to their employer's door, bike-sharing has been envisioned as a way for users to complete their errands before, during, and after the workday. Therefore, the presence of dense retail should provide trip destinations for bike-share users who live or work nearby.

When analyzed in conjunction with population density and general employment density, this indicator helps show land-use mixing, which "tends to reduce travel distances, and allows more trips to be made by walking and cycling…Employees who work in mixed-use commercial areas are more likely to commute by alternative modes."[30] This was confirmed by Cervero, who found that "having appreciable retail/service activities within a 1-mile radius of a person's origin generally encouraged that person to bicycle."[31] Cervero also reported that "for every 1,000 retail workers within a half mile of a person's home, the likelihood a person will bike or walk to non-work activities goes up by 7 percent."[32]

However, not all retail is created equal; some may generate a greater number of trips than others. Using the number of establishments or square footage may over-weight large but low-intensity uses such as furniture warehouse outlets; therefore, we used the number of retail jobs to measure intensity of retail use.[33]

Frank and Pivo found that job density has a greater impact on commute mode choice than residential density, particularly when workplace density reaches 50 to 75 employees per acre.

28 Tyler Benson, "Public Use Bike Share Feasibility Study: Volume Two: Demand Analysis," 2009, p. 2.18.
29 Benson, p. 2.103.
30 Benson, p. 2.104.
31 Ibid.
32 Arrington & Cervero, as quoted in Benson, p. 2.105.
33 "Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing?" Journal of the American Planning Association, 2008, p.478

Commute Trip Reduction

Commute Trip Reduction (CTR) is a law that mandates larger employers to manage the transportation demands of their employees. Businesses with more than 100 employees in any one location are required to implement a CTR plan. The City of Seattle works with over 250 employers with a total of over 55,000 employees, a number that includes the City itself as a major employer. Participating companies must provide an Employee Transportation Coordinator for the program, develop a plan to reduce drive-alone commute trips, submit the plan and an employee survey every two years, and exercise good faith efforts to reduce drive-alone commute trips.[34] This indicator was not included in the Philadelphia feasibility study but was added as an indicator here as a beneficial feature in Seattle.

> In addition to being a way for commuters to travel "the last mile" from their transit endpoint to their employer's door, bike-sharing has been envisioned as a way for users to complete their errands before, during, and after the workday.

Transportation demand management programs like CTR use incentives to encourage use of alternative transportation.[35] The programs do not require employees to change habits, but they do create the support structure to make those choices easier.

This CTR program facilitates relationships between SDOT and major employers and can provide a communication point for implementing bike-sharing. Employee Transportation Coordinators have training and interest in reducing single occupancy vehicle (SOV) trips and are a good resource. In addition, the survey process provides a no-cost tool for additional measurement of bike-share usage, at least for these participating employers. This program can help support true involvement from large employers in the city.

The bike-share program and CTR can be mutually supportive; studies show that comprehensive CTR programs can reduce peak-period automobile trips by 5 to 20 percent, and even more when accompanied by transit improvements.[36] Seattle's goals for the downtown neighborhoods are to increase non-SOV trips by 14 percent. Bike-sharing and additional transit improvements can help meet or exceed that goal. See Appendix C for mode share targets from the Commute Trip Reduction Plan.

CTR paired with bike-sharing can reach employees who would not have chosen alternative transportation before. Employees sometimes choose to drive to work just to have a car to run errands at breaks. Bike-sharing can help provide options for these employees.

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34 City of Seattle. (2009). Commute Trip Reduction Basics. Retrieved January 22, 2010, from City of Seattle: http://www.seattle.gov/waytogo/commute.htm

35 Victoria Transport Policy Institute. (2010, January 25). Commute Trip Reduction. Retrieved January 30, 2010, from TDM Encyclopedia: http://www.vtpi.org/tdm/tdm9.htm

36 Ibid.

Employers with less than 100 employees are not covered by CTR requirements. The Downtown Seattle Association and the City of Seattle work together to reach out to these employers and coordinate alternative transportation choices.[37] This coordination can help bring education about bike-sharing to smaller companies that are not covered by CTR.

CTR employers were selected as an indicator because of the systems in place to encourage bike-share among employees. The employment density of these companies was also counted under the job density indicator. Including them in a separate category gave them extra weight, which was warranted by the CTR planning and implementation in place.

Tourist Attractions

Tourist attractions are destinations for bike-share users. The degree to which the presence of a tourist attraction affects bike-share ridership will vary on the basis of whether the business model allows short-term memberships.

The Vélib' program in Paris was specifically designed and priced to support tourist travel. It allows purchase of daily and weekly memberships in addition to annual memberships. Daily memberships cost 1 Euro (approximately $1.40, or 3 percent of the cost of an annual membership) and weekly memberships cost 5 Euros (approximately $6.90, or 17 percent of an annual pass)—in addition to the hourly rate. This allows tourists to purchase short-term memberships at kiosks with their credit cards. Day passes have been relatively popular; in its first year Vélib' generated 198,913 annual subscriptions and 3,683,174 one-day subscriptions.[38] Programs being designed in Philadelphia and Minneapolis are also taking this approach.[39]

In contrast, the Bicing program in Barcelona does not offer memberships shorter than one week, and these, like the annual memberships, are restricted to residents of Spain. This decision was made to avoid draining business from private tourist-oriented bicycle rental companies. Current demand from annual users already exceeds capacity without the inclusion of tourists.[40]

Transportation demand management programs like CTR use incentives to encourage use of alternative transportation. The programs do not require employees to change habits, but they do create the support structure to make those choices easier.

37 City of Seattle, Commute Trip Reduction Basics, 2009, http://www.seattle.gov/waytogo/commute.htm (accessed January 22, 2010).
38 Nice Ride, Twin Cities Bike Share, Non-Profit Business Plan (Minneapolis: City of Minneapolis; Community Planning and Economic Development Department, 2008).
39 Ibid.
40 Ibid.

This analysis assumed that a Seattle program would include membership options for tourists. Many tourist attractions are focused in the downtown area. Tourists using bike-share could access these attractions without contributing to the congestion and parking pressures in the downtown area. This would be an added benefit of increased mode share choices.

In addition to enticing short-term members, the tourist attractions included in this study could also generate trips for Seattle resident bike-share users, as community amenities such as museums and libraries were included in the tourist attraction category.

Parks

Parks are a bike-friendly land use; cyclists are comfortable biking in parks. Parks serve as a destination for both residents and tourists in Seattle. However, we used a half weight for parks because bike-sharing will likely serve more work, shopping, and social trips than recreational trips. In fact, experiences in other cities have indicated that modern bike-share systems are not used for recreational purposes. In Barcelona, 57 percent of Bicing users made trips for work reasons.[41] Data from Washington, D.C., showed similar results: SmartBike DC riders used bike-share primarily for social purposes: 26.2 percent; work: 22.2 percent; and shopping: 20.0 percent.[42] A 2007 survey of Paris users showed that 67 percent of weekday riders used bike-share for work purposes.[43] This emphasis on non-recreational riding means that bike-sharing is less likely to be used inside parks, though parks do serve as possible destinations.

One of the primary goals of a bike-share program is to encourage non-motorized transportation and increased bicycle use. Although categorizing parks as bike-share destinations was consistent, our analysis excluded the idea of placing stations within parks, as this would change the focus of bike-sharing to a recreational activity.

Topography

Though the available literature on the effect that urban topography has on rates of cycling is limited, there are a few main points worth noting that heavily influenced our use of topography as an indicator. A recent study on the determinants of bicycle mode share for journey to work trips found that hilliness is a very significant indicator of the proportion of people that cycle to work.[44] Furthermore, ridership is elastic in response to hills, with a 10 percent increase in the degree of hilliness linked to a 10 to 15 percent reduction in the proportion of people cycling to work.[45]

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41 Tyler Benson, "Public Use Bike Share Feasibility Study: Volume Two: Demand Analysis," 2009, p. 2.77

42 Benson, p. 2.78

43 http://www.nxtbook.fr/newpress/Mairie-de-paris-direction-voirie-deplacements/Paris_transport_and_travel_2007_report/index.php#/20

44 Parkin, J., Wardman, M., & Page, M. (2008). Estimation of the determinants of bicycle mode share for the journey to work using census data. Transportation , 35, 93-109.

45 Parkin, J., Ryley, T. J., & Jones, T. J. (2007). Barriers to Cycling: An Exploration of Quantitative Analysis. In D. Horton, P. Rosen, & P. Cox (Eds.), Cycling and Society (pp. 67-82). Burlington, Vermont: Ashgate Publishing Company.

It is clear from a review of the literature that steep hills can be a major impediment to cycling. However, this is especially true in the case of bike-sharing because the bicycles are typically heavier than average and utilize fewer gears. In addition, a higher proportion of novice cyclists or occasional riders are likely to use the system in comparison to regular cyclists or bicycle commuters in the city. Therefore, topography should be considered very carefully when the potential demand of a program and location of implementation are analyzed.

Transit Network

Regional and local transit stops have been selected as an indicator because they provide a ready population of people traveling to destinations. Bike-sharing can provide on-demand "last mile" transportation for these transit customers, creating a seamless transportation experience. It is likely that bike-sharing will become a part of the variety of choices available to commuters. In other cities, once bike-sharing has been implemented, many bike-share trips are trips diverted from transit. However, research has shown that these are likely just segments of a trip partially completed on transit, where bike-share serves as one more travel choice. In Lyon, more than 50 percent of bike-share trips were diverted from transit, but there was very little reduction in the number of transit passes purchased.[46] These bike-share users "diverted" from transit were likely still using transit and then using bike-share to complete the last mile of their journey in a more convenient manner.

New users may be attracted by the increased travel options that bike-sharing offers, and existing transit users may be retained when they can quickly move between transit and a bicycle.

The transit network category was divided into separate indicators: regional transit and local transit.

Regional Transit

Regional transit was defined as stations or stops serving Amtrak, Washington State Ferries, King County Ferries, Sound Transit Link light rail, Sound Transit Commuter Rail, Sound Transit Express Bus Service, and other transit that crosses city lines. People arriving in Seattle via regional transit are ideal customers for bike-sharing. They are heading to a destination within Seattle but likely have an additional segment to complete, the "last mile." Bike-sharing can provide a quick and convenient mode to get them there.

Local Transit

Local transit is a separate indicator because trips made by King County Metro local bus service and City of Seattle South Lake Union Streetcar are typically shorter than trips made by regional transit. Although King County Metro also provides regional trips, it is the main provider of local transit.

46 Tyler Benson, "Public Use Bike Share Feasibility Study: Volume Two: Demand Analysis," 2009, 2.71.

Some local bus trips have the potential to be highly complemented by bike-sharing on both the origin and destination sides of the trip. Studies have shown that the wait time between buses or during transfers is perceived to be two to three times longer than the actual time. Any reduction in perceived wait times will help attract riders.[47] Thus, new users may be attracted by the increased travel options that bike-sharing offers, and existing transit users may be retained when they can quickly move between transit and a bicycle. In rare cases, local transit trips may be replaced entirely by bike-sharing if the trip is short enough.

Bicycle Infrastructure

Several studies in the United States have found that the presence of bicycle lanes and paths is correlated with higher rates of bicycling or willingness to cycle. Few studies, however, provide data on what specific types of bicycle infrastructure (bicycle lanes, off-street trails, shared-lane markings) will be most effective at encouraging bicycle commuting among the general population. Indeed, most large sample surveys do not include questions about routes or facility preferences.

Several simple, stated-preference studies have found that people prefer bicycle paths and lanes or indicate that having such infrastructure would encourage them to bicycle more.[48] In addition, a national survey found that while frequent bicyclists preferred bicycle lanes rather than recreational paths, infrequent bicyclists were more likely to want more bicycle paths rather than lanes.[49]

Proximity to "Bicycle-Friendly Streets," Including Streets with Bicycle Lanes
A recent study in Portland, Oregon, documented the travel patterns of 166 cyclists for one week by using GPS technology. The researcher found that about half of all the miles of bicycle travel recorded by the GPS units occurred on roads with bicycle lanes, paths, or bicycle boulevards[50]—even though these facilities made up only about 8 percent of the Portland street network available to cyclists. For our purposes, these facilities can be classified as "bicycle friendly streets."

Proximity to Streets with Bicycle Lanes
Of the 52 percent of bicycle travel that occurred on "bicycle friendly streets," over half of those miles traveled took place on streets with defined bicycle lanes.[51]

The conclusions of the Portland study included the following: a supportive bicycle environment appears necessary to encourage bicycling for everyday travel; a network of different types of infrastructure appears necessary to attract new people to bicycling; and the areas where the highest levels of bicycling occur also have a well-connected street grid and mix of

47 Institute of Transportation Engineers. (1997). A Toolbox for alleviating traffic congestion and enhancing mobility.
48 Dill, J. (2009). Bicycling for Transportation and Health: The Role of Infrastructure. Journal of Public Health Policy , 30 (S1), S95-S110.
49 Bureau of Transportation Statistics. (2004). How Bike Paths and Lanes Make a Difference. Washington, D.C.: Bureau of Transportation Statistics.
50 Dill, J. (2009). Bicycling for Transportation and Health: The Role of Infrastructure. Journal of Public Health Policy , 30 (S1), S95-S110.
51 Ibid.

land uses.[52]

By taking into consideration the proximity to "bicycle friendly streets" (including streets with bicycle lanes), as well as the proximity to streets with actual bicycle lanes, we essentially "double-counted," or weighted more heavily, the presence of on-street bicycle infrastructure in our analysis. This was done intentionally to take into account the impact of on-street bicycle infrastructure on rates of cycling, as noted in the literature on the subject.

Analytical Method

This effort addressed two primary questions: 1) where in Seattle is bike-sharing most suitable, and 2) what are the anticipated demand levels within those areas? Both of these questions were resolved by using a methodology adapted from the efforts of Krykewycz et al. from the DVRPC.[53]

Market Area Identification

The first step in this analysis was the development of the twelve demand indicators. Each indicator was assigned a weight to account for the relative influence it would have on measuring bike-share potential. Nearly all indicators were assigned a weight of 1.0, except the Non-institutionalized Group Quarter Population Density (NIGQPD) and Parks and Recreation metrics, which were given weightings of 0.5. The assumption that each indicator, with the exception of the two lower weighted indicators, would have a relatively equal effect on bike-sharing was based on our literature review and a desire to simplify the evaluation.

Each of the twelve indicators was evaluated for the entire City of Seattle by using geographic information systems (GIS) analysis. In a process known as raster analysis, an analysis was completed by gridding the city in 10-meter-square cells and assessing each cell for the strength of each indicator. In some cases (illustrated in Figure 2), data were only available at a more aggregated transportation analysis zone (TAZ) level. To create consistency, the TAZ level data were converted to the 10-meter-square cell resolution by applying the measurement to each cell within the TAZ.

Using GIS, we applied a variety of raster calculations, as indicated by the Scale and Metric attributes of our indicators (see Figure 2). After the raster file had been produced for each indicator in GIS, the distribution of scores was reclassified into a 10-point scale by using the quantile method.[54] For each indicator, the end product was a raster layer with each cell scored on a scale from 1 to 10. Appendix A displays the raster maps for each indicator; the darkest color and highest score always represent the cells deemed most suitable for bike-sharing, whereas the

52 Dill, J. (2009). Bicycling for Transportation and Health: The Role of Infrastructure. Journal of Public Health Policy , 30 (S1), S95-S110.

