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Philadelphia Bikeshare Concept Study

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With: Delaware Valley Regional Planning Commission

For: City of Philadelphia
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1 – Executive Summary

This report examines the potential for success of a proposed bikeshare program in Philadelphia. It includes a comprehensive planning-level analysis of the bikeshare concept while also exploring key ancillary issues—such as bike-lane infrastructure and interoperability with public transit—that are likely to influence the potential success of the system.

This Executive Summary defines the bikeshare concept and presents the primary results and conclusions from this study. Four main chapters that describe the four primary phases of this process and their outcomes follow.

- Review of Comparables
- Demand Determination
- Review of Local Factors and Key Challenges
- Recommendations

Interpretation of the results suggests a positive expectation for the potential success of bikeshare in Philadelphia, and also helps indicate a set of actions and guidelines for how to best move the concept forward.

What is Bikeshare?

Bikeshare is an emerging urban transportation concept based on collective paid use of a distributed supply of public bicycles. It is similar in function and programming to carsharing initiatives that have been very successful in Philadelphia. The bikeshare concept was pioneered (in its current form) in Europe and is now being implemented, designed, and/or studied in many North American cities.

In general, bikeshare consists of strategically distributed "stations" containing ten to twenty bikes on average with a centralized payment/control kiosk. Customers—who range from one-time users to long-term subscribers—"unlock" a bicycle with a credit card or smartcard, then ride to any other station in the city where they can deposit the bike concluding their trip.

Figure 1-1: Shared Bicycles in Lyon, France

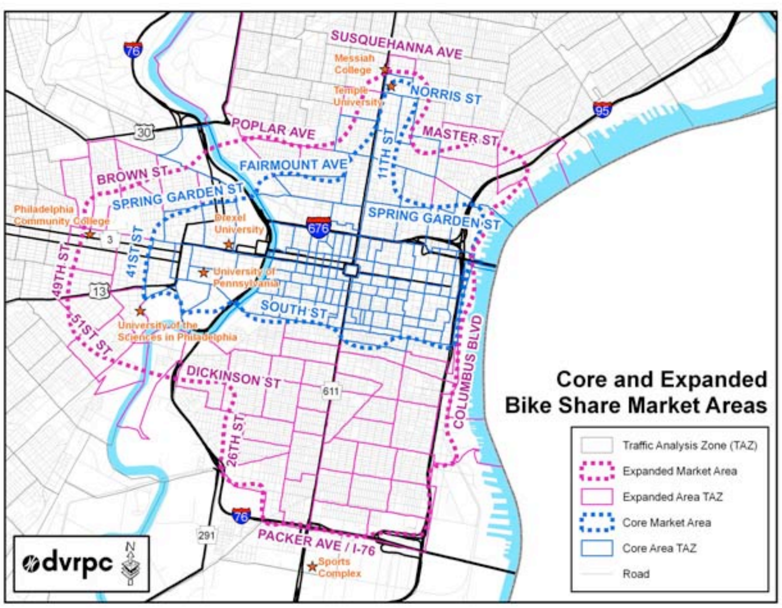
Bikeshare fills a number of key “niches” in the urban travel market (which are described in this report) and is particularly useful for relatively short-range travel beyond the length of comfortable walking distance. Its key advantage is that it gives virtually everyone access to what in the past had largely been viewed as a specialized form of urban transport, promising increased use of bikes for short-distance travel helping to decrease pressure on traffic and transit systems.

What is the Optimal Form of Bikeshare in Philadelphia?

The analyses conducted as part of this study suggest a first phase deployment of 1,750 bikes within a defined “core” consisting of the city's most intensely and diversely developed central districts. Within this area, bikeshare stations would consist of approximately 15 bikes per station distributed at a density of about 20 stations per square mile.

If successful, later phases of deployment would include an “expanded” market-area representing some of the city's dense residential neighborhoods in and around the central core. Further phases could include strategic systematic advancement along transit corridors or into other key emerging and established neighborhoods.

Figure 1-2: Proposed Bikeshare Core (blue) & Expanded (red) Service Areas



Source: DVRPC

Bikeshare in Philadelphia would optimally consist of key intermodal considerations such as, most importantly, integration with the city's transit network. The bike stations themselves would take a variety of forms and specific locations, including public parks/plazas, private plazas, on-street “pods” (fitting within two to four parking spaces), and in covered parking garages.

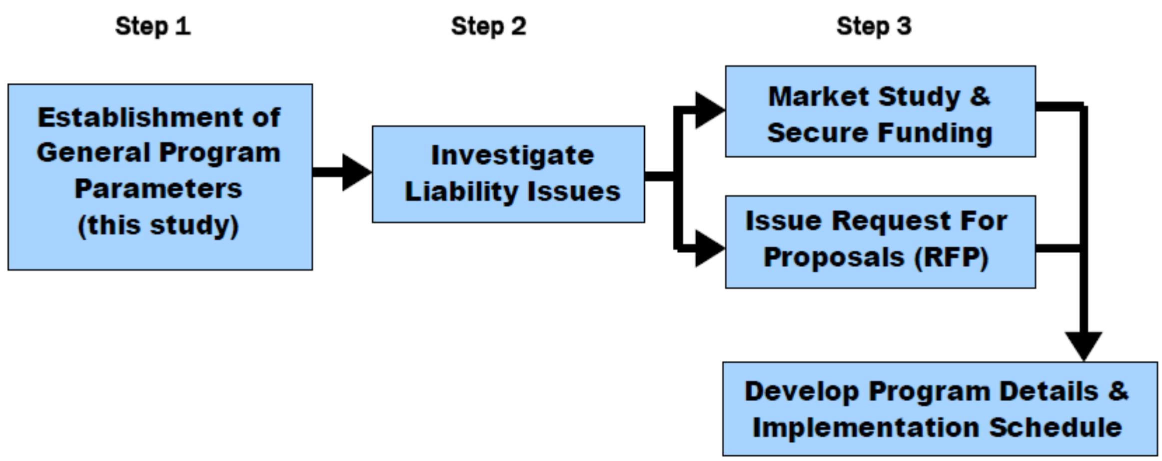
What are the Next Steps?

This study was conducted to examine the general applicability of the bikeshare concept to Philadelphia. While the results demonstrate the concept to be potentially viable, the ultimate outcome will depend on a number of additional key considerations, including:

- Upgrades to the bike-lane/path network throughout the core area to provide safe circulation options for both expert and novice riders.
- Aggressive levels of education and enforcement to minimize conflict among bikes, cars, and pedestrians on the city's constrained streets and sidewalks.

In coordination with such supporting actions—along with detailed study of market conditions and liability issues—it is recommended that the bikeshare process advance toward implementation through the initiation of a Request for Proposals (RFP) process. The intent of this process would be to attain and compare the qualifications of a wide variety of potential private and public operators, based on a set of guidelines that clearly outline the city's goals and basic requirements for the system.

Figure 1-3: Summary of Proposed Next Steps



Since Philadelphia's flat geography and consistent urban scale comprise an idealized biking environment (pending the designation of adequate circulation facilities), the bikeshare concept holds much promise to help the city continue to evolve toward a sustainable future. As available car-traffic capacity dwindles in the face of ongoing development, innovative transport options such as bikeshare represent a key means of continuing to accommodate the circulation needs of residents, workforce, and visitors.

2 – Review of Comparables

2.1 Overview

The purpose of this summary report is to introduce and document the variety of bikeshare programs throughout the world, from which Philadelphia could potentially extract key lessons and opportunities. Sample programs to be explored include:

- Lyon, France – *Vélo'v*
- Paris, France – *Vélib'*
- Barcelona, Spain – *Bicing*
- Montréal, Quebec, Canada – *Bixi*
- Washington DC – *SmartBike DC*
- Minneapolis, Minnesota – *NiceRide*

Additional programs are discussed where relevant, particularly if they offer approaches or data not readily available from the primary examples.

Section 2.2 provides a brief background of each of the primary sample programs, including basic information about city size, transportation characteristics, and population.

Section 2.3 compares specific features of these programs/cities on a topic-by-topic basis, organized by the following categories:

- Geographic Characteristics
- Program Infrastructure Characteristics
- Program Operations/Management Characteristics
- Performance Indicators

For the purposes of this evaluation, data were collected from a variety of sources, most notably academic papers, direct sources from program operators, and journalistic coverage. Secondary sources included the various cities' bikeshare feasibility studies, business plans, and requests for proposals (RFPs).

Section 2.4 offers preliminary conclusions about the applicability of these experiences to Philadelphia, to the degree possible based on general comparisons with respect to city characteristics and targeted program objectives.

All data is up-to-date as of Summer 2009.

2.2 City/Program Background

A. Overview of Public-Use Bikeshare Programs

Over ninety bikeshare programs of various types/sizes currently operate throughout the world, with many additional cities in the planning stages (see **Figure 2-1** for examples). Each program is specifically tailored to its own context and purpose, with many variations related to technology, expanse of service-area, targeted users, usage restrictions, and other physical/operational qualities. In addition to contextual differences, system variations are often related to the nature of the operator (public/private) or specific local preferences.

Figure 2-1: Sampling of Worldwide Bikeshare Programs

Europe		The Americas	Elsewhere
Paris	Copenhagen	Montréal	Beijing
Lyon	Berlin	Washington DC	Hangzhou
Barcelona	Vienna	Minneapolis (planned)	Melbourne (planned)
Munich	Stockholm	Santiago	Brisbane (planned)
Milan	Marseilles	Rio de Janeiro	
Seville	Rome	Miami Beach (planned)	
Helsinki	Brussels	Denver	

The following core programs were selected for detailed investigation due to their success, length in operation, and favorable availability of data:

- Lyon, France – *Vélo'v*
- Paris, France – *Vélib'*
- Barcelona, Spain – *Bicing*

In addition, three North American cities have been included in this analysis despite being in their nascent stages. Although for these cities the availability of data—particularly with respect to performance—is limited compared with their European precedents, they offer useful insights in how the bikeshare concept is being adapted to North America:

- Montréal, Québec, Canada – *Bixi*
- Washington DC – *SmartBike DC*
- Minneapolis, Minnesota – *NiceRide*

As these cities and programs vary significantly in size and coverage (see **Figure 2-2**), it is essential to bear such differences in mind when conducting a cross-system analysis of specific indicators.

Figure 2-2: Summary Statistics for Six Bikeshare Programs

	Lyon : Vélo'v	Paris: Vélib'	Barcelona: Bicing	Montréal: Bixi	Washington, DC: SmartBike DC	Minneapolis: NiceRide
Population	611,000	2.18 million	1.6 million	1.62 million	588,292	373,000
Population Density	26,000/sq mi	64,620/sq mi	39,436/sq mi	17,138/ sq mi	9,639/sq mi	6,722/sq mi
Bike Share Bicycles	4,000	20,600	6,000	4,000 (Spring 2009)	120	1,000 (Spring 2010)
Resident/Bike	118	106	267	675	4902	373
Operator	JCDecaux	JCDecaux	Clear Channel	Stmt de Montréal	Clear Channel	Non-Profit Organization

Sources: www.population.de and Program Websites

B. Overview of Vendors

Private vendors play a critical yet varying role in the implementation of bikeshare. In most cases, vendors are primarily responsible for providing the necessary technology and infrastructure, and in some instances also coordinate ongoing operational services such as subscription, monitoring, redistribution of bicycles, and routine maintenance. **Figure 2-3** highlights the seven largest private vendors of bikeshare services.