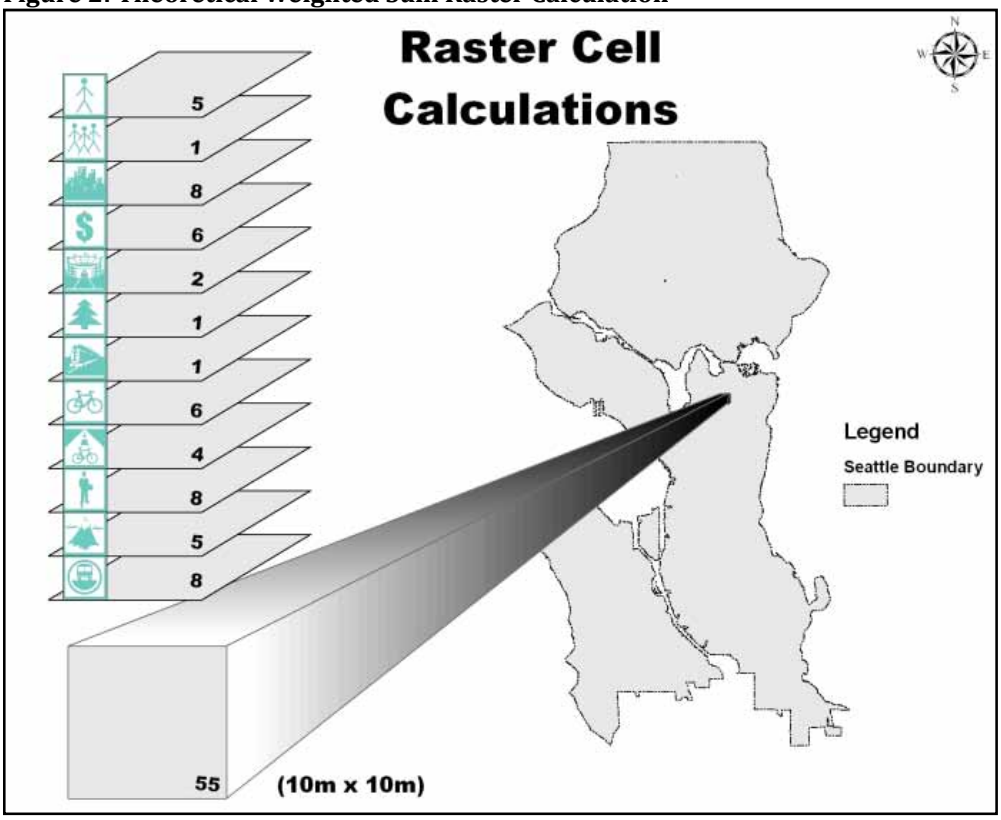
53 JzTI and Bonnette Consulting, *Philadelphia Bikeshare Concept Study*, (Philadelphia: Delaware Valley Regional Planning Commission, 2010).

54 In the quantile method, each classification has the same number of original measurements.

lightest, lowest-scoring cells are least suitable.

The individual raster files were combined by applying the weights and summing the score for each indicator. This process is known as a weighted sum raster analysis. The result was a raster map of Seattle with a composite bike-share score, with cell scores ranging from 11 to 110. Again, the higher numbers indicate more suitability for bike-sharing. The summation process is demonstrated for a hypothetical cell in Figure 2.

Figure 2: Theoretical Weighted Sum Raster Calculation



The final step for our analysis was reclassification of the raw raster summation into six bins using the geometrical interval classification[55] method, maintaining the 10 meter square resolution, and using higher numbers to indicate greater favorability. Maps of both the raw raster data and the reclassified data can be found in Appendix A of this document (Indicator Maps, Figures 11 to 22; Seattle Weighted Sum Raster Analysis, Figure 23; Seattle Weighted Sum Raster Analysis Reclassified to Six Levels, Figure 24; and Proposed Seattle Bike-Share Implementation Phases with Weighted Raster Analysis, Figure 25). We refer to cells in the reclassified map as being of Level 1 through Level 6, corresponding to their score.

Reclassification of the cells generated a data set that could be analyzed to assign proposed phased implementation areas for bike-share. This analysis supported drawing geographic

55 According to ArcGIS documentation, the method of geometrical interval classification creates class ranges with three properties: the squared sum of differences between the values in a class and the average value of the class is minimized for all classes; each class has approximately the same number of values or observations; changes between the range of each interval are approximately consistent. The coefficient or rate by which the interval changes may inverse once across all ranges.

borders for three proposed phases of implementation. Explained in further detail in the next section, regions with the greatest concentration of the Level 6 and 5 cells correspond to the best market area(s).

Demand Estimates

Upon completion of the market analysis, the proposed implementation areas were evaluated with a sketch-planning method to determine their likely demand for bike-share. This evaluation again relies on the work of Krykewycz et al., who used survey data from three existing bike-share programs in Europe (Lyon, Paris, and Barcelona) to indicate the relative attractiveness of bike-share to the users of various modes. Unfortunately, at the time of this study there were no comprehensive bike-share systems in North America with available data. Using the existing ridership of those modes, and the modal diversion rates, approximate numbers of bike-share trips are estimated. Table 4 illustrates the modal diversion rates developed by Krykewycz et al. that will be used in this analysis.[56]

Table 4: Bike-Share Modal Diversion Rates

	Diversion Rates		
	Low	Med	High
Car	0.06%	0.14%	0.18%
Bus	1.40%	3.80%	4.60%
Bike	1.80%	2.60%	3.40%
Walk	0.48%	0.56%	0.64%
New Trips	1.10%	2.20%	4.40%

Once identified, the diversion rates were applied to Seattle travel data. Seattle travel data was provided by the PSRC Travel Demand Model,[57] representing trip production and trip attraction characteristics at the TAZ level from 2006 base year data. For purposes of this study, the number of trips for each mode originating and terminating in each TAZ were summed and divided by two in order to avoid double counting. TAZ boundaries were overlaid on the proposed implementation areas identified during the demand analysis. In this manner we had access to the trip-level data necessary, when combined with diversion rates, to estimate bike-share trips for each TAZ. We then aggregated trip counts by mode for all TAZs in the implementation area.

56 Krykewycz et al. note that several assumptions were made in calculating the European diversion rates. Given, original mode share data for the European cities was only available at the metropolitan scale, simple factor was necessary to estimate mode share for the bike-share implementation area. Accordingly, their belief is that auto-mode share is likely to be over-estimated while other modes are likely to be under-estimated.

57 Puget Sound Regional Council Travel Demand Model, 2006 Daily Trips – Productions and Attractions aggregated to TAZ level. Provided by Chris Overby on 2/12/2010.

Transit Diversion Discussion

As Table 4 indicates, the majority of bike-share trips are being diverted from public transit. Although this shift from public transit might seem like a problem, especially for transit providers, the origin and relevance of this statistic should be further explored. Philadelphia's bike-share study notes that European public transit systems experience more peak-period 'crush-loading' than American systems. This would indicate a "higher initial mode-share burden and greater impetus for travelers to seek a more comfortable alternative."[58] The Philadelphia authors also state that the "survey results are not clear as to whether the cited bike-share trips had replaced all or just part of a transit trip, which would have different implications. An example of the latter case would be someone using bike-share rather than the bus to get to a train station, then resuming the journey on public transport."[59] In the public bike system in Lyon, France, up to 50 percent of bike-share trips were shifted from public transit, but "there was very little impact on the number of transit passes purchased, suggesting that public bike usage becomes part of an individual's array of transportation mode choices."[60] It is our conclusion that upon further review, the high diversion rate from public transit is not a drawback, but an opportunity to grow ridership by providing additional transportation alternatives.

Results

As described in Analytical Methods, we divided the City of Seattle into 10-meter-square cells to identify a proposed implementation area. Each square was evaluated on the basis of each bike-share indicator discussed in the Demand Indicators section. For example, cells with little to no difference in elevation within the cell bounds receive a high score for the *Topography* indicator; cells at a great distance from Metro bus and streetcar stops receive a low score for the *Local Transit Stops* indicator. We chose this method for its ability, at a granular level, to delineate areas of probable success.

In recommending potential implementation areas, it is assumed that a contiguous network that minimizes distance between stations is a critical characteristic of successful bike-share systems. A square-shaped implementation area is preferable when compared to a long, thin rectangle. This means that having a large number of contiguous Level 5 or 6 cells as well as maintaining a square-like shape were important factors in identifying the recommended implementation area boundaries.

Based on our analysis and these considerations, we are recommending a three-phase implementation strategy. Following successful implementation of Phase 1, Phases 2 and 3 can be brought on-line as the program grows and resources become available.

Implementation Phases

The Proposed Seattle Bike-Share Implementation Phases map in Figure 3 displays the three proposed implementation phases identified from our GIS analysis. The map generally

58 Philadelphia Bikeshare Concept Study, 2010, pg. 28.
59 Ibid.
60 Quay Communications Inc, V2, 2008, 16

shows Seattle's downtown and surrounding neighborhood areas scoring strongly as a candidate area for bike-share. Accordingly, we recommend this downtown area as the implementation area for Phase 1, depicted by the green shaded area. It is approximately four square miles, fairly symmetric with respect to height and width, and engenders a network in which stations would be evenly distributed. Reviewing the individual indicator maps, Appendix A, the downtown scores very strongly on five of the twelve indicators: *Commute Trip Reduction Companies*; *Tourist Attractions*; *Regional Transit*; *Streets with Bicycle Lanes*; *Local Transit Stops*, and strongly on four additional indicators: *Population Density*; *Job Density*; *Retail Job Density*; *Bicycle Friendly Streets*.

The proposed Phase 1 area is almost entirely composed of Level 6 cells. Furthermore, we know that the large pocket of Level 5 cells within the Phase 1 area is the Seattle Center, which scores lower for a lack of job, population, transit, or bicycle facility densities but is otherwise a very strong draw for residents and tourists alike. Although we acknowledge this is a large island of lower scoring cells, we believe that the presence of the Seattle Center is actually a partial reason that the surrounding cells score high. Given this fact, we believe it is important to include the Seattle Center in the proposed Phase 1 implementation area.

Despite the large number of Level 6 cells in the University District (UD), we did not include it in Phase 1—although this might be an issue worth exploring in greater detail. Note that the presence of the University of Washington (UW) and Children's Hospital in the UD could benefit a bike-share program. The UW has a strong history of supporting transportation alternatives, such as its UPass program. The UW also has a high potential to generate bike-share ridership, with 60 percent of its students and employees who don't already walk or bike living within 5 miles of campus. Furthermore, Sound Transit's LINK Light Rail line will be expanded to the UD in 2016, which will support connections with regional transit in the future. Finally, while Children's Hospital is not contained within the proposed implementation area, its previously stated interest in a bike-share program and planned facility expansion may ultimately affect whether this area is included.

However, although the UD has benefits to offer a bike-share program, it is approximately 2 miles from the downtown area, with varied topography and poor bicycle infrastructure in between, which could discourage bike-share trips between the downtown and the UD. Implementation in both areas, with or without intermediate stations, would create a disjointed network, increasing implementation risk without adding the benefits of a larger, contiguous network. A disjointed bike-share implementation area has not been observed in other bike-share programs in Europe or North America, so we believe that the risk would be too high for initial implementation.

For the proposed Phase 2 area we recommend a substantial increase in the network, adding approximately 14 square miles, including the UD. Along with the UD, the goal of Phase 2 is to expand to Level 5 cells. Doing so, while maintaining a

dense, contiguous network, will require the inclusion of areas between these centers that scored lower than Level 5 or 6. These exceptions will be made in a desire to reduce user uncertainty about entering and exiting the network.

Finally, for proposed Phase 3, we propose expanding the implementation area to include outlying areas in North, Southeast and West Seattle. As seen in Figure 5, these centers lack a strong connection with the first two implementation areas, as measured by our bike-share indicators. However, we also recognize the importance of moving to a city-wide network, accessible to all residents. The decision to expand to these outlying areas should be contingent on the success of phases 1 and 2.

Demand Estimates

Having identified geographic boundaries for proposed implementation phases, we then proceeded to estimate the level of demand within those areas. To do this, we once again leveraged the methodology introduced by Philadelphia, incorporating survey data from European systems.

In recommending potential implementation areas, it is assumed that a contiguous network that minimizes distance between stations is a critical characteristic of successful bike-share systems.

Trip Estimates

Survey data from users of existing systems provided us with baseline diversion rates for various transportation modes. Specifically, users of existing systems were asked, what mode would they have used to make their trip if not for the bike-share system? Note that, in some instances, users indicated they would not have made the trip at all—indicating a new trip rate in addition to the existing mode diversions. This data is presented in Table 4 in the Analytical Method section.

The survey-generated diversion rates were applied to TAZ-level trips in Seattle to produce an estimated range of daily bike-share trips in each proposed phase of implementation. The Phase 3 implementation area did not have a good geographic match with the TAZ boundaries. To compensate for this discrepancy, a ratio of implementation area to TAZ area was applied to the trip estimates to correct for the over-estimation. The results were provided in three scenarios—low, medium, and high—based on the low, medium, and high diversion rates. The analysis showed that the proposed Phase 1 will produce between 2,600 and 6,800 daily bike-share trips; Phase 2 will produce between 1,900 and 4,800; and Phase 3 will produce between 300 and 800. Appendix A provides a table showing the number of bike-share trips diverted from each mode of transportation in each proposed phase of implementation.