Figure 2-3: Largest Bikeshare Vendors

VENDOR	COMPANY	COMPANY TYPE	PROGRAMS	INNOVATIONS
Cyclocity	JCDecaux	Multinational Outdoor Advertising Company	• 19 in Europe, (Lyon {4,000}, Paris {20,600+}) • Expanding beyond Europe with contract in Brisbane, Australia	• Pioneers in advertising financed systems • World's largest system (Paris) • 5 years experience as operator of systems
SmartBike (Adshel)	Clear Channel	Multinational Outdoor Advertising Company	• First 3rd Generation program in Rennes, France • 13 in Europe and America (Barcelona {4,000}, Washington, DC {120 bikes})	• Mostly residential subscription bases • Advertising based programs as well as acting operator programs
Cemusa	Cemusa	Multinational Outdoor Advertising Company	• 3 in Europe (Milan, Italy {Pilot, 250 bikes}, 2 in Spain)	
Public Bike Systems	Stationnement de Montréal	Parking Authority (Quasi-Governmental)	• 2 in North America • Montréal (2,400 bikes by May 2009) • Minneapolis (1000 bikes for Spring 2010	• Solar-powered kiosks • Wireless communication • Modular and portable stations • Incorporation of kiosks as parking pay kiosks
B-Cycle	• Humana Inc. • Trek Bicycle Corporation • Crispin Porter + Bogusky	• Health Benefits • Bicycles • Advertising	• 2007: Freewheelin' at Humana Campus • 2008: Freewheelin' at Democratic and Republican National Convention • 2009-2010: Denver (600 bikes), Miami Beach (500 bikes), and National Park Service in DC (30 bikes)	• Connects bike sharing to health and community benefits • Provides user feedback web pages as a way to document health and usage patterns
Veloway	Veolia Transport	Urban Transportation Services	• Took over OYBike in 2008 • Hammersmith and Fulham in London, England • 2009 St. Xavier University in Chicago, Illinois (65 bikes)	• Shaft-driven bicycles reduce maintenance • 3rd Generation program on college campus • Accessible by card or cell phone
Call-A-Bike	Deutsche Bahn	German National Railway Company	• 6 major German cities • Arlington, VA may implement a program in 2010	• Access by cell phone • No fixed stations- left at rail stations or major intersections

Sources: Vendor Websites

C. Lyon, France - *Vélo'v*

Vélo'v in Lyon is known as one of the world's most successful bikeshare programs. It was the first third-generation, large-scale bikeshare program in the world. Operator JCDecaux provides the infrastructure and operational services to the City of Lyon in return for exclusive rights to street furniture advertising.

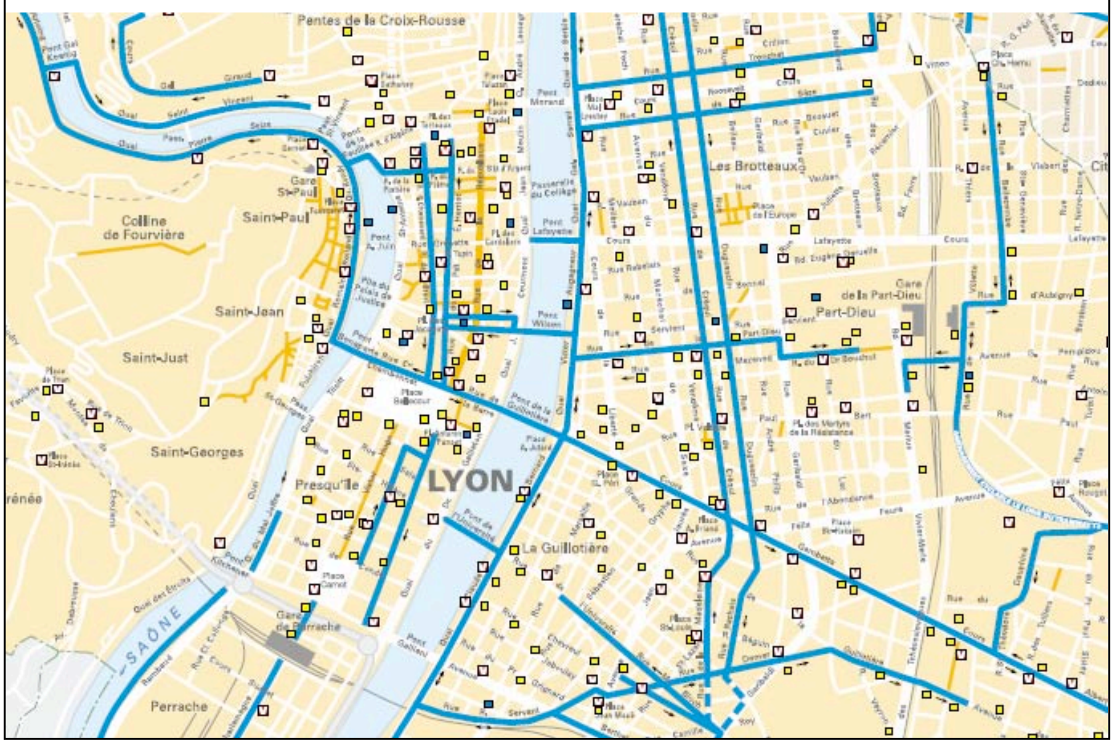
Figure 2-4: Statistics, Photo, and Map of Lyon's *Vélo'v* Program

Program Name: *Vélo'v*

Number of Bicycles: 4,000

Initiated: 2005

Operator: JCDecaux



Lyon is particularly relevant to this analysis due to its similarities to Philadelphia, with respect to size, geography, and transit coverage.

D. Paris, France - *Vélib'*

Paris has the largest bikeshare program in the world. It is regarded as an extremely successful program with widespread use amongst professionals, students, and tourists, and is currently being expanded into the Paris suburbs. In Paris, the *Vélib'* program has a very high proportion of professional/commuter users, helping to decrease peak-period pressure on its extensive yet congested metro system.

Figure 2-5: Statistics, Photo, and Map of Paris' *Vélib'* Program

Program Name: *Vélib'*

Number of Bicycles: 20,600

Initiated: 2007

Operator: JCDecaux

E. Barcelona, Spain - *Bicing*

Barcelona's *Bicing* program is a good example of a multi-functional bikeshare system in a varied-activity urban core. Proximity to beaches and tourist attractions, as well as typical urban uses, create a setting for attracting a wide variety of user-types to the system.

Figure 2-6: Statistics, Photo, and Map of Barcelona's *Bicing* Program

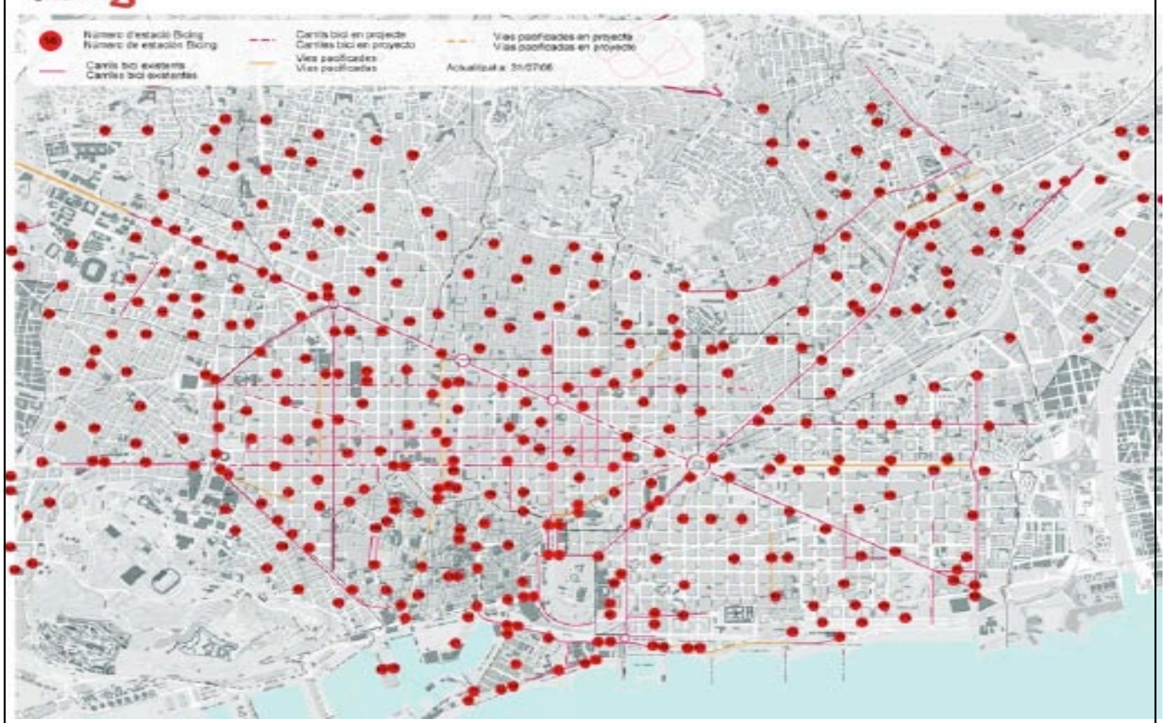
Program Name: *Bicing*

Number of Bicycles: 6,000

Initiated: 2007

Operator: Clear Channel

bicing



Barcelona is also comparable to Philadelphia in terms of size and its variety of trip generators including large universities and multiple tourist attractions.

F. Montréal, Quebec, Canada - *Bixi*

Montréal's *Bixi*, which began operation in May 2009, is North America's first large-scale bikeshare program. The system is seasonal in that its portable stations are to be removed during the winter. Yet even during its shortened bikeshare season, early projections are for strong ridership as benefiting from a wide range of urban/recreational uses in and around the service area.

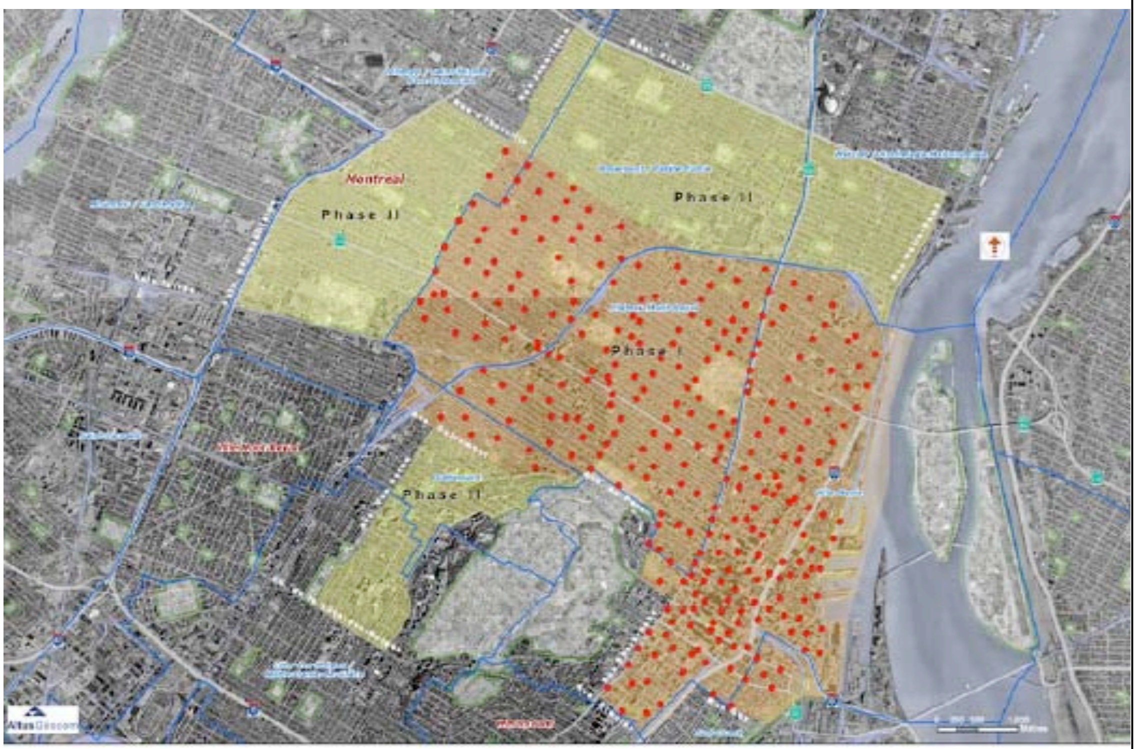
Figure 2-7: Statistics, Photo, and Map of Montréal's *Bixi* Program

Program Name: *Bixi*

Number of Bicycles: 1,200 (4,000 planned)

Initiated: 2009

Operator: Stationnement de Montréal



Montréal's system is also unique (among the other examples) in that a public non-profit rather than a private company operates it.

G. Washington DC – *SmartBike DC*

Washington's *SmartBike* program is the first example of a third-generation bikeshare program in the United States. Clear Channel operates the system as part of a street-furniture contract.

Figure 2-8: Statistics and Photo of Washington's *SmartBike DC* Program

Program Name: *SmartBike DC*

Number of Bicycles: 120

Initiated: 2008

Operator: Clear Channel

H. Minneapolis, Minnesota - *NiceRide*

Like Montréal, Minneapolis' bikeshare program is intended to be seasonal-only due to intense winters and heavy annual snowfall accumulation. Also unique about Minneapolis' program is that it was initiated by a non-profit organization, with infrastructure and operational knowledge to be supplied by Stationnement de Montréal.

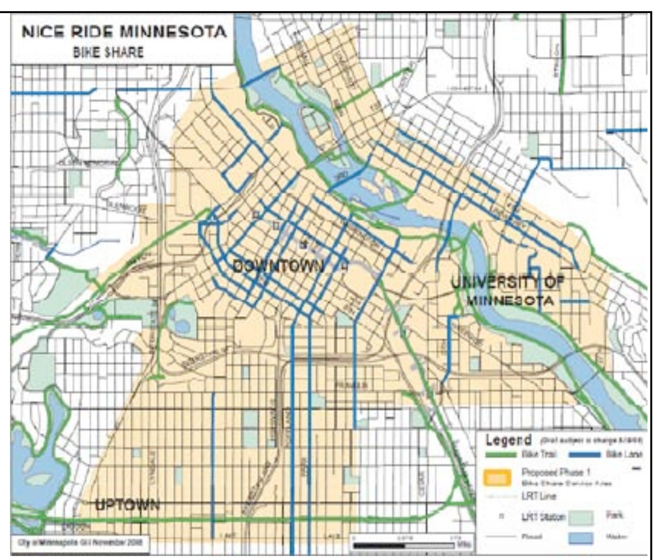
Figure 2-9: Statistics, Logo, and Map of Minneapolis' *NiceRide* Program

Program Name: *NiceRide*

Number of Bicycles: 1,000 planned

Initiated: Planned for Spring 2010

Operator: Stationnement de Montréal (planned)



2.3 Comparison of System Features/Indicators

This cross-city, cross-system analysis is intended to help broaden the local knowledge base of existing bikeshare applications for the broader purpose of helping to inform the analysis/planning of a potential Philadelphia system. This section analyzes a total of twenty-four "indicators" that compare specific features across the six primary comparable programs (plus several secondary examples where applicable). These indicators have been organized into four broad categories representing various aspects of the evaluated cities and systems (see **Figure 2-10**).

Figure 2-10: Categories/Indicators of Evaluation

CATEGORY	INDICATOR
GEOGRAPHIC	Mode Share in Program Cities
	Cycling Infrastructure
	Weather
	Topography
	Bicycle Culture
PROGRAM INFRASTRUCTURE	System Size
	Phasing Strategies
	Integration with Other Systems
	Bicycle Components
PROGRAM OPERATIONS/MANAGEMENT	Overview of Estimated Costs
	Funding Methods
	Insurance Methods
	Fee Structure
	Education Strategies
	Maintenance
	Institutional Involvement
	Employment
PROGRAM PERFORMANCE	Usage Statistics
	Trip Purpose
	Mode Shift
	Accident Rates
	Theft
	Environmental Impacts
	Economic/Tourism Impact

These indicators help to furnish a detailed snapshot of particular characteristics of the evaluated cities, both before and after the initiation of their bikeshare programs. While the **geographic** indicators primarily assess the background characteristics of the evaluated locales, the remaining indicators specifically focus on the attributes and experiences of their respective bikeshare systems.

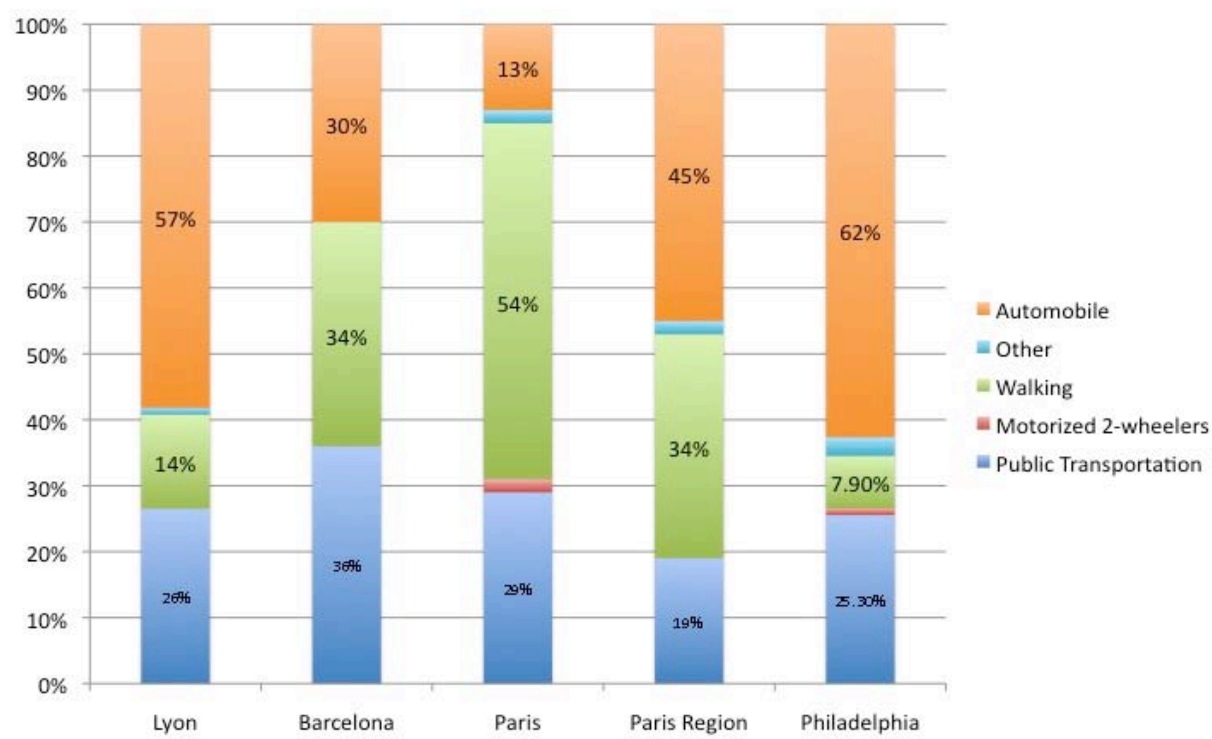
A. Geographic Characteristics

Geographic indicators assess the evaluated cities' general characteristics prior to bike sharing. These encompass measures that describe the cities' environmental/topographical contexts as well as the "background" travel behavior of their residents.

1. Mode Share

One of the most important indicators for assessing the travel character of any particular city is *mode share,* which is the proportion of total daily person-trips captured by the various available travel modes. In general terms, most European cities—due largely to their denser historic patterns of development—exhibit higher mode shares for non-car-based travel modes (such as walking and transit) when compared with their American counterparts. However, as shown in **Figure 2-11**, the differences between older (comparatively) large American cities such as Philadelphia and the cited European examples are much less sharp than the national/continental averages.

Figure 2-11: Mode Share in Evaluated Cities (and Philadelphia) Prior to Bikeshare



Sources: Lyon: "Vélo dans la Ville", http://www.millenaire3.com/uploads/tx_ressm3/velodanslaville.pdf, Accessed March 11, 2009
Barcelona: "European Best Practices in the Delivery of Integrated Transport: Barcelona, Spain" p. 3-29,
Commission for Integrated Transport www.cfit.gov.uk/docs/2001/ebp/ebp/stage2/, Accessed March 1, 2009
Paris: Bilan des Déplacements en 2007, Mairie de Paris, http://www.nxtbook.fr/newpress/Mairie-de-paris-direction-voirie-deplacements/Bilan_des_deplacements_en_2007_Paris/index.php#/22/OnePage, Accessed March 11, 2009
Paris Region: Enquête Globale des Transports, Direction Régionale de L'Équipement, Ile-de-France http://www.ile-de-france.equipement.gouv.fr/IMG/pdf/transport_58_deplacements_cle27119b.pdf, Accessed March 31, 2009
Philadelphia: Census Mode Share 2007 American Community Survey, http://factfinder.census.gov, Accessed April 7, 2009

While Paris and Barcelona have high **walking** mode-share and relatively low **automobile** share, the profiles for Lyon and Philadelphia, the former of which has successfully implemented a bikeshare program, are very similar.

Figure 2-11 also shows that the pre-bikeshare-program use of bicycles in each of these cities—as a percentage of total daily person-trips—was relatively small (included in the "other" category). Finally, it should be noted that the Philadelphia statistics include lower-density outer areas such as the northeast, which likely dilute higher percentages of walking and transit in the more central neighborhoods.

2. Cycling Infrastructure

A safe, interconnected bicycle circulation network is a critical supporting element to any bikeshare system. As such, it is useful to compare the extent of Philadelphia's existing bicycle network with those of the evaluated "successful" European bikeshare cities. "Cycling infrastructure" refers to any combination of bicycle lanes, multi-use paths, bicycle boulevards, etc. that together provide a safe bicycling environment for both experienced and novice riders. **Figure 2-12** indicates the extent of such infrastructure in the selected cities, in terms of both total length and, more importantly, as a percentage of total city street-length.

Figure 2-12: Broad Assessment of Cycling Infrastructure in Evaluated Cities

	Lyon	Paris	Barcelona	Philadelphia
Length Before Program	33 miles	203 miles	80 miles	242 miles
Length After Program	~193 miles	~231 miles	~89 miles	NA
% Roads with Bike Lanes Before Program	~2%	~19.25%	~10%	~9.39%
% Roads with Bike Lanes After Program	~12%	~22%	11%	NA

Sources: Lyon: Grand Lyon http://www.grandlyon.com/Donnees-chiffrees.99.0.html, *Accessed March 10, 2009*
Paris: Mairie de Paris
http://www.paris.fr/portail/deplacements/Portal.lut?page_id=19&document_type_id=5&document_id=4914&portlet_id=652, *Accessed April 1, 2009*
Barcelona: "Guia Mobilitat Sostenible", Ajuntament de Barcelona http://w3.bcn.es/fitxers/mobilitat/guiamobilitatsostenible.442.pdf *and* http://w3.bcn.es/fitxers/mobilitat/dadesbasiques2006.222.pdf, *Accessed March 10, 209*
Philadelphia: Streets Department and the Bicycle Coalition of Greater Philadelphia, http://www.phila.gov/STREETS/ *and* www.bicyclecoalition.org, *Accessed March 11, 2009*

As shown in **Figure 2-12**, the percentage of Philadelphia's streets that have some formal demarcation of bicycle facilities is very close to the "after bikeshare" figures for both Lyon and Barcelona. Although this appears as a strong sign that Philadelphia is prepared to safely host a bikeshare program, this data must be interpreted cautiously. In particular, the following aspects of Philadelphia's existing bicycle network should be carefully considered:

- Streets outside the central core, which is, for the present, presumed to be a major focus of a Philadelphia bikeshare system, represent much of the bicycle-accommodating mileage. Streets within the core are more constrained than those in outer areas.
- In addition to large portions of Center City, the existing bicycle network exhibits "gaps" in overall connectivity particularly at high-volume intersections where traffic movements have been heavily prioritized.
- The quality of Philadelphia's bicycle accommodation is very variable, with the general standard represented by a five-foot-wide striped lane where permitted by available curb-to-curb width. It will be important to revisit the quality of facilities along key routes as this project progresses.

In short, it is encouraging that Philadelphia already has a substantial "base" system of bicycle infrastructure, yet the opportunity to upgrade and expand such facilities will continue to be a critical issue with respect to the viability of introducing a safe bikeshare program to the city.

3. Weather

The extremes of weather affect bicycling more so than any other practical mode of transportation, on both a short-term (day-by-day) basis and longer-term trends. Extreme heat, extreme cold, and heavy rainfall are the top weather phenomena leading to decreased numbers of cycling trips. As such, a comparison of temperature and rainfall in the evaluated cities is warranted.