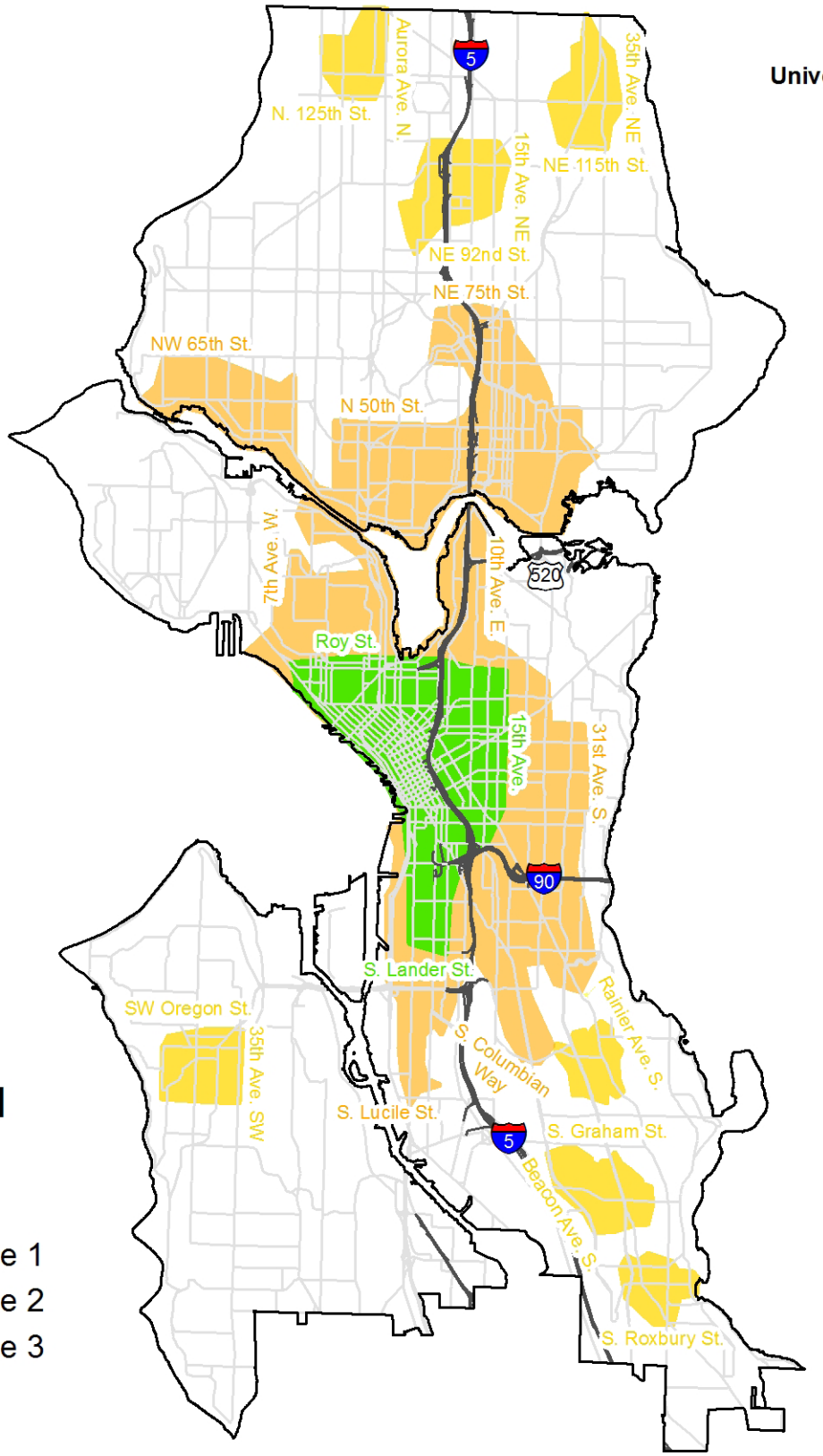
Bicycle Demand Estimates

To estimate the number of bicycles needed for the program, we again reviewed information from existing systems. After reviewing various methods for calculating an adequate level of

Proposed Seattle Bike-Share Implementation Phases

SEATTLE BICYCLE SHARE feasibility study

University of Washington
Bike Share Studio



Legend

Seattle

- Phase 1
- Phase 2
- Phase 3

0 0.5 1 2 3 4 Miles

Figure 3: Proposed Seattle Bike-Share Implementation Phases

bicycle deployment, we settled on using an average of trip-generated and station-generated demand estimates. The final demand estimates were provided within a range, low to high.

- **Trip-Generated Demand**: The trip-generated demand was based on data that indicated, on average, that a bike-share bicycle is used 7.67 times per day. To calculate demand in this manner, we used the number of daily bike-share trips originating from our trip estimates, discussed earlier in this section. Although the trip estimates provided low, medium, and high scenarios, we used only the low and medium figures. Using the high scenario would have produced bike-sharing rates in Seattle higher than those in its peer European cities. Given that bike-sharing is relatively new in North America, we thought that this was unlikely to happen, so we used the low and medium scenarios to estimate demand. To estimate the number of trip-generated bicycles needed, we calculated by using what we know:

  Trip-Generation Demand for Bicycles: number of bicycles = number of daily trips ÷ trips per bicycle (7.67)

- **Station-Generated Demand**: The station-generated demand was based on standard supply-side equations used by bike-share vendors and peer cities in Europe. Assuming 15 bicycles per station, a station density, or stations per square mile, criterion was applied to each proposed implementation area to generate the number of bicycles needed. Research and industry best practices indicated that 15 bicycles per station is an appropriate number.[61] Given that our proposed Phases 1, 2 and 3 implementation areas had significantly different land-use patterns and relative bike-share demand, we adjusted the equation to use different station densities for different phases of implementation. We assigned the proposed Phase 1 a station density of 20 stations per square mile. This density is the accepted industry minimum density to support a fully optimized bike-share operation in key destination areas. The proposed Phase 2 and Phase 3 implementation areas were assigned a station density of 10 stations per square mile. This density is more appropriate for residential areas that produce mostly origin bike-share trips and follows an accessibility-based standard. The standard is based on the fact that all residents should be within a 5- to 10-minute walk of a bike-share station. To estimate the number of station-generated bicycles needed, we can calculated as follows:

  Station-Generated Demand for Bicycles: number of bicycles = station density (20 stations per square mile for Phase 1 and 10 stations per square mile for Phase 2 and 3) * implementation area (square miles) * bicycles per station (15)

On the basis of our analysis, this indicated an estimated range of 800 to 1000 bicycles for the proposed Phase 1 implementation. For Phases 2 and 3, estimates ranged from 1,100 to 1,200 and 360 to 380 bicycles, respectively, for a potential maximum of nearly 2,500 bicycles. Table 5 summarizes the results of the bicycle demand estimation. In comparison,

61 JzTI and Bonnette Consulting. Philadelphia Bikeshare Concept Study. Philadelphia: Delaware Valley Regional Planning Commission, 2010.

Barcelona has approximately 6,000 bicycles in its system, Lyon has 4,000, Paris has 20,000, and Washington, D.C., has 120.

Table 5: Bicycle Demand Estimates by Proposed Phases of Implementation

		Phase 1	Phase 2	Phase 3
	Density (station per square mile)	20	10	10
Low Bicycle Demand	Trip-Generated Demand	341	179	37
	Supply-Generated Demand	1,245	2,049	675
	Final (Average)	793	1,114	356
High Bicycle Demand	Trip-Generated Demand	712	422	75
	Supply-Generated Demand	1,245	2,049	675
	Final (Average)	978	1,235	375

Bicycle Station Demand Estimates

By using the proposed implementation area boundaries and recommended standard for number of bicycles per station, we were able to calculate the expected number of stations necessary for the identified implementation areas. Research and industry best practices suggest that each station should contain docking for about 15 bicycles.[62] This figure is used only as a general guideline for estimating the number of stations needed for implementation. When the exact size of each station is planned, it is possible that some stations should contain more or less than 15 bicycles. However, the exact station placement and size was beyond the scope of this study. Therefore, calculations follow the form:

Number of bicycles / bicycles per station (15) = number of stations

Station estimates for each phase had the following ranges: 53 to 65 for Phase 1, 76 to 85 for Phase 2, and 24 to 25 for Phase 3. Table 6 displays the number of bike-share stations for the proposed Phases 1, 2 and 3.

Table 6: Bike-Share Station Estimates by Proposed Phases of Implementation

	Phase 1	Phase 2	Phase 3
# Stations Low (Bikes / Bikes per station (15))	53	76	24
# Stations High (Bikes / Bikes per station (15))	65	85	25

62 JzTI and Bonnette Consulting, Philadelphia Bikeshare Concept Study, (Philadelphia: Delaware Valley Regional Planning Commission, 2010); 72.

Potential Impacts of Climate and Culture

Our methodology for determining trip diversion rates relied on data from cities with existing bike-share programs. To provide some context for this comparison, we researched variables relating to climate and culture. However, little empirical data exist that would show the true impact, if any, of these variables on bike-share ridership.

Although we cannot say the degree to which each of the following will influence bike-share ridership, below are our hypotheses regarding their effects:

- The amount of winter rainfall in Seattle is at least twice that of our comparison bike-share systems. The amount of precipitation during other seasons is comparable to other cities. This implies that using diversion rates from other cities will overstate Seattle ridership. However, because the diversion rate data are provided only annually, it is unclear how much, if any, this rainfall difference will affect our estimates.
- Seattle experiences more rainy days than Barcelona during all seasons, and two to four more days per month than Paris and Lyon during the winter season. However, it experiences fewer days of rain than Paris and Lyon in the summer and comparable amounts during the spring and fall. Therefore, using diversion rates from other cities might overstate ridership for winter months and understate it for the summer.
- Seattle's temperatures are approximately ten degrees lower than Barcelona's in every season and within five degrees of Paris and Lyon's in all seasons. Temperature is therefore unlikely to have a great effect on diversion rates.
- Seattle has similar bicycle mode share, but substantially higher automobile mode share and lower transit mode share. Furthermore, Seattleites make more walking trips than citizens in some of, but not all, the comparison cities. Because of the lack of empirical data and the variation among comparison cities, it is not clear how the differences will influence Seattle ridership.
- Seattle has significantly lower population density than our comparison cities; it is at least 10 percent as dense as Paris and 25 percent as dense as Lyon. While public transit systems generally work better in denser environments, the extent of this effect on bike-share is unclear.
- Seattleites own more cars per capita than residents of other cities with bike-share systems—50 percent more than Lyonnais and three times as many as Parisians. Because automobile ownership is generally regarded as a primary determinant of

While we believe using diversion rates from cities with existing bike-share programs is the best method for estimating potential demand in Seattle, the validity of this approach depends on the similarity of these cities to Seattle.

mode choice, this could decrease the number of bike-share users relative to other cities.[63]

- While topography affects route choice within cities (users tend to use bike-share for downhill trips and other modes for up-hill trips), we uncovered no data to indicate how topography affects overall usage.
- Due to the variations in climate, Seattle may consider operating a three-season system, as is done in Montréal. A seasonal system would likely affect both ridership and costs. While these systems are designed to be easily removed, the operator would still incur additional costs for the removal and storage of the infrastructure. However, there would be little maintenance or operating costs during the winter months. It is unclear what impact a seasonal system would have on total ridership; as mentioned above, Montréal has not yet generated ridership figures and Minneapolis has not yet launched their system.

63 Moshe Ben-Akiva and Steven R. Lerman, Some Estimation Results of a Simultaneous Model of Auto Ownership and Mode Choice to Work, (Transportation , 1974). Accessed at: http://www.springerlink.com/content/v51007r34tqg5748/

3. Policy Framework

Introduction

In this chapter we identify a possible policy framework for planning and implementing a bike-share program in Seattle. This framework encompasses several proposed elements of a bike-share system, including program model, siting and installation of stations, user fee structure, and public outreach and education. The overall policy framework also includes city and regional plans and policies that we have identified as potentially affecting implementation of a bike-share program in Seattle.

These plans and policies include the following:

- The King County bicycle helmet law
- Seattle sign code restrictions
- The Seattle Bicycle Master Plan
- Land-use and right-of-way improvement regulations
- Curbspace management policies
- The Seattle Pedestrian Master Plan
- Race and social justice initiatives
- Other Sound Transit or King County Metro policies that would affect a bike-share program in Seattle

System Elements

This section reviews the potential system elements we have identified as necessary pieces for successful planning and implementation of a bike-share program in Seattle.

Basic Program Model

There are two basic models of bike-share programs: “flexible” programs and “fixed” programs.

Flexible programs are similar to the Call-a-Bike program operated by Deutsche Bahn, the German national rail company. Flexible programs do not use designated check-out stations. Instead, they rely on existing bicycle racks, poles, and posts throughout the implementation area. Bicycles are checked out and returned to any of these fixtures that are near the origin and destination, respectively. The check-out method consists of using a cellular phone to obtain a combination for the bike’s built-in locking device. A benefit of flexible programs is that they do not require the additional hardware of designated docking stations; they have much lower capital costs and are cheaper to operate and maintain. A drawback of flexible programs is that users may not find a bicycle when they need one.

Fixed programs involve the more "traditional" method of assigning designated check-out stations from which bicycles can be checked out and returned. An example of a fixed program is Barcelona's Bicing program. A benefit of fixed programs is that users can easily locate bicycles by identifying check-out stations near their trip origin. Furthermore, the operating agency can provide greater public outreach by supplying the public with maps that indicate all station locations throughout the implementation area. A drawback of fixed programs is that capital and maintenance costs are higher. In addition, some sort of protocol must be implemented to redistribute bicycles from at-capacity stations to empty stations. Redistribution efforts can add significant operating costs and be particularly challenging in hilly areas, as bicycles tend to flow downhill and remain at lower elevations.

Station Installation

Within the category of fixed programs, there are two additional categories that relate to the installation of the check-out stations: "permanent" stations and "modular" stations.

Permanent stations are installed directly into the street or sidewalk and are powered with existing infrastructure. An example of a program that utilizes permanent stations is the Vélib' program in Paris. A benefit of permanent stations is that they become part of the built environment, communicating that the program is "here to stay." A drawback of permanent stations is that they are costly to alter if initial demand estimates are inaccurate and stations need to be expanded or reduced to meet actual demand.

Modular stations, on the other hand, are not installed directly into the street or sidewalk. These stations are dropped into the location with a crane or forklift and secured by their sheer weight. The docking stations and payment kiosk are powered by solar power. An example of a program that utilizes modular stations is Montréal's Bixi program. Benefits of modular stations are that they are easy to install and remove and can be more easily expanded or reduced, depending on space or demand. For example, an entire program can be scaled back during seasons of poor weather and low usage, thus saving on maintenance costs. Potential drawbacks of modular stations include the psychological impact of a "removable" program on users as well as the uncertain capacity of solar power to keep the system operable 24 hours a day. Note, however, that neither of these drawbacks has been confirmed by the literature.

Site Criteria and Placement of Stations

Over the years, an industry standard for bike-share station density has become accepted. This density, also referenced as one bike-share station every 300 meters or one station every four to five blocks, is the density needed to ensure that users

The number of bicycle docks in the entire network of stations should be twice the amount of bicycles in the system.

can find a bicycle when they need one and return it easily when they are done.[64]

Bike-share station sizes in Seattle should vary depending on the expected volume of traffic and proximity to other stations. Important factors include population density, worker density, proximity to cultural or recreational attractions, and proximity to retail shopping opportunities. The number of bicycle docks in the entire network of stations should be twice the amount of bicycles in the system.[65] For instance, if a program has 100 bicycles, there should be 200 individual bicycle docks spread throughout the network of stations. This ensures that users can always find a place to leave their bicycle.

Some cities have identified general guidelines for the placement of bike-share stations.[66] Best practices for bike-share station placement suggest that bike-share stations be:

- On wide sidewalks or in the roadbed; Stations should not impede pedestrian or vehicular traffic
- Spaced with enough frequency to ensure program visibility and use (every 300 meters)
- Along existing or proposed bicycle lanes whenever possible
- Near light rail stations, major bus stops, and other transit hubs
- Near major cultural and tourist attractions
- Adjacent to major public spaces and parks

Transport for London (TFL) is in the process of planning a bike-share program for central London. In deciding on general locations for station placement, TFL planners placed a grid over a map of the Central London implementation area (Zone 1), a size of about 44 square kilometers. The grid was spaced in such a way that there were nine small squares per kilometer—three on each side—and one station was to be placed somewhere within each square. Each small square was 333 meters on each side, providing TFL with a distance of approximately 300 meters per station. TFL is planning to install 400 stations for Zone 1. Each station will average 25 bicycle docks with 15 to 20 bicycles per station, for a total of 6,000 bicycles that serve Zone 1.[67]

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64 New York City Department of City Planning. Bike-Share Opportunities in New York City. New York City: New York CIty Department of City Planning, 2009.
65 Cabañas, Jordi, interview by Max Hepp-Buchanan. Smartbike Interview (September 7, 2009).
66 New York City Department of City Planning. Bike-Share Opportunities in New York City. New York City: New York CIty Department of City Planning, 2009.
67 Hillcoat, Chris, interview by Max Hepp-Buchanan. Transport for London Interview (September 21, 2009).

User Fee Structure

Many bike-share programs offer a long-term (one-year), short-term (one-month or one-week), and one-day subscriptions. Subscription rates vary depending on the program operator and location. Table 7 shows the consumer cost for an annual subscription in three European programs. In comparing programs, it is important to remember that cost will drive ridership to some degree. To our knowledge, no studies have been designed to determine the relationship between the costs of annual membership and ridership.

Table 7: Consumer Cost in European Bike-Share Systems

Consumer Cost in European Bike-Share Systems				
City	Residents Within Service Area	Number of Annual Subscribers	Annual Subscription Rate	Annual Subscription Price (in USD)
Paris	2,166,200	166,000	8%	$37.70
Lyon	466,400	52,000	11%	$36.50
Barcelona	1,000,000	100,000	10%	$31.20

Source: Non-Profit Business Plan for Twin Cities Bike Share System (http://www.niceridemn.com/downloads/doc_plan.php)

After a user pays for a subscription of some length of time, almost all bike-share programs offer the first 30 minutes of use free of charge. After the first 30 minutes, prices often increase at an escalating rate for each additional 30 minutes. Table 8 illustrates fee structures for two programs that are operated by two different vendors: JCDecaux (Paris) and Public Bike System Company (Montréal). The table shows that the fees paid by the users are proportionally the same.

Table 8: Typical Bike-Share Usage Fee Structure

Typical Bike-Share Usage Fee Structure				
Program & City	1st Half Hour of All Trips	2nd Half Hour	3rd Half Hour	4th Half Hour & Each Additional
Vélib' (Paris)	Free	1 euro	2 euro	4 euro
Bixi (Montréal)	Free	$1.50	$3.00	$6.00

Customer research undertaken for London showed that charging for the initial 30 minutes could reduce up-take by as much as 15 percent.[68] This reduction could be even higher for smaller programs with limited network options.

68 Transport for London. Feasibility study for a central London cycle hire scheme. London: Transport for London, 2008.

Public Outreach and Education

Though public outreach and education is not a system element in the same way that program models and types of installation are, we recognize the importance of an extensive public education and outreach campaign before, during, and after bike-share implementation. This effort would be essential in educating the people of Seattle about what bike-sharing is, how it works, and why it is important. People would want to know why the city was investing in this new form of mobility, and public outreach would help explain this.

Many bike-share programs, such as Vélib' in Paris, assigned city employees at all major bike-share stations during the first week of implementation to answer questions and help new users experience the program for the first time.[69] Furthermore, evidence from Montréal's Bixi program suggests that an extensive public education and outreach campaign during the bike-share planning phase can help reduce rates of vandalism after the program launches.[70] Citizens of Montréal were asked for their opinions on the style of bike, system components that were important to them, and even for name suggestions. The name "Bixi" itself was named by a resident of Montréal. As a result, Stationnement de Montréal believes that residents see Bixi as a form of public transportation that was designed for them and therefore hold themselves accountable for the system's integrity.[71]

> People will want to know why the City is investing in this new form of mobility, and public outreach will help explain this.

A key element of the outreach and education campaign in Seattle might be to market the proposed bike-share program as a supplemental element to the city's transportation systems. Bike-sharing should not be seen as a competitor to Sound Transit and King County Metro, but rather as an instrument for completing the last mile of a commute. Furthermore, any integration of bike-sharing with the ORCA card—such as the ability to check out a public bicycle by using ORCA—would help facilitate this integration.

City and Regional Policies and Plans

This section examines the city and regional plans and policies we identified as having a potential effect on the proposed bike-share program in Seattle. Each policy or plan is discussed in detail, with potential problem areas, best practices to overcome challenging aspects, and recommendations where appropriate. A summary of our key findings from each analysis of policies and plans can be found at the end of this section.

King County Bicycle Helmet Law

King County has long had a bicycle helmet law, but it was not until the King County Bicycle Helmet Regulation, revised and unanimously adopted by the King County Board of Health in July 2003, that the law expanded to the City of Seattle as well. The law now mandates

69 Didier Couval, interview by Max Hepp-Buchanan, , Vélib Interview, (August 26, 2009).
70 Bérengère Thériault and Michel Philibert, interview by Max Hepp-Buchanan, , Bixi Interview, (September 25, 2009).
71 Ibid.

that all bicycle riders in King County wear a fastened, safety-approved helmet.[72] The penalty for violation is a civil infraction (ticket), and the base fine is $30. Additional court costs of $51 are added to the base fine amount for a total of $81. All law enforcement officers have the authority to enforce this code.[73]

The self-service nature of most bike-share programs limits their ability to provide helmets. Most bike-share programs in existence do not require helmets for users over the age of 18, and we did not find any program that actually requires users to wear helmets. Helmet use would be a challenge to bike-share use in Seattle and throughout King County, as people might not always be carrying a helmet with them. Unless a way around the helmet law in King County is discovered, the helmet requirement could dramatically reduce the number of bike-share riders by eliminating the spontaneity of bike-share use.

Best Practices Regarding Helmet Use

There are no easy answers to the question of how a bike-share program would operate under the King County helmet law. However, the best practices that inform our recommendations are discussed below.

JCDecaux

Global bike-share provider JCDecaux has already begun investigating the practice of imbedding membership cards into personal bicycle helmets.[74] However, this practice would require that bike-share users carry a helmet with them in order to use the program, which would almost certainly have a negative impact on usage rates. In addition, if the city wanted to offer one-day subscriptions to the public, there would be no way to make use of the program contingent on wearing a helmet through this practice.

New York City

Though much more research is needed to find a way to satisfy the helmet requirement and still have high rates of use, the New York City Department of City Planning has identified several innovative ways to encourage helmet use:[75]

- Give out free helmets with annual bike-share membership

Unless a way around the helmet law in King County is discovered, the helmet requirement may dramatically reduce the number of bike-share riders by eliminating the spontaneity of bike-share use.

72 King County, "Bike helmets are "Ticket to Safety", Public Health - Seattle & King County, May 15, 2004, http://www.kingcounty.gov/healthservices/health/news/2004/04051501.aspx (accessed February 23, 2010).
73 Davis Law Group, P.S., Answers to your legal questions, http://www.injurytriallawyer.com/faqs/is-there-a-helmet-law-in-seattle.cfm (accessed March 5, 2010).
74 New York City Department of City Planning, Bike-Share Opportunities for New York City, (New York: New York City Department of City Planning, 2009).
75 Ibid..

- Explore the "chip in helmet" program that is being developed by JCDecaux
- Continue public service campaigns encouraging helmet use

Minneapolis
In Minneapolis, the Nice Ride bike-share program (due to launch in spring of 2010) will not provide rental helmets to users because of sanitation and physical integrity issues.[76] Helmets are also not required for Minneapolis cyclists by local regulations. However, bike-share users will receive education about helmets and sign an agreement that helmet use is their responsibility. Website subscribers will also be offered a reduced rate on the purchase of helmets from local bicycle shops.[77]

Boston
In January 2009, the Massachusetts Legislature enacted Chapter 525 of the Acts of 2008, which provides that "[a] person, firm, or corporation engaged in the business of renting bicycles shall make available a bicycle helmet conforming to the specifications for bicycle helmets of the United States Consumer Product Safety Commission to each person renting a bicycle."

The European Cyclists' Federation believes that, instead of making it compulsory for cyclists to wear helmets, the authorities should concentrate on preventing accidents.

Boston's 2009 request for proposal (RFP) for bike-sharing requires that the vendor "make a helmet available to each person renting a bicycle so as to be in compliance with the Massachusetts Bicyclist Safety Bill."[78] However, the Boston RFP also notes that the legislation "does not define what 'shall make available' means. Potential vendors are encouraged to consult their counsel to develop a system for helmet purchase that complies with the law… ."[79]

There are significant differences between the Massachusetts law and the King County law—namely that King County requires that all cyclists wear a helmet whereas Massachusetts requires that all bike-rental businesses make helmets available to their customers.[80] Nevertheless, observing the proposal of Public Bike System Company (Boston's selected vendor of bike-sharing) to satisfy the mandates in the RFP and conform to the Massachusetts helmet requirement might give the City of Seattle some insight into how to approach this challenge.

76 City of Lakes Nordic Ski Foundation, Non-Profit Business Plan for Twin Cities Bike Share System, (Minneapolis: City of Minneapolis Community Planning and Economic Development Department, 2008).
77 Ibid.
78 The bill is Ma. Stat. 2008, c. 525, s.7." Metropolitan Area Planning Council, Request for Proposals, (Bostson: Metropolitan Area Planning Council, 2009).
79 Metropolitan Area Planning Council, Request for Proposals, (Bostson: Metropolitan Area Planning Council, 2009).
80 Washington State does not appear to have a similar law requiring private bicycle rental companies to provide helmets for their customers.

Europe

Europe has a different take on helmets altogether. The European Cyclists' Federation believes that, instead of making it compulsory for cyclists to wear helmets, the authorities should concentrate on preventing accidents.[81] The Federation believes that promoting the wearing of helmets by cyclists is not an effective way to improve safety for cyclists and that road safety for cyclists can only be improved by calming traffic and removing the danger at its source. Some European leaders believe that requiring cyclists to wear helmets actually discourages cycling as a major form of transportation because helmet laws make riding inconvenient and communicates to the public that it is somehow unsafe.[82] The clear policy direction under this framework would be to overturn the King County helmet law, although such a major change is viewed as highly unlikely.

Conclusion and Recommendations

The above best practices may not lead to any immediate solutions for approaching the challenge of required helmet use in King County. However, if enforcement of helmet laws were loose or contingent on the commission of a separate offense (as is the case with the state's seatbelt law, in which a driver can only be cited if pulled over for another violation), it might be possible for bike-share-related helmet use to be handled the same way it is handled for regular cycling—that is, riders choose whether or not to comply with the law.

Some European leaders believe that requiring cyclists to wear helmets actually discourages cycling as a major form of transportation because helmet laws make riding inconvenient and communicates to the public that it is somehow unsafe.

Until the bike-share industry develops a way to overcome this challenge, we recommend that the City of Seattle do the following:

- Consult with a team of legal experts on liability issues surrounding bike-sharing and helmet use
- Subsidize helmets for online subscribers by providing them with a voucher for a free or low-cost helmet from a local business[83]
- Consider contracting a low-cost local helmet manufacturer to mass-produce and saturate the city with helmets for public use that can be obtained from businesses near bike-share stations
- Consider the implications of the selected helmet policy on the use of bike-sharing by tourists and non-residents of Seattle. In heavily touristed areas, we

81 Quay Communications, Inc., TransLink Public Bike System Feasibility Study, (Vancouver: TransLink, 2008).

82 Ibid.

83 ProRider, a local helmet manufacturer quoted the cost of a single helmet at $3.95, purchased in bulk by an organization. Quote accessed at http://www.prorider.com, as of March 11, 2010.

recommend exploring ways to easily provide helmets to one-time bike-share users, perhaps through the installation of helmet vending stations

Sign Code Restrictions

The sign code presents several issues that would need to be addressed if Seattle developed a bike-share program. Bike-share systems rely on signs to advertise their presence, to explain how to use the system, and, in some cases, to fund the system by advertising other products. The Seattle permitting process presents several regulatory and procedural challenges to creating a bike-share program, particularly given the lack of precedence for bike-sharing. The general categories of issues that need to be addressed are as follows:

- **Jurisdiction**: Depending on sign locations, approval must be given by the Department of Planning and Development (DPD), the Seattle Department of Transportation (SDOT), the Department of Neighborhoods (DON), the Seattle Department of Parks and Recreation, and/or several Preservation Boards.
- **Classification of signage type**: Signage rules vary depending on whether the content of the sign is informational, advertises other products, advertises the bike-share system itself, or is a sponsorship. If legal review of the code shows that advertising for other products is impossible or extremely limited, the potential of an advertising-based business model will be limited.
- **Nature of bike-share station**: Rules differ for public infrastructure facilities, business establishments, and off-premises advertisements.
- **Zone and network-specific regulations**: Sign regulations vary by land-use zone and, in some cases, by street corridor. A bike-share network spanning several zones could have to meet several different sets of requirements, depending on the intensity and interpretation of signage elements.
- **Administrative process issues**: The sign code calls for a separate permit application for most signs, which would make implementation lengthier. However, there is a rule allowing for special exceptions from the Director of Planning in certain zones under specified circumstances.
- **Sign design**: The sign code mandates materials of a certain quality, clearances, and illumination.

These are discussed in detail below.

Overview

The municipal code description of the intent of sign code standards reads as follows:

A. To encourage the design of signs that attract and invite rather than demand the public's attention, and to curb the proliferation of signs;

B. To encourage the use of signs that enhance the visual environment of the city;

C. To promote the enhancement of business and residential properties and neighborhoods by fostering the erection of signs complementary to the buildings and uses to which they relate and which are harmonious with their surroundings;

D. To protect the public interest and safety;

E. To protect the right of business to identify its premises and advertise its products through the use of signs without undue hindrance or obstruction; and

F. To provide opportunities for communicating information of community interest.

Note that the aim of the sign code is explicitly to "curb the proliferation of signs." It is expressly designed to make it difficult to add signage. Thus, bike-share developers should anticipate some degree of challenges when dealing with this code.

This is not to say that the code is entirely set against a bike-share system. It could be argued that signage advertising a bike-share service could be designed to enhance the visual environment of the city (element B), promote the enhancement of a bike-share "business" (element C), protect the public interest by supporting transportation choice (element D), protect the right of a bike-share business to identify its premises (element E), and that advertising the existence of bike-sharing would communicate information of community interest (element F). On the other hand, advertising on bike-share stations that promoted the use of unrelated products could run contrary to the intent of elements C through F.

Jurisdiction

Authority for sign approval varies depending on whether the sign is in the public right-of-way and whether the sign is in a historic review district.

- For signs not in the Public Right-of-Way: DPD issues sign permits
- For signs that extend into the Public Right-of-Way: SDOT must issue a Street Use Permit before DPD may issue the sign permit. These signs are governed by the Street Use Ordinance, Title 15 of the Seattle Municipal Code (see Station Design & Permit Review discussion)
- For signs in historic or special review districts, or on the same lot as a Landmark structure: the preservation board with jurisdiction over the property must first make a recommendation to DON, which must then issue a written approval of the proposal before DPD may issue the sign permit
- For sign kiosks located adjacent to a park, playground, or publicly owned community center: Seattle Department of Parks and Recreation must also review the sign design. Requirements for this type of sign are listed in

Appendix D

Two Types of Signs

The business model on which a bike-share system was based would determine which elements of the sign code were applicable. Bike-share systems that relied on advertising of other products would have more stringent requirements to meet than bike-share systems that only needed to advertise itself on its stations. A system that relied on sponsorships might also have fewer regulatory hurdles to clear. For example, Seattle Streetcar stations display the name of a corporate sponsor (but not product advertising) and therefore did not need to go through an additional permitting process.

On-bicycle advertising might present less of an issue, as the sign code does not address vehicle-based advertising. This has allowed Metro to advertise inside and outside its buses. However, unlike buses, bike-share bicycles might spend substantial time parked on public right-of-way. SDOT would therefore want to verify that docked bicycles would not be viewed as an advertising sign. See Figure 4 for examples.

Nature of the Bike-Share Station

The sign code includes different rules for public infrastructure, business establishments, and off-premises advertisements. However, it is not clear which of these categories a bike-share system would fall under. It could potentially be construed as a vending machine, which is not addressed under the sign code.

The rules for off-premises advertisements are the most restrictive. Business establishment rules are intended to allow business owners to display the names of their establishments on the outsides of their buildings. Public infrastructure rules are the least defined in the code.

Off-Premises Signs

SDOT should determine whether signs on bike-share stations that were used to advertise other products would fall under the category of "Off-premises signs." If so, the sign code has a number of restrictions. These are detailed in Appendix D.