Figure 2-13: Weather Comparison of Select Cities

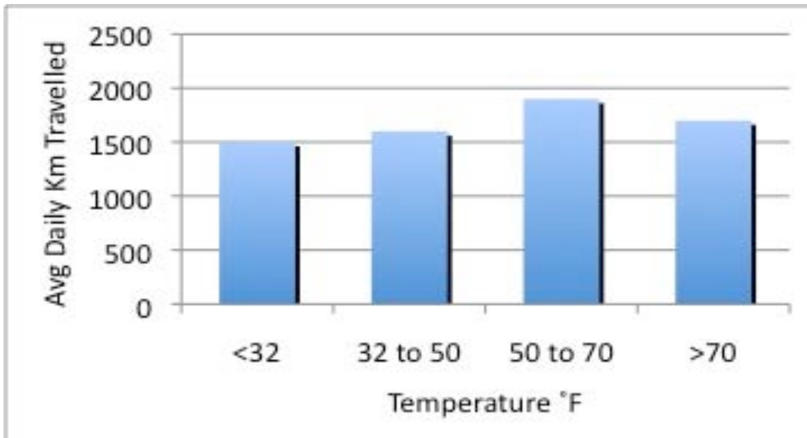
	Lyon	Paris	Barcelona	Montréal (Quebec)	Minneapolis	Philadelphia
Latitude	45°45N	48°50N	41°21'N	47°14'N	44°59'N	39°57'N
Average Yearly Precipitation	~813mm	~619mm	~587mm	~1008mm	~725mm	~1022mm
Average Maximum Summer Temperature	~75°F	~73°F	~78°F	~69°F	~76°F	~79°F
Average Minimum Winter Temperature	~34°F	~37°F	~47°F	~11°F	~15°F	~31°F

Sources: BBC Climate Trends, http://www.bbc.co.uk/weather/world/city_guides/, Accessed March 30, 2009

As indicated in **Figure 2-13**, Philadelphia experiences, on average, more annual precipitation than any of the other evaluated cities, marginally ahead of Montréal and about 25% more than Lyon.

With respect to temperature, Philadelphia's average maximum summer temperature is comparable to those of all the other cities. Philadelphia's average minimum winter temperature is a little lower than those of the three European cities, yet significantly higher than those of the two North American comparables. Importantly, it should be noted that both Minneapolis and Montréal plan to use their bikeshare systems seasonally, i.e. they will be removed for at least part of the winter due to extreme cold plus high levels of snow/precipitation.

Figure 2-14: Bikeshare Usage Versus Temperature (Data from Lyon, France)



Sources: "Analyse Quantitative d'un Service de Vélos en Libre-Service: Un Système de Transport à Part Entière", Mindjid MAIZIA and Élodie DUBEDAT, Métropolis, January 2008, pg. 73-77.

According to the Lyon data presented in **Figure 2-14**, the sensitivity of overall bikeshare use with respect to temperature is relatively small, with bikeshare activity peaking in the 50-to-70 degree (F) range. The relatively small variations (<15%) on days outside this range suggest that Lyon's system is supported by a core of everyday users supplemented by a surge in "choice" riders on ideal bicycling days.

4. Topography

Like weather, topography has an impact on the willingness of people to use bicycles, although in this case it is often limited to certain trip patterns rather than affecting system usage as a whole. This is apparent in the evaluated European bikeshare cities, which regularly exhibit shortages of bicycles at stations at the tops of hills or steep gradients—suggesting that many users are riding downhill but not back upwards.

The three European examples all have unique topographical characteristics but do not differ greatly from Philadelphia: Lyon has two hills on the outskirts of a relatively flat city center; Paris has one large hill and a few smaller hills spread throughout the city; and, Barcelona sits in a "bowl" with the beach and city center situated close to sea level. Bikeshare usage in these cities have shown that while the topography has certainly contributed to occasionally empty stations on the tops of hills, it has not had a negative overall effect on the programs' success. It does, however, pose an operational issue for redistribution of bicycles.

5. Bicycle Culture

Generally, cities in Spain and France—as compared with, for instance, the Netherlands and Denmark—are not historically revered for a strong "background" bicycle culture, as exhibited by the modest presence of bicycles in their pre-bikeshare mode-share characteristics (see **Figure 2-11**). On the contrary, typical issues of bicycle theft, storage, and maintenance had been common barriers to owning a bicycle, partially explaining the emergence of a "latent" bicycle demand when their respective bikeshare programs eliminated these as obstructions to widespread bicycle use.

In short, it does not appear that any particular "baseline" of bicycle usage is needed to set the stage for a successful bikeshare program.

B. Program Infrastructure Characteristics

The following sub-sections compare several specific aspects of the bikeshare infrastructure provided within the evaluated cities.

1. System Size

The sizes of the three primary European bikeshare programs range from 4,000 bicycles in Lyon to more than 20,000 in Paris, partly reflecting the population and density of the targeted service areas. All three cities have bicycle stations as close as 250 meters apart, with this range increasing up to about 550 meters (one-third mile) in Lyon. The number of bicycles per station averages approximately 12 to 15 in the three cities.

Figure 2-15: Comparisons of the Physical Extent/Statistics of Select Bikeshare Systems

	Lyon: Vélo'v	Paris: Vélib	Barcelona: Bicing
# of Bikes	4000	20,600	6000
# of Stations	340	1451	400
Bikes/Stations	~11.76	~14.2	~15
Avg Distance b/w Stations	250 to 550 meters	250 to 350 meters	250 to 350 meters
Subscribers	~60,000	~170,000	~100,000
# Subscribers/bike	~15	~8.25	~16.67

Sources: Provider Websites and Translink Public Bike System Feasibility Study- Local Context Analysis (Vancouver), March 2008

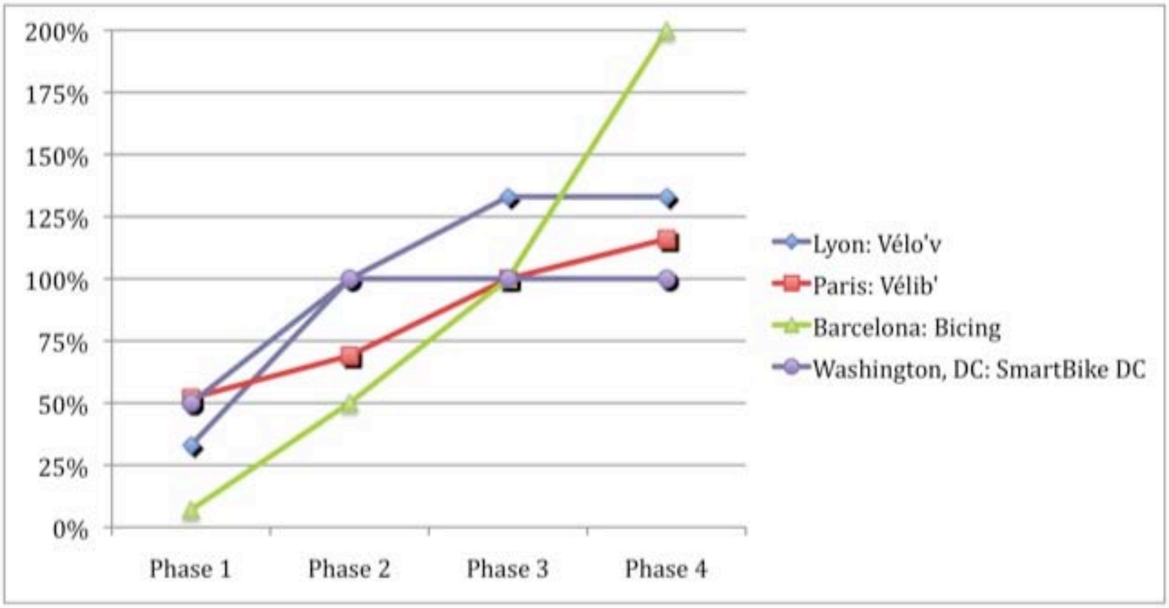
The number of subscribers per bicycle in Paris (8) is only about half that in Lyon and Barcelona (15 to 17), reflecting differences in the objectives and operations of the individual systems.

2. Phasing Strategies

The success of a bike-sharing program depends largely upon ready availability of bicycles at sufficient numbers of trip generators, consisting of both origins and destinations. Much of the available bikeshare literature has stressed the importance of convenient, reliable accessibility of bicycles. Therefore, it can be assumed that successful program initiation requires an adequate "base" supply of bicycles from the outset, else the potential combinations of origin-destination trips could be severely limited.

As shown in **Figure 2-16**, Lyon, Barcelona, Paris, and Washington DC all launched their systems with approximately 50 percent of their eventual target bicycle supply in place from the very beginning or shortly thereafter.

Figure 2-16: Bikeshare Implementation Phasing in Select Cities



Sources: Provider Websites

Also evident from **Figure 2-16** is that Lyon, Barcelona, and Paris eventually expanded their programs beyond their initial targets (i.e. the "100%" line), with Barcelona doubling its number of bicycles, suggesting that actual demand exceeded the initial projections in these cities. Similarly, Washington DC is planning an expansion of its system during the course of 2009.

3. Integration with Other Systems

Based on experience and surveys in other cities, it has been demonstrated that bikeshare encourages "intermodality" with links to transit and walking trips. In support of this notion, many bikeshare providers coordinate their efforts with other transportation providers in order to maximize the convenience and reach of their systems. For instance, in both Lyon and Paris, the bikeshare membership card is integrated with the regional rail, metro, and bus fare-card system.

Elsewhere, Germany's Deutsche Bahn (the national railway operator) offers a consolidated fare card (Mobility Bahn Card 100) that can be used to access the local bikeshare and carsharing systems as well as regional/national rail services.

4. Bicycle Components

Figure 2-17 indicates the typical components of a bikeshare-worthy bicycle. These include use of heavy-duty materials and puncture-resistant tires to help withstand the additional wear-and-tear of varied individual users.

Figure 2-17: Typical Components of a Bikeshare-Ready Bicycle

Typical Shared Bicycle Components
Step Through Frame
Adjustable Seat
Front Basket
High Stability Kickstand
Heavy Duty Material
Chain Guard
Bicycle Bell
Secondary Lock
Disc Brakes
Lights
Fenders
3 Speed Derailleur
Puncture Resistant Tires

C. Program Operations/Management Characteristics

This section compares information regarding the management of bikeshare systems, including costs, funding methods, fee structures, and various aspects of day-to-day operation.

1. Costs

Figure 2-18 compares the bikeshare costs in select cities *as available*. These estimated figures—the accuracy/completeness of which is restricted by limited willingness of the providers to share such information—illustrate the wide potential range of costs and revenues depending on system size and target market.

Figure 2-18: Estimated Costs of Bikeshare in Select Cities

	Lyon: Vélo'v	Paris: Vélib'	Barcelona: Bicing	Montréal: Bixi	Minneapolis: NiceRide
Size of System	4,000 bikes	20,600 bikes	6,000 bikes	2,400 bikes (Spring 09)	1,000 bikes (Spring 09)
Start Up Capital Cost	NA	~$120 m	~$2.9 m (1500 bikes)	$8.8 m	$3.4 m
Operating Cost	$5.1 m	$46 m	~$6 m (3000 bikes)	$8.8 m	$1.6 m
Annual Revenue	NA	$104 m ($65m to JCDecaux, $39m to Paris)	NA	NA	$1.2 m

Sources: Lyon: Grand Lyon, Vice President Gilles Vesco
Paris: TransLink Bike System Feasibility Study- Vancouver, March 2008
Barcelona: Ajuntament de Barcelona
Montréal: "Implantation d'un Système de Vélos en Libre-Service au Centre-Ville de Montréal"
Minneapolis: "Non-Profit Business Plan for Twin Cities Bike Share System"

2. *Funding Methods*

With the substantial upfront investment required for a bikeshare program, there are a variety of funding methods that have been demonstrated by the evaluated cities. The most prevalent method of funding has been through a street furniture/advertising contract whereby the city bestows upon an advertising agency (such as JCDecaux in Paris and Lyon) a set level of advertising rights in return for installation and operation of the bikeshare program. Other cities, such as Barcelona, have applied various sources of revenue—such as that from advertising contracts and local parking fees—toward the purchase and installation of their bikeshare system.

In North America, there is likewise a diversity of funding schemes. Washington DC has engaged Clear Channel Communications in much the same role as JCDecaux in Paris and Lyon. In contrast, Montréal's program is to be funded by the municipal government and operated by the local parking authority (Stationnement de Montréal). In Minneapolis, a non-profit organization has been tasked to operate the program with funding from local institutions along with Federal transportation funds.