Zone and Network-Specific Regulations

Sign restrictions vary by zone, making it potentially challenging to design a sign that would be appropriate in every zone. Each zone has restrictions on the number, size, and illumination standards for signs. Restrictions in single family zones are the most restrictive, while most commercial zones are least restrictive. However, the Pioneer Square Preservation District and the International Special Review District present particularly stringent design requirements and review processes. Pike Market Historic District, Shoreline areas, and certain transportation corridors also have additional requirements, although these appear easier to satisfy.

The Application Process

The codes call for the applicant to obtain the zoning and zone-specific sign regulations from DPD Sign Inspections for each sign. This is because sign regulations vary by zone. Depending on the location and extent of the implementation area and the number of stations, this

Figure 4: Photos of On-Station and On-Bicycle Advertising Opportunities

1 NYC Department of City Planning, "Bike-Share Opportunities In New York City," Spring 2009, http://www.nyc.gov/html/dcp/pdf/transportation/bike_share_complete.pdf, p.45.

2 NYC Department of City Planning, "Bike-Share Opportunities In New York City," Spring 2009, http://www.nyc.gov/html/dcp/pdf/transportation/bike_share_complete.pdf, p.88.

3 MetroBike, LLC, "Nextbike," The Bike-sharing Blog, July 3, 2007, http://bike-sharing.blogspot.com/2007/07/nextbike.html.

4 MetroBike, LLC, "Onroll Rolls Across Spain," The Bike-sharing Blog, December 21, 2009, http://bike-sharing.blogspot.com/2009/12/onroll-rolls-across-spain.html.

5 MetroBike, LLC, "Washington, D.C. Launches North America's First Bike-sharing," ," The Bike-sharing Blog, August 13, 2008, http://bike-sharing.blogspot.com/2008/08/washington-dc-launches-north-americas.html.

6 Max Hepp-Buchanan, 2009

could involve many separate applications under several different regulations. For example, the bike-share system in Paris covers 35 square miles and consists of 1,451 stations. If separate permits for each station were required of a system of this size, the permitting process could be onerous.

Each application would have to include the precise location of the sign, as well as a description and drawing of the sign. The requirement to accompany the application with adequate plans and specifications would likely be waived for bike-share stations, as the building official can waive this requirement when the structural aspect is of minor importance.

Finally, each application has a corresponding permit fee. SDOT might want to investigate whether it would be possible to waive these fees for a bike-share system.

While this process would not be insurmountable, it would add time and coordination to the process, especially because there should be stations every 300 meters. If separate permits had to be obtained for each station, this could cause delay.

Special Exceptions for Signs in Commercial and Downtown Zones (Seattle Municipal Code (SMC) 23.55.040)

Perhaps the most important element of the sign code is its allowance for special exceptions granted by the Director of Planning. Regulations for size, number, type, height and depth of projection of on-premises signs in neighborhood commercial, commercial, downtown office core, downtown retail core, downtown mixed commercial and downtown harborfront zones may all be waived pursuant to Chapter 23.76, Procedures for Master Use Permit and Council Land Use Decisions. Note that no special exception may be authorized for video display methods. These exceptions can take place if the proposed sign plan shows an exceptional effort toward creating visual harmony among signs, desirable streetscape features, building facades and other architectural elements of the building structure through the use of a consistent design theme.

Sign Design

The code includes restrictions on sightlines, illumination and movement, clearance, and construction standards. Sightlines and illumination are discussed below; clearance and construction standards are discussed in the appendix.

Sightlines

Signs that are 10 feet or less in height and obscure the vision of motorists must be located at least 20 feet from intersections.[84] This could affect the potential for placing bike-share stations in curbside areas that are located next to intersections and currently prohibit parking.

Illumination and Movement

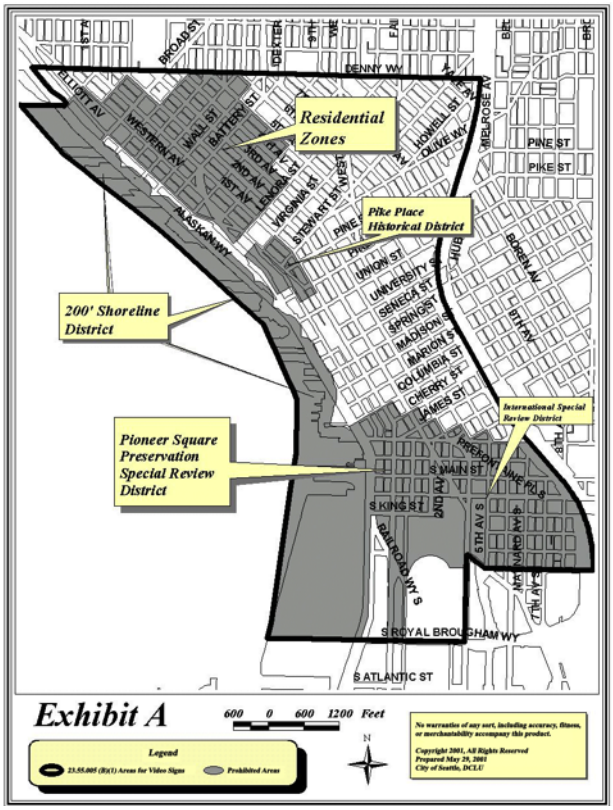
Certain types of signs are explicitly outlawed by the land use code. For example, flashing signs, quickly rotating signs, and banners are allowed in few if any zones. There are substantial restrictions on signs that use a video display method; video signs are not allowed

84 SMC 23.55.008

off-premises or in residential, Neighborhood Commercial 1, Neigborhood Commercial 2, Special Review District, Historical District, Preservation District, or shoreline zones. Video signs within 50 feet of a residential zone must be oriented so that no part of the sign face is visible from structures in that zone. The code favors video signs smaller than 3 ft by 3 ft. Additionally, the code governs the duration and timing of the video messages and forbids accompanying audio.

Note that several of the areas with special sign restrictions are included in the area we are recommending for Phase 1 implementation, as shown in Figure 5.

Figure 5: Special Sign Restrictions in Center City Seattle



Seattle Bicycle Master Plan (BMP)

Primary Goals of the BMP

The Seattle Bicycle Master Plan (BMP) has two primary goals, both of which would be furthered through implementation of a bike-share program in Seattle. These goals are as follows:

> Goal 1: Increase the use of bicycling in Seattle for all trip purposes. Triple the amount of bicycling in Seattle between 2007 and 2017.

Though we cannot at this time accurately predict how many cycling trips a bike-share program would add in the next seven years, the general purpose of bike-

Increasing the use of bicycling in Seattle through implementation of a bike-share program (Goal 1) also helps to accomplish the second goal of the BMP by adding more cyclists to the street and creating "safety in numbers."

sharing is to increase mobility in urban areas. Implementation of a bike-share program would add a significant number of trips made by bicycle to the current levels of bicycle mode-share in the city. For example, in only one year of operation, the Velo'v program in Lyon essentially tripled the mode share of bicycles.[85]

Goal 2: Improve safety of bicyclists throughout Seattle. Reduce the rate of bicycle crashes by one third between 2007 and 2017.

Bicyclists feel safer when other cyclists are on the road. Increasing the use of bicycling in Seattle through implementation of a bike-share program (Goal 1) would also help to accomplish the second goal of the BMP by adding more cyclists to the streets, creating "safety in numbers."

Principal Objectives of the BMP

The city has identified four principal objectives for achieving the goals of the BMP. Of the four objectives, two are directly relevant to implementation of a bike-share program and are discussed in detail below.

Objective 2: Provide supporting facilities to make bicycle transportation more convenient.

The BMP states, "In order for bicycling to be a fully viable form of transportation in Seattle, other programs and facilities are needed to complement the Bicycle Facility Network." Although the BMP does not specifically mention implementation of a bike-share program as an "action item" in the chapter for Objective 2, bike-sharing does relate to the following items recommended in the plan:

- Improve bicycle storage facilities at transit stations. Bike-share stations installed at transit stations throughout the city could help serve this purpose by allowing users to leave a public bicycle at a transit station and pick up a new one at their destination station
- Continue to fund and promote the use of staffed bicycle facilities. This action refers to the Seattle BIKE PORT® transportation center (formerly known as BikeStation Seattle®) in Pioneer Square, but it could also be applied to bike-share stations, as they would also make it easier for "bicyclists to make trips by linking bicycling and transit."
- Improve bicycle access to transit stops, stations, and ferries. Installation of large bike-share stations at these locations would help "improve the ability of bicyclists to connect to transit throughout the city."

85 Keroum Slimani, interview by Max Hepp-Buchanan, , Lyon and Velo'v, (September 3, 2009).

- Increase the availability of bicycle parking throughout the city. Current industry standards locate bike-share stations every 300 meters throughout the implementation area. A bike-share network with this density would add public use bicycle parking "located in close proximity to building entrances and transit entry points," which would be "essential in order to accommodate bicycling." While bike-share stations do not accommodate the parking of private bicycles, they are technically places to park (public) bicycles and serve the market of those cyclists who may not own a private bicycle

  Objective 3: Provide bicycle education, enforcement, and encouragement programs through partnerships.

The BMP states, "The education, enforcement, and encouragement programs recommended in this chapter are intended to help grow the number of bicyclists while also increasing safe and appropriate behavior by bicyclists and all other roadway users." Again, bike-share implementation is not mentioned as an action item in this chapter, but it does relate to the following actions recommended in the plan:

- Educate Seattle transportation system users about new bicycle facility types. Bike-sharing in Seattle would be a new facility type. Most existing bike-share programs made extensive public outreach and education efforts by stationing staff at bike-share stations throughout the city at program inception. Staff could educate new subscribers about use of the program and about improvements to the bicycle infrastructure.

- Promote bicycle and pedestrian education and encouragement in Seattle through partnerships with community organizations. A relatively new practice in the bike-share industry is to contract local businesses for bicycle maintenance and upkeep of the program. Similar efforts could be made with organizations in Seattle—such as the Cascade Bicycle Club—to help educate the public on how bike-sharing works and how to safely use the program.

- Increase enforcement of bicyclist and motorist behavior to reduce bicycle and motor vehicle crashes. An increase of bicyclists on the road, brought about through implementation of a bike-share program, would require increased enforcement of traffic laws for both cyclists and motorists on the part of Seattle Police Department.

Implementation of a bike-share program in Seattle would have a significant impact on the success of the BMP. Bike-sharing directly relates to both of the BMP's primary goals, two of its primary objectives, and several of its action items.

Note that the bicycle infrastructure indicator used in our demand analysis was heavily weighted with regard to on-street bicycle facilities. Therefore, any acceler-

ated or aggressive implementation by the city of the infrastructure and network projects recommended by the BMP—especially within the proposed Phase 1 implementation area—would facilitate the success of a bike-share program in Seattle.

Station Design Policies

Bike-share station design would be affected by a variety of Seattle regulations. The Right-of-Way Improvements Manual governs construction and design in the right-of-way. Requirements for standard clearances and widths should not prevent bike-share station implementation. However, some special consideration might be warranted for stations. Given the low-profile and open nature of bike-share stations, they might impede movement less than their footprint would suggest. However, most right-of-way regulations consider footprint size.

Figure 6: Bixi, Montréal Bike-Share Station Footprint Impact: With Bikes and When Empty.
Photos: Max Hepp-Buchanan, 2009

Special review districts exist in many neighborhoods, which would add a layer of design review for bike-share stations. The city should attempt to coordinate district review. If placement of bike-share stations was proposed in one or several districts, the city should work to ensure that the same station design could be acceptable in all districts.

Special District Review

Generally, the preservation board for special districts must review changes to the right-of-way, and the Director of the DON must approve proposals. Signs must be compatible with the district design. In the Pioneer Square District, electric signs and freestanding signs are not allowed (SMC 23.66.160). Verification would be needed if freestanding bike-share payment kiosks were allowed, though this would likely be the case given their similarity to parking pay stations.

Bike-share stations that required changes to the right-of-way would require review and approval in these districts: Pioneer Square (SMC 23.66.190), International District (SMC

23.66.334), Ballard Avenue (SMC 25.16.070), Columbia City (SMC 25.20.070), Fort Lawton (SMC 25.21.060), Harvard-Belmont (SMC 25.22.090), and Pike Place Market (SMC 25.24.060). The approval by the DON Director is required before approval of a Master Use Permit (SMC 23.76.010).

Right-of-Way Improvements Manual Requirements

The Right-of-Way Improvements Manual guides installation and construction in the public right-of-way. Bike-share providers would have to comply with requirements of the manual. Some sections provide specific design guidance that might also be useful.

Bicycle parking requirements would likely apply to bike station racks. Section 4.13.2 of the manual specifies design for on-street bicycle racks. Racks must have a minimum height of 2.5 feet, be intuitive to use, and have adequate clearance.[86] These requirements are reasonable and make sense to apply to bike stations.

Bike-share providers should also be asked to consider pedestrian mobility around bike stations, both when bicycles are docked or when docks are empty. Some stations, such as those in Washington, D.C., use a long bar that impedes movement. Other stations have single bars for each bike, so pedestrians can move between bike spaces when the station is empty. The city should ask for a similar design to aid in movement near stations.

Section 4.20 explains appropriate clearances between street elements (see tables 9 and 10). These requirements would need to be considered when potential locations were identified. These requirements would eliminate some potential locations or reduce possible station size. If stations were interpreted to be similar to parking meter posts, there will be fewer limits on possible locations. The exceptions for these posts allow for closer placement to the curb face, to the sidewalk edge, and several other elements. If the stations did need to retain the 3-ft clearance from the curb face, as well as the required sidewalk widths, potential location areas would be limited.

86 City of Seattle, "4.13 Bicycle Facilities," Seattle Right of Way Improvements Manual, 2010, http://www.seattle.gov/transportation/rowmanual/manual/4_13.asp (accessed January 30, 2010).

Table 9: Standard Lateral Clearances from Right-of-Way Manual[87]

Standard Lateral Clearances		
From	**To**	**Standard Clearance**
Curb face	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	3 feet
Edge of sidewalk	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	1 feet
Textured surface of wheel chair ramp	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	1 feet
Edge of sidewalk	Stair riser	2 feet
Pole face, fire hydrant	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	5 feet
Stop sign	Nearest parking space	30 feet
Obstruction in sidewalk	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	6 feet
Multi-use trail, edge of pavement	Closest part of any fixed object (excluding traffic control signs and parking meter posts)	2 feet (3 feet preferred)

Table 10: Standard Lateral Clearances from Bicycle Parking, from Right-of-Way Manual[88]

Standard Clearances from Bicycle Parking		
From	**To**	**Standard Clearance**
Bicycle parking	Curb when adjacent to parking	3 feet
	Curb when adjacent to vehicle travel lane	2 feet
	Street trees and street furniture for the rail-type rack	1 foot

Section 4.25, governing street furniture, public art and unique objects in the public right-of-way, is particularly significant to the installation of bike-share stations. Bike-share stations would likely qualify as "unique objects," similar to public kiosks, bus shelters and wayfind-

87 City of Seattle, "Clearances," Right-of-Way Improvements Manual, January 2010, http://www.seattle.gov/transportation/rowmanual/manual/4_20.asp (accessed February 22, 2010).
88 Ibid.

ing signage.[89] Design considerations include the following:[90]

- The leading edge of the object should be less than 27 inches above the sidewalk, for accessibility considerations for pedestrians with vision impairment
- SDOT coordinates approval for unique objects for the applicant by working with the Design Commission, Arts Commission, Seattle Parks Department Historical Preservation section, Office of Arts and Cultural Affairs, and other appropriate review authorities
- An annual street use permit is required
- The pavement should be durable, slip resistant, and free of trip hazards
- The City of Seattle will require a maintenance agreement and may also require insurance

The Landscape/Furniture Zone denotes a specific area of the sidewalk, which is where bike-share facilities might be located. However, flexibility in placement for some elements of stations is suggested. Similar to parking pay station placement, bike station payment kiosks should not be an issue when placed closer to the curb face. The zone is a minimum of 4 ft wide, with 3 of those feet creating a buffer from the face of the street curb. Street furniture, art, and landscaping should be placed here, and bike-sharing would also be a logical use. This is also the zone designated as a Transit Zone for bus shelters, benches, customer waiting, and other transit functions.[91] Next to the landscape/furniture zone is the pedestrian zone.