3. *Insurance Methods*

Insurance is one of the most repeatedly cited concerns for system implementation in North America. Unfortunately, as is evident in **Figure 2-19**, there are few "best practices" directly applicable to Philadelphia, due to significant background differences in the health care systems and litigation cultures of Europe, Canada, and Australia compared with the United States.

Figure 2-19: Overview of Insurance Methods and Related Issues in Select Cities

	Washington, DC	Denver	Minneapolis	Montréal	Lyon	Paris
Health Coverage	Private	Private	Private	National	National	National
Insurance Method	Unknown	Municipal	TBD	Municipal (Civil)	Municipal (Civil)	Municipal (Civil)
Restrictions	18+	18+ (Mun. Emp. Only)	18+	14-18: w/ permission	14-18: w/ permission	14-18: w/ permission
Helmet Requirement	None	None	None	None	None	None

Sources: Provider Websites Paris: Vélib à Paris- Mairie de Paris, 2007

It is important to note that currently no well-known, successful bikeshare program requires the use of a helmet. However, Brisbane, Australia and Vancouver, Canada are presently planning bikeshare programs for which helmet usage will be required (as per provincial or national law). It is yet to be seen what affect this may have on bikeshare success. With the helmet requirement, it is anticipated that spontaneous usage of bikeshare would decrease as most such users would not typically travel with their own helmets, while the concept of shared helmets faces its own risks and operational difficulties.

4. Fee Structure

Fees for bikeshare use vary among the cited examples; however, most programs offer options for both a long-term and shorter-term subscription (see **Figure 2-20**). The short-term subscription is valuable in part because it allows users to test the system without a long-term commitment, while also enabling tourists and non-residents to economically utilize the system on an occasional basis.

In general practice, the user will typically authorize some form of security deposit to ensure proper care and return of the system's bicycles. Also, it is typical for most systems to structure their fees to discourage long-term use (i.e. for more than a couple hours).

Figure 2-21 examines the costs of hypothetical short trips within the center of a city by various travel modes, as a means of identifying the potential niche of a bikeshare system. The focus of **Figure 2-21** is any relatively short trip expected to last between approximately thirty minutes to an hour; it shows only the direct short-term costs (i.e. excluding subscription or gasoline costs) in order to best replicate a typical trip-by-trip cost comparison.

Figure 2-20: Fee Structures for Select Bikeshare Programs

($1.27 to 1€) ($0.80 to $1CAD)	Lyon: Vélo'v	Paris: Vélib'	Barcelona: Bicing	Washington, DC: SmartBike DC	Montréal: Bixi
Registration: Annual	5€ ($6.35)	29€ ($36.83)	30€ ($38.10)	$40	$78 CAD (Apr to Nov) ($62.40)
Registration: Monthly	NA	NA	NA	NA	$28 CAD ($22.40)
Registration: Weekly	1€ ($1.27)	5€ ($6.35)	1€ ($1.27)	NA	NA
Registration: Daily	See above	1€ ($1.27)	NA	NA	$5 CAD ($4)
1st 30 Minutes	Free	Free	Free	Free	Free
2nd 30 Minutes	+1€ ($1.27) +0.50€ Annual (63¢)	+1€ ($1.27)	+0.50€ (63¢)	Free	+$1.50 CAD ($1.20)
3rd 30 Minutes	+1€ ($1.27) +0.50€ Annual ($0.63)	+2€ ($2.54)	+0.50€ ($0.63)	Free	+$3 CAD ($2.40)
4th 30 Minutes	+2€ ($2.54) 1€ Annual ($1.27)	+4€	0.50€ ($0.63) Fine of 3€ if >2 hours	Free Up to 3 hours	+$6 CAD ($4.80)
Security Deposit	150€ ($190.50)	150€ ($190.50)	150€ ($190.50)	$550 (charged if stolen/not returned)	Up to $1000 CAD ($800)

Sources: Provider Websites

Figure 2-21: Cost Comparisons for Short Intra-City Trips

Comparison	Lyon	Philadelphia
30 Minutes on Shared Bicycle	Free (after subscription fee)	NA
Taxi (3 miles)	8.5€ ($10.80)	$9.50
One-Zone Transit Fare	1.60€ ($2.03)	$1.45 (Token) / $2 Cash
Bicycle Rentals	7€ (half day) ($8.89)	$20 (4 hours)
Metered On-Street Parking-Center City (1 hour)	2€ ($2.54)	$2
Garage Parking (1 hour)	1.95€ ($2.48)	$9

Sources: Lyon: Lyon Parc Auto www.lpa.fr, Transports en Commun de l'Agglomération de Lyon www.tcl.fr, Accessed March 15, 2009 Philadelphia: Philadelphia Parking Authority www.philapark.org, Southeastern Pennsylvania Transportation Authority, www.septa.org, Accessed March 15, 2009

5. Education Strategy

Most existing bikeshare programs have been paired with cyclist and motorist safety campaigns. However, none of the current programs strictly require participation in an educational program as a prerequisite to subscription. The most critical safety information is, in some cases, presented selectively on the handlebars of the shared bicycles, on panels at kiosks, and/or on pamphlets distributed with subscription cards.

This aspect of bikeshare is presumed to be very significant since many of the people expected to use bikeshare are non-bicycle-owners who are largely unfamiliar with the local bicycle environment. Information about preferred (i.e. safest) local routes could potentially be incorporated into the bikeshare education effort.

6. Subscription Process

Bikeshare's best chance of success depends on its accessibility in terms of both its location/convenience and its subscription process. The ease of the latter can have a distinct impact on usage numbers, as opportunity to purchase short-term subscriptions at bikeshare kiosks (whether daily or weekly) allows users to “test” the system, often leading to longer-term memberships.

Short-term subscriptions are generally enabled by credit-card swipes at the bicycle kiosk, covering both the bicycle rental fee as well as an authorization for a security deposit until the bicycle is successfully returned (to any station). Long-term subscriptions, which can be obtained by mail, telephone, or on the Internet, likewise usually include some form of security deposit.

7. Maintenance and Redistribution

Maintenance and redistribution present the most time-consuming and costly issues for bikeshare operators. With heavy and often uneven patterns of usage (for instance, bicycles used for downhill but not uphill trips), operators are faced with the frequent need to repair and redistribute many of the bicycles to ensure a reliable system.

In terms of routine maintenance, in Paris approximately 80 percent of all repairs are conducted by on-site mechanics that travel by electric bicycle. Bicycles in need of more serious repairs are picked up either by barge on the Seine River or on trucks powered by natural gas, which are also used to redistribute the bicycles as needed.

Barcelona and Lyon have similar maintenance and redistribution programs. In Lyon, it is estimated that 60 percent of “redistribution” occurs naturally, while 20 percent is “forced” (i.e. the user cannot return a bicycle to a particular station because it is full, and therefore must go to another station), and the remaining 20 percent is completed through the use of trucks.

(Sources: “Feasibility Study for a Central London Cycle Hire Scheme,” Transport for London and the Clear Zone Partnership, December 2008)

8. Local Involvement

Major institutions such as museums and universities—as well as commercial districts and park/stadium operators—have traditionally played a significant role in the success of bikeshare programs. Many such institutions and organizations themselves represent consistent trip generators and, as such, are often major beneficiaries of the service.

As an example of a non-optimal situation, in Washington DC four major organizations have implemented closed (i.e. non-integrated) bikeshare programs, to the detriment of the goal of achieving a comprehensive citywide program: DC Department of Transportation, the National Park Service, Washington DC (the City), and Capitol Hill. These four isolated programs, in essence, compete with and exclude each other, thereby limiting the potential for an interconnected, cooperative system.

Institutions also represent potential for financial and/or in-kind support (such as hosting locations, etc.).

9. Employment
Bikeshare programs help generate a variety of jobs for local economies, including maintenance, redistribution, marketing, and management of subscriptions/memberships. **Figure 2-22** shows the number of full-time employees generated by the three European bikeshare examples, as well as (for purposes of comparison) each system's total number of bicycles and bicycles/employee.

Figure 2-22: Employment Information from European Bikeshare Programs

	Lyon: Vélo'v	Paris: Vélib'	Barcelona: Bicing
Full Time	32	400	162
# Bikes	4,000	20,600	6,000
Bikes/Employee	125	~52	~37

Sources: Provider Websites

D. Performance Indicators

Performance indicators help to denote the success of various bikeshare programs, and thus can help increase the understanding of the ultimate effects of various system components. The following sections highlight valuable statistics from the variety of bikeshare programs previously introduced.

1. User Demographics
Figures 2-23 and **2-24** illustrate several aspects of the user-profiles of the three evaluated European bikeshare programs. The gender profile of *Vélo'v*, *Vélib'*, and *Bicing* show that the majority of their users are men. The employment profile (available only for *Vélo'v* and *Bicing*) shows that, in both Lyon and Barcelona, "professionals" comprise approximately one-third of total users, presumably for daily commute purposes. Proportion of student use is related to the size, location, and degree of integration with major educational institutions within the service area.

Figure 2-23: User Profile for Select Bikeshare Programs – Gender

Sources: Lyon: "Vélo'v: Un Service de Mobilité de Personnes à Transferer?", Benoît BEROUD, Université Lyon 2- Mémoire de Master Recherche, March 10, 2007.
Paris: Bilan des Déplacements en 2007, Mairie de Paris, http://www.nxtbook.fr/newpress/Mairie-de-paris-direction-voirie-deplacements/Bilan_des_deplacements_en_2007_Paris/index.php#/22/OnePage, Accessed March 11, 2009
Barcelona: "Guía Metodológica: Para la Implantación de Sistemas de Bicicletas Públicas en España", Gobierno de España:Ministerio de Industria, Turismo y Comercio.

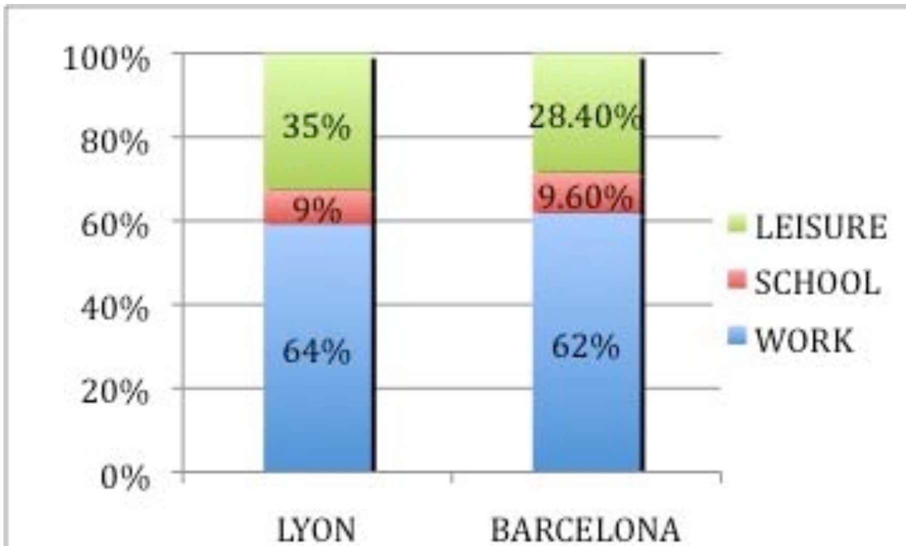
Figure 2-24: User Profile for Select Bikeshare Programs – Employment

Sources: Lyon: Grand Lyon, http://www.grandlyon.com/Info.1164+M53f7b303bcf.0.html, Accessed March 10, 2009
Barcelona: "El Bicing logra 130.000 abonados en su primer año de funcionamiento en Barcelona," El Periódico, March 27, 2008, http://www.elperiodico.com/default.asp?idpublicacio_PK=46&idioma=CAS&idnoticia_PK=495205&idseccio_PK=1022&h=, Accessed March 10, 2009

2. Trip Purpose

Figure 2-25 shows that the majority of bikeshare users in the evaluated cities use the system to travel to and from work, which reflects the user-profiles shown in **Figure 2-24**. This suggests highest usage during the peak commute hours, which has been corroborated by supporting data.