The Pedestrian Zone is the portion of the sidewalk reserved for pedestrian travel and is a minimum of 6 ft. wide. Bike-share facilities could not extend into this zone.[92] Any flexibility would need to be balanced against the need to retain 6 ft of the sidewalk for pedestrian uses.

Figure 7 illustrates the landscape/furniture zone and the potential for a bike-share station in that location, given sufficient sidewalk width. The landscape/furniture zone could also function as an extension of a bike-share station located in parking spaces along the curb.

89 City of Seattle, "4.25 Street Furniture, Public Art and Unique Objects in the Public Right-of-Way," Right-of-Way Improvements Manual, January 2010, http://www.seattle.gov/transportation/rowmanual/manual/4_25.asp (accessed January 30, 2010).
90 Ibid.
91 City of Seattle, "4.11 Sidewalks," Right-of-Way Improvements Manual, January 2010, http://www.seattle.gov/transportation/rowmanual/manual/4_11.asp (accessed January 30, 2010).
92 Ibid.

Figure 7: Landscape Furniture Zone, from Seattle Right-of-Way Improvements Manual[93]

Bike-share stations fit the definition of uses in the Landscape/Furniture Zone. This zone also provides a 4-ft-wide area for station elements extending from the curbspace into the landscape/furniture zone. The city should consider interpreting some elements of a bike-share station, such as the pay station kiosk, as similar to parking pay stations to allow for additional potential locations.

Curbspace Management Policy

The SDOT curbspace priorities do not explicitly address bike-share use.

In residential areas the priorities for curbspace use are as follows:

1. transit use (bus stops and spaces for bus layover)
2. passenger and commercial vehicle loading zones
3. parking for local residents and for shared vehicles
4. vehicular capacity

In business or commercial areas, including blocks with mixed-use buildings containing residential units, the priorities for curbspace use are as follows:

1. transit use (bus stops and spaces for bus layover)
2. passenger and commercial vehicle loading zones

93 City of Seattle. (2010). 4.13 Bicycle Facilities. Retrieved January 30, 2010, from Seattle Right-of-Way Improvements Manual: http://www.seattle.gov/transportation/rowmanual/manual/4_13.asp

3. short-term customer parking (time limit signs and paid parking typically for 1-or 2-hours)

4. parking for shared vehicles, and vehicular capacity[94]

If bike-sharing were considered "transit use," then it could be listed as the number one priority for curbspace. To the extent that it was considered a "shared vehicle," it could be construed to fall under the third priority for residential areas and the fourth priority for business or commercial areas. If bike-share stations were considered "short-term customer parking," then they would fall under the third highest priority for business and commercial areas.

These rankings are derived from SDOT's Transportation Strategic Plan elements, including the following:

- Make the best use of the streets we have to move people, goods, and services
- Increase transportation choices
- Make transit a real choice
- Encourage walking and biking—they're the easy, healthy way to get around
- Price and manage parking wisely
- Promote the economy by moving freight and goods
- Improve our environment
- Connect to the region
- Protect our infrastructure
- Make the most of transportation investments[95]

Specifically, the Strategic Plan's parking principle is to "Price and manage parking to support healthy business districts and transit use. Manage curbspace to recognize the importance of principal arterials in moving people, goods and services." This does not seem to exclude using curbspace as bike-share parking. As the Strategic Plan is updated, it can be rewritten to specifically reference bicycle parking and bike-sharing.

Existing priorities in the Bicycle Master Plan have already established precedence for removing spaces. Parking spaces were converted to bicycle racks in three locations in 2009, and additional on-street bicycle parking facilities are actively being

94 Seattle Department of Transportation, "Curb Use Priorities in Seattle", City of Seattle. Accessed at: http://www.cityofseattle.net/transportation/parking/parkingcurb.htm
95 Seattle Department of Transportation, City Of Seattle Transportation Strategic Plan, 2005 Update, http://www.cityofseattle.net/transportation/tsphome.htm

planned.[96]

Regardless of the department's stated priorities and existing precedent, it is likely that some people would object to any removal of automobile parking spaces. This is particularly likely in the downtown area, given the upcoming Alaskan Way Viaduct closure.

Regardless of the department's stated priorities and existing precedent, it is likely that some people would object to any removal of automobile parking spaces. This is particularly likely in the downtown area, given the upcoming Alaskan Way Viaduct closure. While Seattle currently has around 5,000 on-street paid parking spaces between Denny Way and the stadiums, and an additional 95,000 off-street parking spaces, up to 1,200 public parking spaces will likely be removed or restricted as a result of construction.[97] Objections from the public might be mitigated to some extent by SDOT parking programs such as the new e-Park electronic parking guidance system.

Seattle Pedestrian Master Plan

Overview

The Seattle Pedestrian Master Plan contains elements that offer both opportunities and challenges to the development of a bike-share program. Pedestrian plan elements that seek to improve non-automotive infrastructure, promote diverse land uses, or reduce conflict between automobiles and non-automotive travel should all help to promote bicycle ridership. Improvements to the sidewalk realm are particularly likely to support bike-share users, as anecdotal evidence from Philadelphia suggests that bike-share users are more likely to ride on the sidewalk than other bicyclists. However, other elements of the Pedestrian Master Plan promote pedestrian uses of the right-of-way over cyclist use. These elements would need to be addressed for successful bike-share implementation. This section discusses Pedestrian Master Plan elements that support or hinder bike-share promotion, as well as other relevant elements of the Pedestrian Master Plan, including performance measurements and "toolkit" findings.

Supportive Policies

Improve Infrastructure

Elements of the Pedestrian Master Plan that plan, fund, or implement improvements to the sidewalk and streetscape should promote the use of a bike-share program. For example:

- Strategy 1.1: Fund new improvements and maintenance programs to promote walking—calls for changes that would generate more sidewalk repair and other streetscape funding from developers and business improvement associations.
- Strategy 2.1: Create and maintain a walkable zone on all streets to enable a clear

96 Seattle Department of Transportation, "On-Street Bike Parking," City of Seattle, http://www.seattle.gov/transportation/bikeparking.htm (accessed March 11, 2010).

97 Center City Parking Program: FINAL Technical Report, Nelson\Nygaard Consulting Associates, June 2008.

pedestrian path of travel—calls for installation of non-slip surfaces, expanded sidewalk maintenance requirements through the site analysis process, and greater consideration of pedestrian facilities in site plan review.

- Strategy 2.3: Create an expanded set of design standards for pedestrian paths and sidewalks—would simplify the right-of-way improvement permit process and fee structure for sidewalk repairs, while simplifying access to qualified contractors.

Similarly, the Pedestrian Plan calls for prioritizing infrastructure improvements in an equitable manner across transportation modes:

- Strategy 4.1: Allocate and design Seattle's rights-of-way to support Complete Streets principles—would revise plans and specifications for curb bulbs, bicycle lanes and signage locations; establish new guidelines for allocating right-of-way by using trails and bikeway designations; and examine locations to determine whether sidewalk widening was possible.

The pedestrian toolkit portion of the plan also discusses the need for curb ramps, which are primarily designed to meet ADA requirements but which also serve the needs of many users, including cyclists.[98]

Improve Land Use

One of the most promising opportunities presented by the Pedestrian Master Plan is its proposal to create bicycle parking in the curbspace near crosswalks. This space is currently kept vacant to maintain pedestrian sightlines. Here, station design would be a critical factor in implementing this strategy; tall and wide pay stations that blocked driver-pedestrian sightlines would defeat the intent of the strategy (see Figure 8).

- Strategy 3.1: Maintain pedestrian visibility at intersections—suggests that SDOT update existing codes, as needed, to allow bicycle and scooter parking within this 20-ft zone in certain situations.

Several elements of the Pedestrian Master Plan call for making land-use decisions with an eye toward improving the urban environment in ways that benefit both pedestrians and cyclists. The following strategies all work toward improving the mix of destinations, the human scale and vitality of street-level design, and the connectivity of spaces:

- Strategy 2.2.a: Prioritize walking connections to major pedestrian destinations—calls on SDOT to consider identifying high priority pedestrian areas by using criteria such as bicycle access, to develop wider

98 City of Seattle, "Curb Ramps," Pedestrian Master Plan, http://www.seattle.gov/transportation/pedestrian_masterplan/pedestrian_toolbox/tools_deua_ramps.htm (accessed March 10, 2010).

Figure 8: Bike-Share Stations Showing Different Levels of Sightline Impact
Photos: Max Hepp-Buchanan, 2009

sidewalks in these areas, and to define the core corridors and hubs that make up the city center walking, bicycling, and transit network.

- Strategy 5.1: Create an appropriate mix of uses and destinations within neighborhoods—calls for using land-use and zoning tools to encourage pedestrian friendly land-use mixes; improving the design review process; and using parking maximums to encourage people to use non-automotive travel means.
- Strategy 5.2: Reclaim and activate public spaces—calls for designing and permitting active, accessible, and connected public spaces, and redeveloping existing unused street space for pedestrian and bicyclist uses such as on-street bicycle parking.

Improve Safety
Bicyclists and pedestrians both benefit from vehicle speed reductions. In addition to the increased level of rider comfort, vehicle speed has been shown to be the primary factor in the risk of injuries to cyclists from bicycle-vehicle collisions.[99] Therefore, the plan's suggestion to slow motorists should encourage use of a bike-share system. Specific implementation measures are listed below:

- Strategy 3.3: Manage vehicle speeds to support and encourage walking—would use enforcement, engineering, and lower posted limits to decrease vehicle speeds, particularly in high pedestrian priority zones.

Promote Non-automotive Travel
The Pedestrian Plan proposes several measures to encourage people to drive less and use other transportation modes more. Although the experience of other bike-share systems suggests that most bike-share users are primarily transit users, drive-less programs may still entice some drivers to try bike-sharing. Proposed efforts are listed below:

99 Ciaran Simms and Denis Wood, *The Relationship between Vehicle Impact Speed and Pedestrian and Cyclist Projection Distance*, 2009, Dordrecht: Springer.

- Strategy 6.1: Promote the benefits of walking as part of citywide sustainability and equity initiatives and through new and expanded programs—calls for expanding auto reduction programs, increasing participants in city commute trip reduction programs, and exploring a "ride free" transit day.

- Strategy 6.2: Foster communication to support pedestrian travel—would develop a "Travel Right" guide to disseminate right-of-way information; distribute sidewalk maintenance guides to property owners; and expand pedestrian wayfinding efforts through signage, maps, and Web-based tools, focusing on transit stops. Note, this would provide an opportunity to put bike-share station locations on transit stop way-finding maps.[100]

Directly Relevant Policies

Maintaining a Walkable Zone

While many elements of Strategy 2.1, Create and maintain a walkable zone on all streets to enable a clear pedestrian path of travel, could boost bike-share ridership through the construction of better right-of-way infrastructure, the proposal to "define a minimum 6' wide x 8' high walkable zone on all streets citywide" could hinder a bike-share program.[101] Many bike-share systems use sidewalk-based bike-share stations. While this might not prove a problem for areas with extra-wide sidewalks, bulbouts, or off-street locations, it could limit the number of feasible station locations. Even in locations where the sidewalk was wide enough to maintain a 6-ft-wide buffer around a station, an implementing agency would need to evaluate station placement on a case-by-case basis, as areas with the greatest sidewalk square footage might also see the greatest pedestrian volume. Additionally, the walkable zone could be encroached upon as bike-share users removed their bicycles from the station racks.

The alternative to sidewalk placement—the reconfiguration of street parking to hold bike-share stations—would also present challenges. In existing systems such as in Montréal, users need to step into the street to retrieve their bicycles from the on-street stations. This would present a potential hazard to bike-share users unless the bike-share provider was instructed to design stations that allowed access from the sidewalk.

Other elements of Strategy 2.1 could also affect bike-sharing. Revising "utility infrastructure…and street furniture placement guidelines so that they do not impact the walkable zone" could limit station placement if the guidelines were not written to consider bike-share stations. Likewise, the proposal to "Identify preferred placement of signage and signal control equipment along the roadway, eliminating signage from the clear pathway…to preserve the walkable zone" might pose ad-

100 City of Seattle, "Pedestrian Master Plan Implementation Actions," Pedestrian Master Plan, September 16, 2009, http://www.seattle.gov/transportation/pedestrian_masterplan/docs/ImplementationMatrixrevised91609.pdf (accessed March 10, 2010).
101 Ibid.

ditional issues to advertising-based business plans.[102]

Non-Policy Elements

While not a Pedestrian Master Plan policy per se, the plan does note that sidewalk and path development is limited near parks because they must be sited within adjacent rights-of-way. (Initiative 42 prevents the conversion of any park property for non-park use.) This could impose a similar limit on the location of bike-share stations.

Likewise, the "Pedestrian Toolbox," while not a policy, seems to advocate increased enforcement to address unsafe behaviors by drivers (running red lights, parking in crosswalks, speeding), pedestrians ("dart-outs," failing to look before crossing), and bicyclists (riding into traffic without looking, riding against traffic, failing to cede the right-of-way to pedestrians on a sidewalk or in a crosswalk, failing to wear a helmet).[103] Enforcement of these unsafe behaviors would make the environment safer for all cyclists but might limit the attractiveness of bike-sharing for some users.

Opportunities

Several of the strategies in the Pedestrian Master Plan would not immediately affect the bike-share program but should be addressed to make sure they would result in bike-share friendly outcomes. For example:

- Strategy 2.3.a. "prepare an expanded set of sidewalk standards (for pedestrian paths and walks), an updated standard driveway detail, and a curbless pedestrian path design standard for inclusion in the City's Standard Plans. Advance these standards through the SDOT review committee and the City review committee… ."
- Strategy 4.1.a "Establish procedures, resources, and responsibility for developing streetscape design concept plans with the goal of appending concept plans to the Right-of-Way Improvements Manual."
- Strategy 4.1.d: "Allocate and design Seattle's rights-of-way to support Complete Streets implementation" addresses Complete Streets modal conflicts through coordination with other modal plans and through the creation of a Complete Streets project checklist and Street Corridor Design Concept Plans.[104]

All of these strategies provide opportunities to incorporate bike-share standards in the development of right-of-way designs and modal priorities, thus potentially contributing to the success of a bike-share program.

Supportive Performance Measures and Targets

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102 City of Seattle, "Pedestrian Master Plan Implementation Actions," Pedestrian Master Plan, September 16, 2009, http://www.seattle.gov/transportation/pedestrian_masterplan/docs/ImplementationMatrixrevised91609.pdf (accessed March 10, 2010).

103 City of Seattle, "Enforcement Tool," Pedestrian Master Plan, http://www.seattle.gov/transportation/pedestrian_masterplan/pedestrian_toolbox/tools_enf.htm (accessed March 10, 2010).