Figure 2-25: Bikeshare Trip Purpose in Select Cities

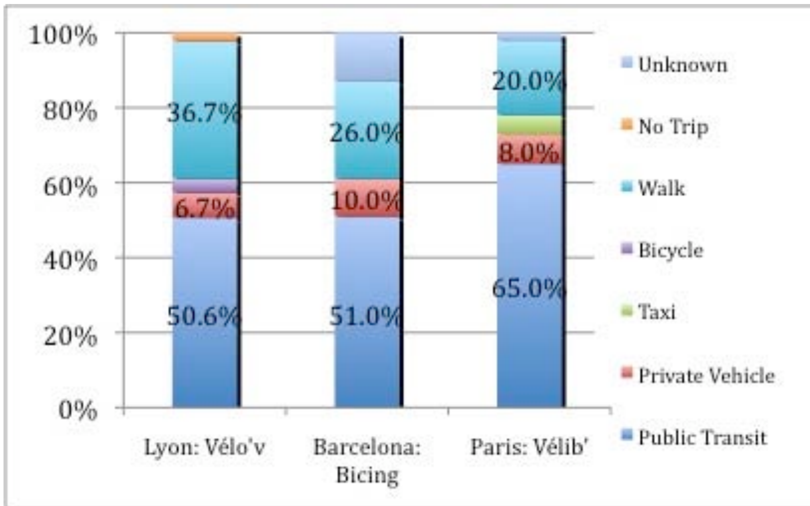


Sources: Lyon: "Vélo'v: Un Service de Mobilité de Personnes à Transferer?", Benoît BEROUD, Université Lyon 2- Mémoire de Master Recherche, March 10, 2007
Barcelona: Bicing- Bikeoff Project, http://www.bikeoff.org/design_resource/dr_PDF/schemes_public_bicing.pdf, Accessed March 5, 2009

3. Mode Shift

With high peak-hour usage, there is considerable potential for bikeshare to accommodate "mode shift" from congested forms of transportation. **Figure 2-26** shows that, in the three primary European examples, more than half of all bikeshare trips replaced equivalent trips on public transportation. However, although the observed shift from private vehicles is much lower than that from public transportation in percentage terms (7 to 10 percent), the impact of such trips on street-level congestion is very significant (with each 1 to 2 bikeshare trips representing a vehicle "removed" from the roadways). Finally, walk trips (presumably lengthy journeys) represent an additional significant source of bikeshare users.

Figure 2-26: Mode Shift Data – "How would you have taken this trip if not by shared bicycle?"



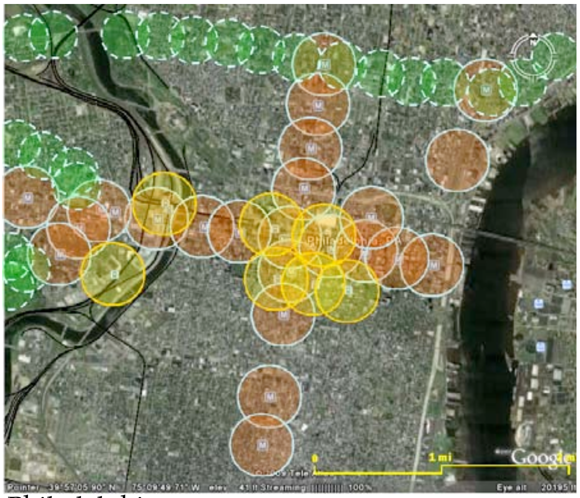
Source: Lyon: "Vélo'v: Un Service de Mobilité de Personnes à Transferer?", Benoît BEROUD, Université Lyon 2- Mémoire de Master Recherche, March 10, 2007.

Although the shifting of people away from public transportation could initially be regarded as a potential drawback, the origin and relevance of this statistic should be further explicated. In particular:

- European public transport systems—Paris in particular—regularly exhibit higher frequency/duration of peak-period "crush-loading" than their American counterparts, indicating a higher initial mode-share burden and greater impetus for travelers to seek a more comfortable alternative.
- The survey results are not clear as to whether the cited bikeshare 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 bikeshare rather than the bus to get to a train station, then resuming the journey on public transport.

Figure 2-27 compares the layout of premium transit services (i.e. excluding buses that operate in mixed traffic) in Philadelphia with those of Paris, Lyon, and Barcelona, with the circular "service-areas" representing a 1000-foot walk from each transit station. It is evident that the overall physical transit coverage in Philadelphia is generally less than those of its European counterparts, suggesting a greater opportunity for *complementary* rather than *competing* trip patterns with respect to bikeshare. This relationship should be further explored as the parameters for a potential Philadelphia bikeshare service are better refined.

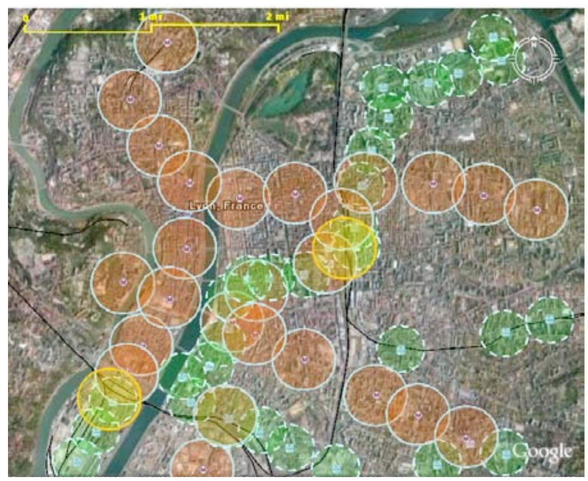
Figure 2-27: Rail Transit-System "Coverage" - Philadelphia and European Examples



Philadelphia

Barcelona

Paris



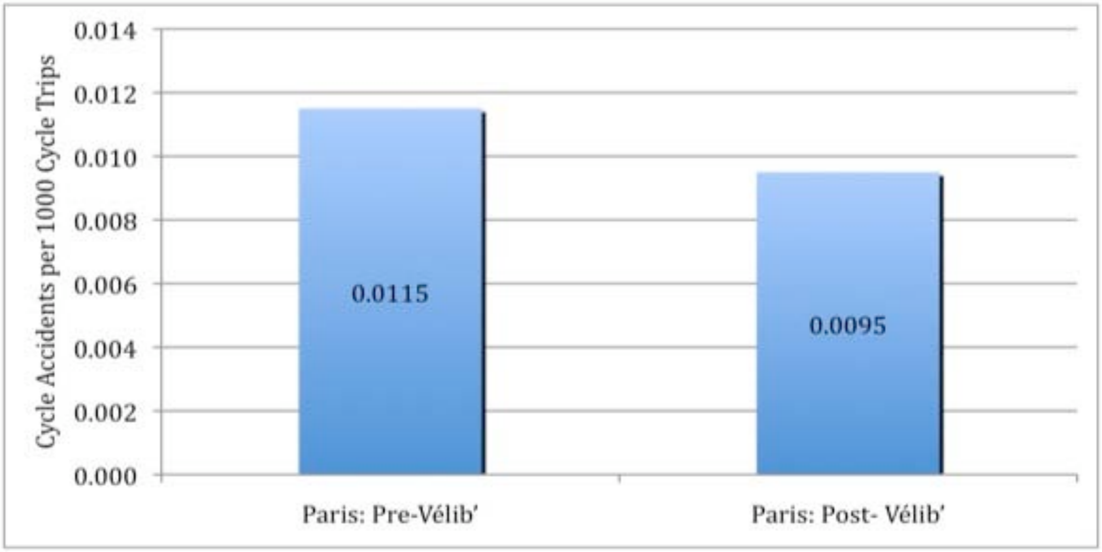
Lyon

4. Accident Rates/Safety

Since a large percentage of shared bicycle users are new cyclists, there is often concern about the safety implications of bikeshare systems. In Lyon, 96% of *Vélo'v* users in 2005 had never before bicycled in the center of the city. In Paris, similarly, 79% of *Vélib'* users in 2007 had started to bicycle just in that year. With six deaths on *Vélib'* in a two-year period, it is important to take note of education and safety measures. Safety is not only dependent on provision of safe facilities linking origins with destinations, but also on education of newer cyclists of the rules, regulations, and precautions needed for safe operation on city streets.

It is difficult to measure the overall effect of bikeshare on bicycling safety, as the concerns about novice cyclists appear to be somewhat offset by the influx of more bicyclists on the streets overall, increasing their visibility and, in ideal conditions, eliciting more cautious driver behavior. **Figure 2-28** shows that, in Paris, there was a small decrease in the cycle accident rate *after* implementation of the *Vélib'* program.

Figure 2-28: Paris Accident Rates Before/After Bikeshare



Sources: Feasibility Study for a Central London Cycle Hire Scheme," Transport for London and the Clear Zone Partnership, December 2008

Although similar useful data from other cities has proven difficult to acquire, Gilles Vesco, the vice president of Grand Lyon, has stated that, "from 2004 to 2007, we've doubled bicycle traffic while the number of accidents has increased by only 7%." However, some of these accidents have resulted in deaths, underscoring the importance of aggressive safety/education programs as part of bikeshare, as well as provision of safe infrastructure.

5. Theft

With any public good, misuse and theft can present distinct problems. With large-scale bikeshare programs, specifically in high vandalism/theft areas, shared bicycles can become a specific target. With nearly 6,000 bicycles in circulation, Barcelona has seen around 200 bicycles (or approximately 3% of its fleet) stolen. Paris, with over 20,000 bicycles in its fleet, has experienced around 3,000 bicycle thefts over the course of a year in operation (15% of the fleet at the time), in part due to improper use (riders leaving them at stations without securing them adequately) and a low-tech fleet. In contrast, Lyon, which has GPS tracking abilities in its shared bicycles, has incurred losses of only around 2.5% of its fleet.

From these experiences, it can be learned that, in planning for a bikeshare program, a certain degree of loss has to be expected (and accounted for); however, advanced features such as GPS tracking abilities greatly impact the theft and vandalism rates of shared bicycles.

Sources: http://www.timesonline.co.uk/tol/news/world/europe/article4289943.ece July 8, 2008, Accessed March 10, 2009

6. Environmental Impacts

The environmental impacts of bikeshare programs have yet to be comprehensively studied. Among possible benefits are decrease in street (auto) congestion and reduction in emmissions.

Sources from Paris have stated that the *Vélib'* program's 20,000 bicycles have reduced carbon-dioxide emmissions by 13,870 tons per year (200 grams/kilometer-traveled on average). Simiarly, sources in Lyon cite that the 40.9 million kilometers traveled on *Vélo'v* since implementation in 2005 will have equated to 8,180 tons of carbon dioxide if those same distances were traveled by car.

Sources: Program newsletters

However, although these proclamations provide a useful base point, it should be remembered that not all bikeshare trips replace car trips meaning that estimation of the true environmental impacts would represent an extremely complex analysis for which the results are likely to have limited precision.

7. Economic/Tourism Impact
Similarly, the economic impact of bikeshare has never been fully studied, although some cities have cited anecdotally an increase/extension of tourism associated with the shared bicycles. The high numbers of short-term subscribers, particularly in Paris, suggest that visitors indeed represent a significant portion of the bikeshare market.

Interestingly, one aspect of the economic impact of bikeshare that has been somewhat estimated has been impact on revenues of private bicycle shops, which have (in the three European sample cities) exhibited an increase in private bicycle sales. This suggests that the increased presence of bicycles, along with improvements to facilities concomitant with implementation of bikeshare, has facilitated a simultaneous increase in private bicycle traffic. The combination of increased bicycle purchases, improved civic attraction, and generation of jobs all represents example components of the potential overall economic impact of bikeshare.

2.4 Preliminary Assessment

Although the intention of this **review of comparables** was to research the methods/characteristics of various bikeshare programs—not yet to determine their direct applicability to Philadelphia—the data contained in this chapter has highlighted trends and patterns important to understand in the ongoing refinement of a local approach to bikeshare. Key findings include:

- Successful bikeshare programs are not limited to idyllic settings with year-round bicycle weather. Programs have been implemented in a variety of locales, adapted to the specific (or observed) usage patterns and targeted toward a variety of broad user-groups.
- There are both advantages and disadvantages to operation through a private company; these implications will have to be carefully weighed while considering the best approach for Philadelphia.
- The size of bikeshare programs varies considerably—in terms of both numbers of bicycles and subscribers—yet the spatial distribution of bicycles seems to be relatively consistent across systems (i.e. 250 to 500 meters between bicycle stations).
- Most bikeshare programs have exhibited an aggressive approach toward phasing, generally establishing the system with 50% or more of the total anticipated (though not necessarily final) capacity of bicycles.
- Costs are highly dependent on funding sources (public/private) and target user groups.
- Most bikeshare programs accommodate both short-term (one-day to one-week) and long-term (one-month to one-year) subscriptions, thereby eliciting a broad user base.
- The applicability to Philadelphia of insurance-related experience from the evaluated cities is severely limited, due primarily to differences in the health-system/litigation cultures in countries where bikeshare programs have been best established.
- A large proportion (approximately one-third) of users in the evaluated European cities identified themselves as "professionals," suggesting potential for a steady base of day-to-day users supported by more occasional customers such as students and tourists.
- Although the European examples showed a significant mode shift away from public transit, comparison of the physical layouts of their rail/metro systems versus that of Philadelphia—along with differences in peak-period loading conditions—suggests a more complementary relationship in the latter.

- Data with respect to before/after accident rates appear inconclusive, as the introduction of novice bicycle users seems to be somewhat offset by the overall increase in bicycling activity/visibility.

The evaluated examples—both European and North American—offer a menu of features that could potentially be transferred to the Philadelphia context. This analysis has demonstrated that there are numerous possible approaches toward implementing/operating a bikeshare program, and has started to investigate the impacts/implications of various system components. Also, it has become clear that there are many commonalities among the evaluated systems—in terms of both system characteristics and outcomes—that could help to form a baseline from which an appropriate Philadelphia-specific program could be developed.

3 – Demand Determination

3.1 Overview

The purpose of the demand determination exercise is to assess as best as possible the potential level of bikeshare usage in Philadelphia. In particular, this task has striven to answer the following questions:

- What are the user groups most likely to participate in a bikeshare program?
- What are the unique challenges/benefits associated with each user group?
- What is the potential market breakdown of prospective users, i.e. residential users, downtown workers, commuters, tourists, recreational users etc.?
- What are the prime target markets toward which operations and technology planning should be focused?

In order to achieve this, it was critical to acknowledge both the experiences of other bikeshare cities as well as specific travel demand patterns in Philadelphia. In addition, it was important to identify local factors likely to influence the outcome of a Philadelphia bikeshare program, including climate, topography, demographics (populations of user groups), mode split, and infrastructure.

Part of this effort includes examining the implications of phased implementation and membership.

The Delaware Valley Regional Planning Commission (DVRPC) through the use of Geographic Information Systems (GIS) and mathematical models performed the core of this analysis.

With any modeling exercise—especially with respect to a developing concept such as bikeshare—there is a limitation to the degree of precision and accuracy that could be expected; this effort has sought to best approximate the potential outcome by:

- building on the experiences of other cities as appropriate, using them as a "base case" as applicable.
- accounting for local conditions as "adjustments" to the general expectations derived from other cities' experiences.

In addition, effort has been made to clearly document all assumptions applied during the course of the analysis. The outcome of this task is a defined "core" and "expanded" bikeshare service area for Philadelphia, as well as documentation of the important factors to consider as this process moves forward.

This chapter is divided into four primary sections following this Overview. **Section 3.2** discusses the bike share demand modeling methods of bikeshare programs in peer cities, and the transferability of these methodologies to Philadelphia. **Section 3.3** defines the bikeshare user groups observed in peer programs, and also discusses Philadelphia's potential user profile. **Section 3.4** presents the initial bikeshare demand estimate for Philadelphia conducted by the Delaware Valley Regional Planning Commission, as noted above. Finally, **Section 3.5** identifies key assumptions and points from the demand modeling process, and establishes a set of preliminary recommendations as derived from the exercise.

Note: Significant sources for this exercise include Voyagez Futé "Implantation d'un Système de Vélos en Libre-Service au Centre-Ville de Montréal" May 2007, *Paris: Bilan des Déplacements en 2007, Mairie de Paris, http://www.nxtbook.fr/newpress/Mairie-de-paris-direction-voirie-deplacements/Bilan_des_deplacements_en_2007_Paris/ index.php#/22/OnePage, Accessed March 11, 2009 and APUR Etude de Localisation des Stations de Vélos en Libre Service, December 2006*

3.2 – Modeling Methods from Sample Bikeshare Cities

Bikeshare demand modeling methods from peer cities have been evaluated, where available, to help establish a basic premise for a Philadelphia model. However, limitations to the availability of data have presented a challenge to the degree of relevant detail that could be drawn from each of the case studies.

Three of the cities discussed in **Chapter 2** engaged in significant modeling efforts prior to implementation; their processes are reviewed here in order to help inform the development of a Philadelphia model. Each city varies in its depth and overall tactics. The three cities with adequate data available are:

A. Lyon, France
B. Paris, France
C. Montréal, Canada

The modeling efforts of these cities are each summarized below.

A. Lyon, France

The *Vélo'v* program in Lyon was the first large-scale third generation bikeshare program. Grand Lyon, the city and regional planning agency, worked to define the guidelines needed to size and locate a bikeshare program in the city. Lyon concluded that significant population density and employment density were required to support a large-scale bikeshare program. Lyon also determined that a specific, relatively compact distance between stations was necessary to ensure availability and accessibility.

Therefore, Lyon's model relied heavily on a process of mapping the population and employment density of the city. To this end, a grid of 300 meters (a relatively short walking distance) was laid over the density maps to pinpoint specific potential high-use areas. Using this grid/density map as a base, Grand Lyon plotted station locations appropriately spaced throughout the grid with alterations for utilities, high-use areas, and historic landmarks.

Lyon's analysis, in essence, was a very visually based assessment that relied heavily on population/employment density as key inputs. Also, based on its methodology, Lyon also had a targeted general level of bicycle distribution (i.e. spacing between stations) that it adjusted as needed based on variations in population density throughout the targeted service area.

B. Paris, France

For its own evaluation of demand, Paris added more specific indicators to Lyon's basic methodology. The *Atelier Parisien D'urbanisme* (the Parisian City Planning Agency) derived a modeling method drawn from city-level data of:

- Population density
- Employment density
- Retail-based trips
- Facility-based trips

Population and employment density were used to profile the types of trips made in specific areas. Retail-based trips (determined by the square-footage of stores and the amount of customers) and facility-based trips (derived from visitor data at stadiums, parks, theaters, tourist attractions, etc.) provided a more refined assessment of the city's demand for bikeshare. Paris used these four main indicators to derive a "cumulative-trip" demand that was used to generate a global map of trips for the city.

It is important to note that several additional indicators were evaluated in the initial stages of study but did not factor into the final determination of trip patterns, specifically: after-hours establishments, topography, and bicycle infrastructure. These were presumably dropped as key factors due to general uniformity in the targeted service area and/or a perceived lack of importance compared to the other factors.

With the map of cumulative trips derived from their four primary indicators, APUR, like Lyon, used a 300-meter grid to highlight areas of three varying trip "thresholds" corresponding to predicted levels of bikeshare activity. The three thresholds (low, medium, and high) dictated the amount of bicycles needed for the system in particular areas.

APUR, like Lyon, ultimately underestimated demand and bicycle numbers (as discussed in **Chapter 2** Phasing Strategies): The highest APUR modeling output indicated a need for 9,000 bicycles, significantly short of the over 20,000 bicycles currently in use. Importantly, this highlights the degree of difficulty in accurately predicting numbers of bikeshare trips, while also underscoring the importance of building a certain level of flexibility into the system to handle outcomes that are higher (or lower) than the initial projections.

C. Montréal, Canada

In Montréal's planning process, such flexibility was well-noted: The planning *"Aims to assess the application in order to gradually adapt the service offered according to what appears justified given the imprecision of existing tools to forecast demand in terms of cycling."*

Therefore, Montréal, in conducting its first study in 2007, relied on Lyon-specific information on density of stations and ratios of bicycles to inhabitants. *Voyagez Futé*, a "Center for Trip Management" firm in Montréal, appears to have arbitrarily (in relative terms) determined the bikeshare service area for Montréal. This service area focuses on the city center that possesses similar population density statistics to Lyon; once this service area was defined, the density and ratio of bicycles from Lyon was applied to Montréal.

Montréal also committed resources to the production of a market study, which enabled them to forecast demand and usage patterns within the predetermined service area, as well as produce pricing and revenue estimates.

3.3 Anticipated User Profile

This section identifies potential bikeshare user groups within the specific context of Philadelphia. The market breakdown of specific users will, in effect, guide the program's operating characteristic; therefore it is important to attempt to identify these main user groups as an input to the demand modeling process.

In peer program cities, the major breakdown of users has been observed to include:

- Professionals
- Students
- Residents
- Tourists

The statistical analysis of these users for each city is discussed in **Chapter 2**. Overall, across peer programs in Lyon, Paris, and Barcelona, these four groups make up the core users and the bulk of usage.

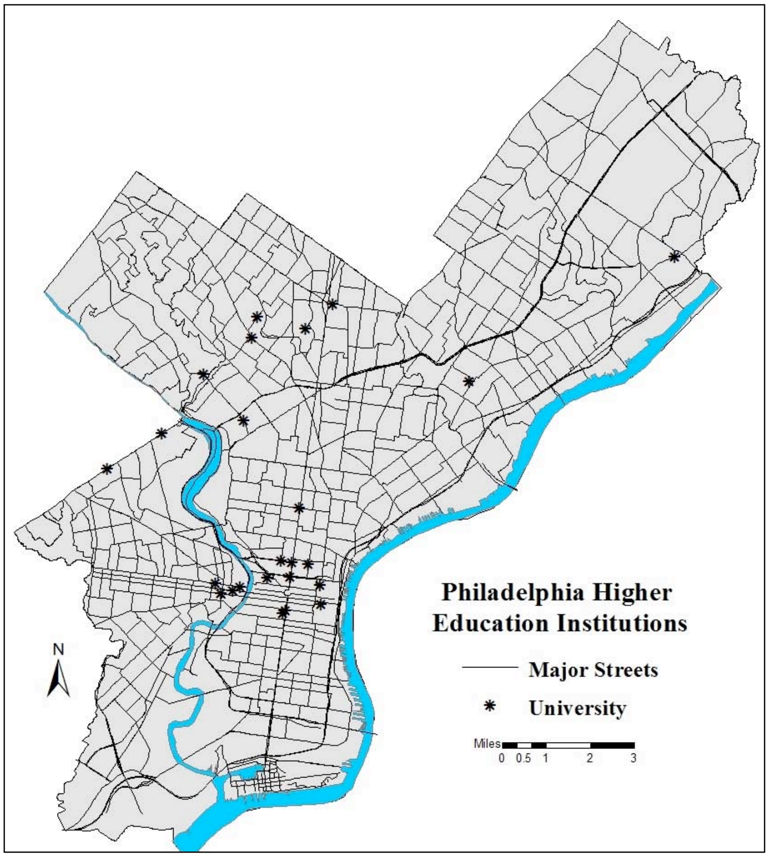
While only direct survey data could specifically identify the user category of each rider, there are other indicators that can help identify types of users in a more general sense. Most importantly, when evaluating usage statistics, the length or method of subscription helps identify the user's general purpose. For instance, "day" users tend to be tourists and residents using the bicycles for leisure, while long-term subscribers tend to be professionals using the bicycles regularly for daily commuting. In Paris, short-term usage made up 36% of trips in 2008, while yearly subscribers made up 26% of users. The remaining 38% linked Vélib and regional rail or metro subscriptions (Paris: Bilan de Déplacements en 2007); this group is comprised mostly of regular (i.e. repeat) users.

Trip purpose can then be broken down into more specific user groups. As outlined in **Chapter 2**, available data suggest that the primary trip purposes across most bikeshare systems include:

- Work Commute
- School
- Leisure

While population and employment density tend to be the best indicators of bikeshare usage, the student population in specific areas has also proven to comprise a sizable user group in some cities. With its numerous universities within the city boundaries (see **Figure 3-1**), as well as a strong student population spread throughout many of the city's central neighborhoods, Philadelphia can be expected to exhibit a high relative share of student users (vis-à-vis other cities). Many transportation experts identify students as one of the most likely subgroups to adopt alternate, innovative forms of transportation, owing to a variety of factors including low car-ownership rates, limited transportation budgets, and greater willingness for experimentation vis-à-vis the general population.