104 City of Seattle, "Pedestrian Master Plan Implementation Actions," Pedestrian Master Plan, September 16, 2009, http://www.seattle.gov/transportation/pedestrian_masterplan/docs/ImplementationMatrixrevised91609.pdf (accessed March 10, 2010).

The Pedestrian Plan is designed with performance measures to ensure successful implementation.[105] Many of these measures could be monitored by bike-share program managers or bike-share providers to determine the environmental conditions affecting bike-sharing. For example, the plan calls for:

- a reduction in 85th percentile vehicle speeds on identified corridors,
- an increase in transit ridership,
- an increase in street use permits that include streetscape elements, and
- a decrease in the percentage of respondents reporting little or no physical activity.

The more that progress is made toward achieving these goals, the better the conditions should be for bike-share use.

Current Condition Issues

While not policy-related, the Pedestrian Master Plan identifies several pedestrian issues with current street conditions that are also relevant to bike-share users. Bike-share providers and planners should be aware of these conditions and, when possible, work to correct them. These are listed in Appendix D.

Race, Social Justice and Bicycling

"The Race and Social Justice Initiative (RSJI) envisions a city where racial disparities have been eliminated and racial equity achieved."[106] In November 2009, the City Council directed that the initiative should continue through 2010. 2010 goals of the agency include beginning to address race-based disparities in economic equity, environmental justice, criminal justice, health, and education.[107]

There are differences in cycling rates among race/ethnic groups, though these tendencies are likely the result of other factors, such as income differences, access to comfortable places to ride, and locations of home and work. Many studies show a high propensity to cycle among whites,[108] though results vary among studies.[109]

Members of the Latino community are also frequent cyclists, "though trip purpose differs [from Caucasians], with the majority of bicycle trips taken by whites being

105 City of Seattle, "Performance Measures and Targets," Pedestrian Master Plan, http://www.seattle.gov/transportation/pedestrian_masterplan/pmp_table.htm (accessed March 10, 2010).
106 City of Seattle. (2009). Race and Social Justice Initiative. Retrieved January 31, 2010, from Seattle.gov: http://www.seattle.gov/rsji/
107 Ibid.
108 Mudon, A. V., Lee, C., Cheadle, A., Collier, C., Johnson, D., & Schmid, T. (2005). Cycling and Built Environment, A US Perspective. Transportation Research Part D , 10 (3), 245-261.
109 Sener, I. N., Eluru, N., & Bhat, C. (2008). An Analysis of Bicyclists and Bicycling Characteristics: Who, Why, and How Much are they Bicycling? Austin: Texas Department of Transportation, Department of Civil, Architectural and Environmental Engineering.

for leisure, and the majority taken by Latinos being for work."[110] The National Survey of Pedestrian and Bicyclist Attitudes and Behaviors Report (2002) also shows higher rates of ridership by Latinos in comparison to whites.[111]

William and Larsen found that race was predictive of bicycle use; Latinos did the most cycling, followed by, in order, American Indians, Asians, Whites, and then African Americans.[112] They also stated that "since many members of Hispanic and Asian populations have recently immigrated to the United States, they may be influenced by the extensive use of bicycles for transport found in Latin and Asian countries."[113]

In order to provide for more equal opportunities to use bike-share, the city could use a discounted rate or a graduated payment plan for low-income populations.

With increased investment and resources, bicycle use should increase among all groups in Seattle. Affordable pricing will help make bike-sharing a feasible alternative transportation choice for Seattleites. Unlike other forms of urban transportation, most bike-share systems rely on annual membership fees, which require the poor to accumulate enough savings to pay for an annual membership. To provide more equal opportunities for using bike-sharing, the city could implement a discounted rate or a graduated payment plan for low income populations.

Bike-share systems have successfully been installed in central business districts, and our recommendation is to do the same. Demand, generally measured through the density of origins and destinations in the downtown core, is greatest there. However, this serves to mostly facilitate the midday mobility needs of central business district workers, not necessarily those of lower income neighborhoods. The city may consider balancing the clear demand created in a business district with the policy goals of supporting racial and social equity through government initiatives. Comparing the Seattle Pedestrian Plan Median Household Income map[114] with our demand analysis, it is clear that outlying neighborhoods with a median income under $30,000 do not rate highly for bike-share demand. There is, however, a high concentration of social services in the city center; bike-share use by people with low-incomes would aid mobility and access to these services. The city might try particular outreach to these organizations to help them encourage their users to consider bike-sharing.

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110 Pucher, J., & Renne, J. L. (2003). Socioeconomics of Urban Travel: Evidence from the 2001 NHTS. Transportation Quarterly , 57 (3), 49-77.

111 National Highway Traffic Safety Administration. (2002). National Survey of Pedestrian and Bicyclist Attitudes and Behaviors. Washington DC: US Department of Transportation's National Highway Traffic Safety Administration.

112 William, J., & Larsen, J. (1996). Promoting Bicycle Commuting: Understanding the Customer. Transportation Quarterly , 50, 67-68.

113 Ibid.

114 City of Seattle. (2010). Median Household Income. Retrieved February 21, 2010, from Pedestrian Master Plan: http://www.seattle.gov/transportation/docs/pmp/maps/Median%20HH%20Income.pdf

Providing public bike-sharing might help address the diabetes and health issues identified by the Pedestrian Plan. However bike-share bicycles are heavy and slow and are intended for short trips and transportation purposes, rather than exercise.

The demand analysis implemented in this study did match up with maps of households with lower rates of car ownership.[115] Some neighborhoods in South Seattle and near Ballard and Fremont are recommended as secondary implementation areas and do have low car-ownership rates. The city might consider balancing equity goals with demand analysis, pushing for a quicker implementation date in these areas. Another method of ensuring equitable bike-share implementation would be to target outreach and education to culturally and economically diverse parts of the city. Education about the benefits of bike-share, subsidized subscription opportunities that might be made available, and marketing of the system would encourage bike-share usage among these populations.

Sound Transit and King County Metro Policies

We were asked by SDOT to consult with Sound Transit and King County Metro (KCM) regarding any policies that could affect the implementation of a bike-share program in Seattle near transit stations and bus stops.

Sound Transit Policies

The studio team consulted with Rebecca Roush, bicycle coordinator for Sound Transit. She was not aware of any Sound Transit policies that would affect implementation of a bike-share program in Seattle. However, bike-share stations would be prohibited on transit platforms (Link light rail and Sounder), and if SDOT wanted to place bike-share stations on other types of Sound Transit property, further consultation with Sound Transit would be required.

King County Metro Policies

The studio team also consulted with Eileen Kadesh, Senior Transportation Planner with King County Metro Transit, and she was also not aware of any KCM policies that would affect implementation of bike-sharing in Seattle. She did note, however, that "Metro is very careful to keep bus zones as uncluttered as possible. There are many zones in downtown where 'street furniture' (trash cans, newspaper vending machines, etc.) are too close to the bus zone, and this can block the

Bike-share provides the opportunity for the City of Seattle and King County Metro to help incentivize employers to provide their staff with bike-share membership subscriptions at a reduced rate, similar to the FlexPass model, now being replaced by ORCA Passport.

115 City of Seattle. (2010). Pedestrian Master Plan. Retrieved February 21, 2010, from Cars per Housing Unit: http://www.seattle.gov/transportation/docs/pmp/maps/Cars%20per%20Housing%20Unit.pdf

line-of-sight for bus drivers."[116] She recommended that once specific areas of implementation and station installation had been identified, SDOT should further consult with KCM and the Transit Route Facilities staff.

The Commute Trip Reduction (CTR) program is a tool that requires large companies (those with over 100 employees) to take into consideration their employee commute patterns and create policies that reduce the use of single-occupancy vehicles. Bike-sharing would provide the opportunity for the City of Seattle and King County Metro to help employers provide their staff with bike-share membership subscriptions at a reduced rate, similar to the FlexPass model, now being replaced by ORCA Passport. A program of this sort would guarantee a certain amount of bike-share program revenue each year, help increase bike-share ridership, and add to the overarching goal of decreasing vehicle miles traveled.

Currently, there do not appear to be any Sound Transit or King County Metro policies that would immediately obstruct the implementation of a bike-share program in Seattle. However, we do recommend working with King County Metro to provide bike-share membership to employees of large companies through the CTR program.

Key Findings from City and Regional Policies and Plans

Below we have summarized our key findings from each of the potential policy implications discussed above. A complete discussion of our recommendations and conclusions is provided in the next chapter.

Helmet Law

- The self-service nature of most bike-share programs limits their ability to provide helmets
- Helmet use would be a significant challenge to bike-share use in Seattle, as there is a county-wide helmet law for cyclists of all ages
- A number of best practices are currently being used and investigated by bike-share providers and cities across world. These practices may shed some light on how the City of Seattle might choose to address the issue of helmet use

Sign Code

- An explicit goal of the sign code is to slow the proliferation of signs, which makes it an inherently challenging goal to satisfy
- The impact of the sign code will vary depending on the business model of the bike-share supplier; advertising-based systems will have a much higher regulatory bar to meet
- The sign code could present a significant implementation hurdle; regulations and regulatory agencies vary by zoning code and transportation corridor

116 Eileen Kadesh, interview by Max Hepp-Buchanan, , King County Metro Bike-Share Email, (February 9, 2010).

- The undefined nature of bike-share systems makes it difficult to determine what the impact of the sign code would be; requirements would differ greatly depending on whether bike-share stations were considered street infrastructure, business establishments, off-premises signs, vending machines, or other.

Seattle Bicycle Master Plan

- Implementation of a bike-share program in Seattle would be consistent with the two primary goals of the Bicycle Master Plan (BMP)
- The city has identified four principal objectives for achieving the goals of the BMP. Of the four objectives, two are supportive of bike-share implementation in Seattle
- Any accelerated or aggressive implementation by the city of the infrastructure and network projects recommended by the BMP—especially within the proposed Phase 1 implementation area—would facilitate the success of a bike-share program in Seattle

Station Design

- Bike-share stations would fit the definition of uses in the Landscape/ Furniture Zone. This zone also provides a 4-ft-wide area for station elements extending out of curbspace
- Special review districts requirements would add a layer of design review

Curb Space Management Policy

- The curbspace management policy does not specifically reference bike-share use but is generally supportive; precedence exists for converting parking spaces to bicycle parking, but pressure almost always remains from the public to maintain and expand—not reduce—current parking supply

Pedestrian Master Plan

- Many elements of the Pedestrian Master Plan would likely promote bike-share ridership, including policies promoting bicycle and street infrastructure, mixed land use, reduced vehicle speeds, and communication strategies to generate non-automotive mode choice
- Some elements of the Pedestrian Master Plan create planning opportunities that should be approached with bike-sharing in mind, such as the plan to redesign street furniture guidelines
- The plan's call for maintaining a 6-ft pedestrian zone clearance could limit the placement of bike-share stations

Race and Social Justice and Bicycling

- Education and outreach to low-income and culturally diverse populations

would help promote bike-share ridership to these groups

- The city should also provide bike-share information to service organizations within the proposed implementation area to encourage usage by low-income populations seeking services within the city center.
- The second and third implementation stages will reach populations with low income levels and low rates of auto ownership. Speeding up implementation in these areas would balance strict demand with race and social justice

Sound Transit and King County Metro Policies

- Currently, there do not appear to be any Sound Transit or King County Metro policies that would immediately obstruct the implementation of a bike-share program in Seattle

4. Bike-Share Program Recommendations

Overview

Public use bike-share programs allow bicycles to be rented for short times from unattended, fixed stations and permit renters who have taken bikes from one location to return them to any other station. Bike-share programs have successfully operated in European cities for a number of years. The first U.S. program began in 2009 in Washington D.C. and programs are currently being studied or implemented in other North American cities. This report presents our analysis of the feasibility of a bike-share program in Seattle. The report was contracted by the City of Seattle and completed, as a studio class, by University of Washington Urban Design and Planning students.

We initially analyzed the potential ridership demand in Seattle for a bike-share system and then evaluated policy and regulatory issues that might be relevant to installation or operation of such a system. Based on these findings, the project team concluded that a bike-share system could be successful in Seattle. However, there are institutional and operational barriers that will need to be addressed. With these barriers in mind, we have developed a series of recommendations to the city that would help to ensure a bike-share system would work. These recommendations are presented in this chapter.

Recommendations

We recommend a three-phase implementation of a bike-share program for Seattle. These phases are based on the GIS analysis detailed earlier in this report. This analysis used a quantitative study of Seattle bike-share market characteristics based on a research approach used in Philadelphia, Pennsylvania. It is important to note that our recommendations are general targets, which serve as useful guidelines to illustrate the potential scope and scale of a bike-share program. The recommended phased areas and demand estimates resulted from a strict interpretation of the demand analysis. Later sections of the report addressed other issues that might impact demand, such as climate, culture, and policy issues.

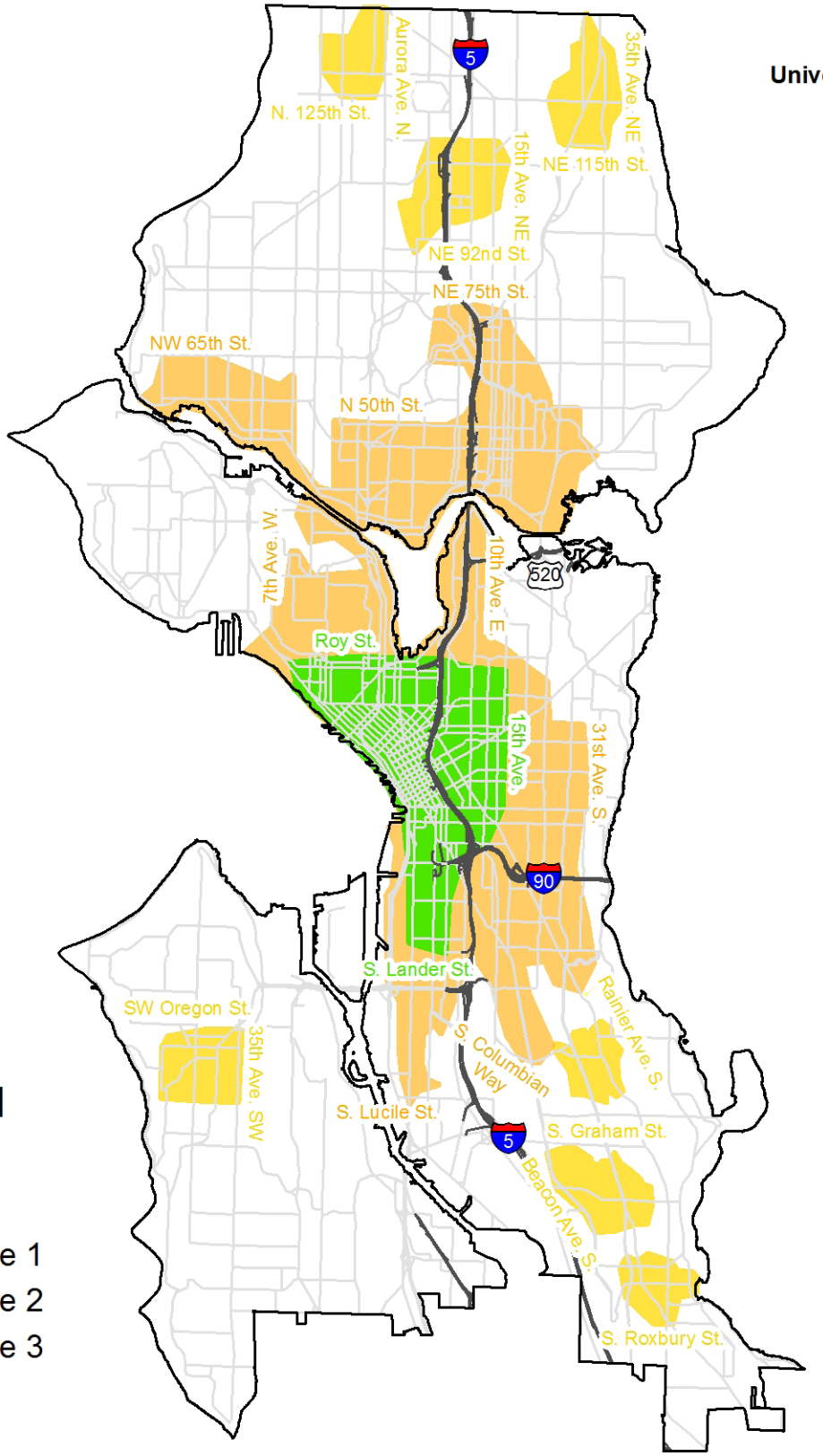
Phased Bike-Share Service Areas

The proposed phasing of bike-share implementation areas is shown in Figure 9. These boundaries are not intended to serve as strict borders, but more as guidelines to represent the general areas in Seattle where bike-share would be most successful. Additional factors such as the location and interests of potential funding organizations, race and social justice concerns, transportation planning policies, geographic equity, and political factors were not included in our analysis. These may be considered by the City of Seattle in determining the final implementation area boundaries and phases. It should also be noted that implementation of Phases 2 and 3 should be contingent on successful implementation of Phase 1.

Proposed Seattle Bike-Share Implementation Phases

SEATTLE BICYCLE SHARE feasibility study

University of Washington
Bike Share Studio



Legend

Seattle

- Phase 1
- Phase 2
- Phase 3

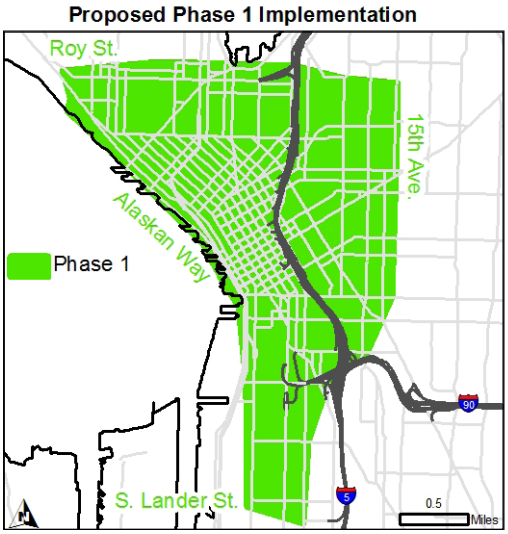
0 0.5 1 2 3 4 Miles

Figure 9: Proposed Seattle Bike-Share Implementation Phases

Phase 1

Phase 1 of the proposed bike-share implementation area covers downtown Seattle and surrounding areas in Lower Queen Anne, South Lake Union, Capitol Hill, International District and SODO. Figure 10 provides a close-up of the proposed Phase 1 area. According to the results of the demand analysis, this area represents the largest contiguous area with a high concentration of potential bike-share users and the related land use and infrastructure that supports bike-share ridership.

Figure 10: Proposed Phase One Seattle Bike-Share Implementation Area



Although the University District scored highly in the demand analysis and has potentially supportive elements, we do not recommend including it in Phase 1 because it is geographically disconnected from the largest contiguous area of high bike-share demand potential in the Seattle downtown core. The primary corridor connecting the University District and the downtown did not score well in the demand analysis and could create a potential risk to the system if the University District was included. Existing and successful bike-share systems have a well-defined contiguous area of service where users can easily enter and exit the system and be assured a bike-share station is always nearby.

Phase 2

Phase 2 of the proposed bike-share implementation area expands out from the Phase 1 downtown core to include surrounding areas and additional neighborhoods in North Seattle. The neighborhoods included in Phase 2 are Queen Anne, Eastlake, Capitol Hill, First Hill, Central District, Northern Beacon Hill, and the Industrial District. The expansion into North Seattle includes the neighborhoods of the University District, Green Lake, Wallingford, Freemont, and Ballard. As with Phase 1, the areas identified in Phase 2 represent a large contiguous area with relatively high demand for bike-share use.

Phase 3

Phase 3 of the proposed bike-share implementation plan expands from Phase 2 to include the outlying satellite neighborhoods of West Seattle, Columbia City, Holly Park, Rainer Beach, Bitter Lake, Lake City, and Northgate. Although we realize these neighborhoods are not directly connected to the proposed Phase 1 and 2 bike-share implementation areas, we feel these neighborhood centers have a relatively high bike-share demand and should be evaluated for potential inclusion after the system has matured and has demonstrated successful operation. It should also be noted that the Phase 3 areas along the existing and planned Sound Transit Link light rail alignment (Columbia City, Holly Park, Rainer Beach, and Northgate) could provide important connections between a bike-share system and regional transit hubs.

Program Size

Using Seattle trip-level travel data and bike-share industry standards, we calculated the demand for the number of bicycles and stations for each of the three recommended implementation phases. These figures are estimates and are designed to provide guidance for a potential bike-share program. Table 11 shows the low and high range estimates for daily bike-share trips, the number of bicycles, and the number of stations for each proposed phase of implementation.

Table 11: Demand Estimates for Phased Bike-Share Implementation

Market Area	Daily Trips		Number of Bikes		Number of Stations	
	Low	High	Low	High	Low	High
Phase 1 (Population 66,649)	2,616	5,459	793	978	53	65
Phase 2 (Population 156,429)	1,864	3,815	1,146	1,273	76	85
Phase 3 (Population 35,498)	284	575	356	375	24	25
Total	4,764	9,849	2,295	2,627	153	175

The proposed Phase 1 implementation area is 4.2 square miles and contains a population of 66,500 people. Although the area and population are relatively small in this phase, the number of daily trips is high because of the downtown's function as a regional urban center. This area is estimated to produce between approximately 2,620 and 5,460 daily bike-share trips. To accommodate these trips, it is estimated that a successful Phase 1 bike-share program would require between 790 and 980 bicycles and between 53 and 65 stations.

The proposed Phase 2 implementation area represents an additional 13.7 square miles and 156,400 people. This area is much larger and contains higher total population than the Phase 1 area, because it is largely residential development. This area is estimated to produce between 1,860 and 3,820 additional daily bike-share trips. To accommodate these trips, it is estimated that the Phase 2 implementation area would need between 1,150 and 1,270 bicycles and 76 and 85 stations. It is important to note the Phase 2 should incorporate knowledge and lessons learned from the operation of Phase 1.

The proposed Phase 3 implementation area represents an additional 4.5 square miles and 35,500 people. These areas are mostly residential and are estimated to produce between 280 and 580 additional daily bike-share trips. To accommodate these trips, it is estimated this phase should include between 360 and 380 bicycles and around 25 stations. A Phase 3 would be dependent on the success of Phase 1 and 2 implementations.

Policy Recommendations

Our findings suggest that there would be enough demand in areas of Seattle to support a bike-share system. Our findings also suggest that a bike-share program, for the most part, would conform to the City of Seattle's master plans. However, any organization intending to implement a bike-share program would need to address several legal, policy, and regulatory concerns.

We evaluated whether a bike-share program was compatible with Seattle's Bicycle Master Plan and concluded that bike-share will help directly meet several objectives of the plan. Similarly, we found that Seattle's curbspace management policy is generally supportive of bike-share as a curbspace use.

Bike-share supports, but also may conflict, with the goals of the city's Pedestrian Master Plan. In particular, the requirement for a six-foot pedestrian zone on sidewalks causes some potential problems. City staff should define the nature of a bike-share station and its elements, and interpret the impacts of stations on sign regulations and right-of-way requirements, before vendor selection. Because bike-share stations would be installed throughout the city, the installation process would be impacted by a variety of regulations linked to different special districts. Given this level of complexity, SDOT staff should help guide a bike-share provider through the permit process.

One challenge to the success of a bike-share program is the legal requirement that all bicycle riders in Seattle wear helmets. Ensuring helmet use by all bike-share program users will be difficult, and the City should be aware of all legal issues in advance. Subsidizing helmets through vouchers with bike-share subscriptions and/or at discounted rates at businesses in the bike-share implementation area may make helmet compliance easier for users.

Bike-share will support transit use, serving as the last-mile solution for transit users, potentially even increasing transit use. The City should work with Sound Transit and King County Metro on station placement near transit stops. The City should also work with King County Metro to provide bike-share membership to employees of large companies through the Commute Trip Reduction program.

Specifically, we recommend City of Seattle staff take action in the following categories:

Helmet Law

- Consult with legal staff on liability issues surrounding bike-share and helmet use
- Consider subsidizing helmets for online subscribers by providing them with a voucher for a free low-cost helmet from a local business
- Consider contracting a low-cost local helmet manufacturer to mass-produce and saturate the city with helmets for public use that can be obtained from businesses near bike-share stations
- Consider the implications of the selected helmet policy on the use of bike-share by tourists and non-residents of Seattle

Sign Code

- Define the nature of a bike-share station before dealing with a vendor
- Designate a staff person to guide a bike-share provider through the permit process
- Consider simplifying the permit process. For example, SMC 23.55.040 allows the Director of DPD to grant special exceptions to signs in the commercial and downtown zones

Seattle Bicycle Master Plan

- Accelerate implementation of bicycle infrastructure and network projects recommended or listed in the Bicycle Master Plan, especially within the proposed Phase 1 implementation area. These improvements will facilitate the success of a bike-share program in Seattle

Station Design

- Consider interpreting some elements of a bike-share station, such as the pay station, as similar to parking meters to allow for greater flexibility regarding station location
- Coordinate permit review to ensure that one station design will be acceptable throughout the city

Curb Space Management Policy

- Revise policy to specifically address bicycle and bike-share parking

Pedestrian Master Plan

- Consider bike-share station design requirements when revising pedestrian infrastructure requirements
- Be creative with station placement, exploring opportunities in plazas, on properties of private partners, etc
- Balance the interests of all users when allocating sidewalk and curbspace

Race and Social Justice and Bicycling

- Consider balancing potential implementation in the downtown core—where the

demand analysis suggests bike-share will be most successful — with the overall equity goals of the City

- Encourage bike-share ridership to low-income and culturally diverse populations through public education and outreach
- Provide bike-share information to service organizations within the proposed implementation area to encourage usage by low-income populations seeking services within the center city

Sound Transit and King County Metro Policies

- Further consult with Sound Transit and King County Metro once specific areas of implementation and station installation are identified
- Work with King County Metro to provide bike-share membership to employees of large companies through the Commute Trip Reduction program
- Coordinate with transit agencies to minimize bike/bus conflicts in downtown and ensure strong connections between bike-share and transit

Bike-Share System Framework

Vendor selection is a relevant policy concern. The vendor, and their associated system operating model and preferred equipment, will impact the style of bicycles and stations provided. We recommend a vendor that has fixed bike stations (as opposed to a flexible program without stations) to help with system visibility and greater public outreach and awareness. Modular fixed stations will permit system adjustments based on demand.

Public outreach and education is necessary before, during and after implementation of bike-share. Systems with higher rates of public "ownership" and buy-in due to outreach programs have reduced rates of theft and vandalism.

We also recommend that the City require any bike-share system operator to implement aggressive program monitoring and data collection to help guide system expansion and support accountability. Useful data includes operating performance, environmental impacts, user surveys, safety data, revenue performance, and travel patterns.

The following points are derived both from the analysis completed as part of this study and from our review of other successful systems in North America and Europe.[117]

Basic Bike-Share Program Model

- Select a fixed program because of the high visibility and potential for greater public outreach and education

117 Susan Shaheen, Stacey Guzman and Hua Zhang, "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future," in Transportation Research Board Annual Meeting (Washington, D.C., 2010).

Check-Out Station Installation

- Use modular stations because of their ability to be adjusted according to observed demand, the ease of installation, and the low carbon footprint. Modular stations can also be scaled back or pulled offline during seasons of undesirable weather for cycling

Site Criteria and Placement of Stations

- Place bike-share stations 300 meters apart in the proposed Phase 1 implementation area and ensure there will be twice as many individual bike docks in the station network as there are bicycles in the system (two docks for every bike)

User Fee Structure

- Offer the option of a one-year subscription, a one-month subscription, and a one-day pass (aimed at tourists)
- Offer the first half-hour of use free of charge, with usage fees increasing for each additional half-hour. This will keep trip durations to 30 minutes or less and ensure there are more bicycles available for public use

Public Outreach and Education

- Work with the selected bike-share vendor to coordinate a large-scale public outreach and education campaign before, during, and after implementation of bike-share in Seattle. The public should be engaged in the planning process to the greatest extent possible
- Integrate the proposed bike-share program with local and regional transit and market the system as a compliment to these systems, not as a competitor
- Incorporate the ORCA card into the bike-share check-out process in order to facilitate the integration of bike-share with local and regional transit

Bike-Share System Components

Based on available data, we recommend that Seattle's bike-share program utilize the features and system components listed below, as these recommendations represent the industry standards and/or most recent advances in bike-share technology.[118]

Check-Out Stations

- Reliable alternative energy sources such as solar power, rather than subsurface power sources
- Real-time communication between stations and headquarters to report number of bicycles per station and facilitate redistribution
- Fully-illuminated stations for nighttime safety and visibility
- Space at stations for an illuminated map of station network and bicycle routes

Bicycle Docks

- State-of-the-art anti-theft mechanism
- Transactions can be made by smartcard, like ORCA, directly at bike dock for quick

118 Rolf Scholtz, interview by Max Hepp-Buchanan, Dero Bike Racks Interview, (April 27, 2009); Paul DeMaio, "Bikesharing: Its History, Models of Provision, and Future," in Velo-City Conference (Brussels, 2009).

check-out

- Capacity for user to identify and flag bicycles that require maintenance
- Indicator showing whether bicycle is available for use or out-of-service when system is shut down or individual bicycle needs repair

Payment Kiosks

- Can combine the functions of public bicycle check-out and payment for automobile parking in order to use available space most efficiently
- Accepts various forms of payment
- Easy access for people with limited mobility

Bicycles

- A frame that is light, strong, and durable
- One-piece handlebar that covers and protects all components
- All cables covered for better protection
- Derailleur integrated into rear axle (internal hub) for seamless shifting
- Chain protector integrated into bicycle structure that prevents riders' clothes from getting greasy or tangled in the chain
- Adjustable seat positioning to fit riders of all sizes
- Front and/or rear rack or basket for added carrying capacity

Making Bike-Share a Success

Our analysis has concluded that a bike-share program has the potential to be successfully implemented in Seattle. Our estimates reveal that there appears to be enough potential ridership demand to support a system initially implemented in downtown and nearby surrounding neighborhoods.

There are a number of institutional policy issues that need to be addressed before a program can be successfully implemented, though we believe they are manageable. These relate mostly to the King County helmet law and the Seattle sign code. Fortunately, it appears the City has the capacity to address these issues.

If the City does decide to implement a bike-share system, there are a number of specific actions listed in this report that City staff can take to ensure that bike-share infrastructure is installed in the most effective locations, will function efficiently, and will provide the maximum benefit to Seattle's transportation system.