Figure 3-1: Concentration of Colleges/Universities in Philadelphia



In Paris, tourists have proven to be a large force behind single-day subscriptions. Tourists use the bicycles to travel to and from major destinations, experiencing the city at a personalized pace at street level. Given Philadelphia's distribution of significant tourist sites throughout the central area, it can also be expected that tourists also represent a strong potential user group in Philadelphia (given an appropriate pricing option).

Recreational use non-attributable to tourists has not been a strong factor in other cities' user profiles. This is partially due to the statistic that most bikeshare trips tend to be around thirty minutes, which is generally far less than time needed for a leisurely ride through a park or recreational area; this average trip length has been, in part, determined by pricing structures that favor short-term usage. Washington DC offers a counter-example: As its cost structure incurs the same charge for any trip up to three hours, generalized recreational trips of two to three hours is believed to be more common than in the other current bikeshare cities.

Philadelphia demonstrates potential to attract each of these types of user groups to its bikeshare system.

Again, however, it should be noted that difficulty in determining exact numbers of users of each type owes to often-substantial differences (with respect to the sampled cities) in program size, distribution of bicycles, accessibility, and pricing structure.

Recommendations for program size and bicycle distribution could be made, to a degree, following the basic demand modeling exercise presented in the next section. In contrast, pricing structure is a more independent variable; its final form could relate both to the expectations of specific types of users as well as to user types that are specifically targeted (i.e. to support secondary objectives such as reduction of peak traffic or extension of tourist visits). Montréal is an example of a city that conducted a detailed market study of potential users in order to assess this issue, yielding important information on expected usage and projected revenues. This topic is further discussed in **Chapter 5**.

3.4 DVRPC Methodology and Results

This section presents an introduction to the DVRPC model used to predict potential bikeshare use in Philadelphia. The following is an annotated version of DVRPC's analysis; the full report is provided in **Appendix A**.

<u>A. **Phase I** Evaluation: GIS Analysis to Identify Core Market Areas</u>

In **Phase I**, various demographic, land use, and infrastructure factors understood to be favorable for bikeshare usage were spatially analyzed in order to define a core market area—the portion of Philadelphia most likely to support a bikeshare program assuming appropriate density and distribution of bikeshare stations. The method used for this task was to conduct a **weighted sum raster analysis** using GIS software. Under this method:

1. Ten GIS datasets were selected to isolate the factors considered favorable to bikeshare use (i.e. high densities, proximity to transit stations) based largely on the experiences of other cities.
2. For "apples to apples" comparisons, each dataset was rasterized, and data was grouped into ten numerical bins using the quantile method of classification in GIS (i.e., equal numbers of records in each score category).
3. Each raster layer was reclassified into a 10-point scale, with values of 10 being assigned to the quantile/bin deemed most favorable for bikeshare, 9 for the next-most favorable, etc.
4. The ten layers were aggregated using a "weighted sum" to arrive at a composite "bikeshare score" dataset. This included assigning weights to each dataset, which determine how heavily they are "counted" in creating the composite dataset.

Figure 3-2 summarizes the datasets used, how they were rasterized, and the weights assigned to each for the weighted sum analysis. With the exception of two factors, for this run of the analysis the weights assigned were kept basically constant (i.e. x1). This is a major assumption about the relative effect of these various factors, and was based again on what could be interpreted from the experiences of other cities in addition to the desire to keep this evaluation relatively uncomplicated. The two factors for which different weights were used include:

- Proximity to parks and recreation areas: This factor was reduced to a weight of 0.5 as this is considered to be less of a generator of bikeshare use compared with measures of population and travel interchangeability, especially in light of marginal recreational usage in other bikeshare programs.
- Proximity to rail stations: As data from the peer cities indicated that interfacing with rail stations was a large predictor for high bikeshare use, the strength of this factor was raised to a weight of 1.5.

Adjustments or refinements to these weights could potentially impact the results of the model; however, it is unlikely that minor or moderate changes would lead to significant differences in the relative spatial distribution of bikeshare demand throughout the city.

Figure 3-2: Input Factors for "Bikeshare Score" Weighted Sum Raster Analysis

Factor	Buffer distance used for analysis	Weight for composite score mapping
Trip origin factors		
Population density at the Census Tract level for persons 17-64 years of age	n/a	x1
Non-institutionalized group quarter population density at the Census Tract level (includes dorms & shelters, but not nursing homes or prisons)	n/a	x1
Trip attraction factors		
Job density at the Traffic Analysis Zone (TAZ) level	n/a	x1
Retail job density at the TAZ level	n/a	x1
Locations of tourist attractors (cultural, entertainment, sports, and destination restaurants from Greater Philadelphia Tourism Marketing Corp. [GPTMC] database)	Raster analysis maps the density of attractors within 500 meters (0.31 miles) of all points	x1
Proximity to parks/recreation areas	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x0.5
Network / facility factors		
Proximity to rail station(s)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1.5
Proximity to "bicycle friendly streets," including streets with bicycle lanes (Phila. Streets Department dataset)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1
Proximity to streets with bicycle lanes (Phila. Streets Department dataset)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1
Locations of bus stops (includes surface trolley stops)	Raster analysis maps the density of bus stops within 500 meters (0.31 miles) of all points	x1
	Total	**10.0**

Source: DVRPC 2009

Through the weighted sum GIS process, each of the above input datasets were aggregated into a composite "bikeshare score" dataset, where each location in the raster grid has a numerical score (also ranging from 1 to 10). In order to identify a core market area or areas, the next step was to observe the distribution of scores.

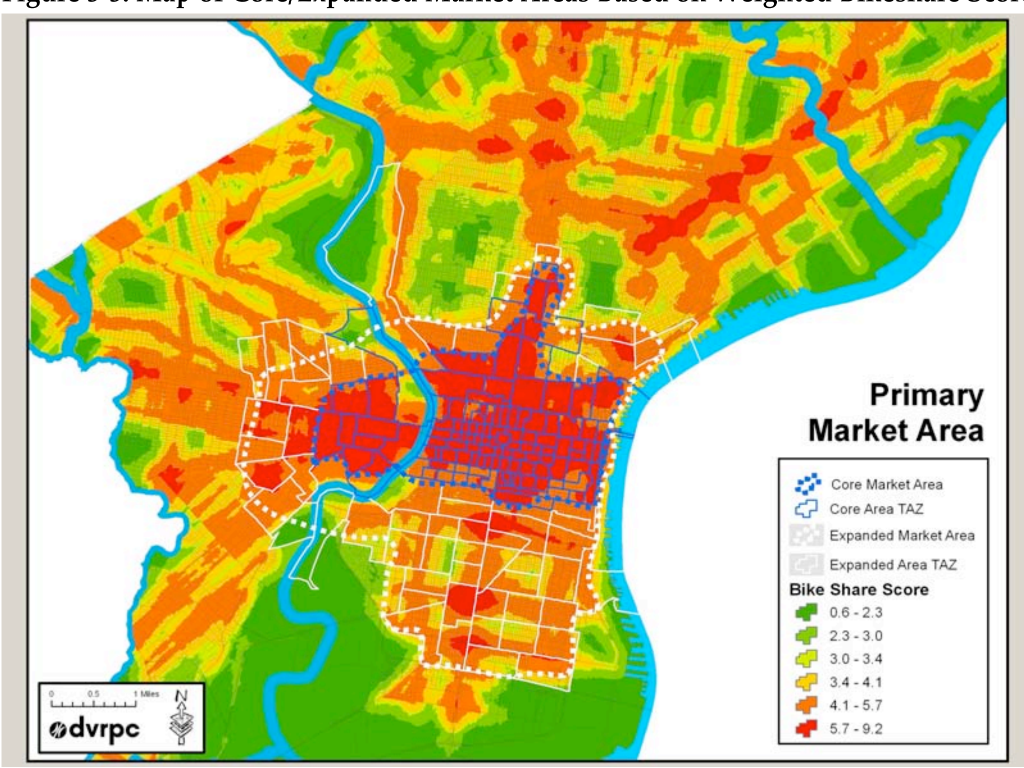
Analysis of the results indicated that the scores fell into six distinct score category ranges. The method of classification used was geometrical interval, which is a modified version of the quantile method of classification (again, equal numbers of records in each category) that adjusts to account for rapid changes in the distribution of scores. The top score category range (5.7 – 9.2) represents portions of Philadelphia with the highest bikeshare scores as defined under this method.

In order to derive a core geographic market area from these scores, they were mapped according to the six main scoring ranges, with the resultant emergence of a projected heavy-use area around the core of Philadelphia, including Center City and surrounding neighborhoods. Generating an outline around the highest-use areas created the core-market boundary.

This core market area (see **Figure 3-3**) is generally bounded by the Delaware River on the east, South Street on the south, 41st Street on the west, and Powelton Avenue & Spring Garden Street on the north (with an extension along North Broad Street to Temple University). Travel Analysis Zones (TAZs) that generally corresponded with this core market area were identified in order to proceed with the Phase II analysis.

An expanded or secondary market area was similarly identified and mapped. This area represents the core market area plus generally contiguous areas of the next highest score category, with scattered pockets of the highest score category also contributing to defining its extent. The expanded market area includes additional parts of West Philadelphia, extends further north of Center City to Girard Avenue including Fishtown and portions of Kensington, and nearly all South Philadelphia river to river.

Figure 3-3: Map of Core/Expanded Market Areas Based on Weighted Bikeshare Scores



The purpose of this tiered approach is to help define a practical approach to project phasing: While the main concentration of high scores in the central area suggest a core location for a first-phase "pilot" program, the next strongest contiguous areas of high scores could be anticipated as the logical locations for future expansion (when/if the program is initially successful in the core market area). There are also non-contiguous concentrations of high scores that also warrant future consideration.

B. **Phase II** Evaluation: Bikeshare Trip Estimates for Core and Expanded Market Areas

A "sketch-planning method" was developed in order to estimate the trip-level demand for bikeshare in Philadelphia based on the demand for existing modes and diversion rates extrapolated from public bicycle systems in other cities. The method involved three steps:

- Calculation of diversion rates based on peer-city experience;
- Calculation of demand for existing transportation modes in Philadelphia; and
- Application of the diversion rates to existing Philadelphia trips to determine the demand for bikeshare.

Each step is described in detail below.

1. Calculation of diversion rates

Traditional travel demand models have typically been used to determine the demand for travel by auto and, to a lesser extent, the demand for transit given various major investment alternatives. Travel demand models have been modified in recent years to also estimate the demand for non-motorized modes (biking and walking) as transportation planning and engineering has moved to a more comprehensive multi-modal approach.

Bikeshare and carsharing, however, are relatively new modes. As such, most travel demand models have not yet been modified to estimate the demand for these modes, particularly since insufficient research has been conducted to determine the fundamental factors that drive the demand for bikeshare trips.

Therefore, is it not possible to directly modify the DVRPC Regional Travel Demand Model in order to estimate the demand for this new mode of transportation. Thus the trip-level demand for bike sharing must be estimated using other means.

In this case, it was decided that the best base source for estimating bikeshare trip demand was the experiences of the peer cities previously discussed. In order to estimate the demand for a Philadelphia bikeshare system, therefore, statistics from other cities (that have already implemented bikeshare systems) were used to help determine bikeshare "diversion rates," which represent the percentage of existing transit/auto trips diverted to bikeshare when such a system was introduced.

Unfortunately, there are currently no comprehensive bikeshare systems in North America from which to obtain data. Washington, DC, has a small pilot system, but it is not large enough to provide meaningful data. Montreal has a larger system, but this program is too new at the time of the study to provide the required data.

DVRPC, however, was able to obtain data from three European cities on the effects of introducing comprehensive, large-scale bike-sharing systems. The three cities are Lyon, France; Paris, France; and Barcelona, Spain. Surveys were done in each of these three cities, where bikeshare users were asked **which mode they would have used if they had not used bikeshare**. The results are summarized in **Figure 3-4**, and are reasonably consistent between cities. (See greater discussion in **Chapter 2**).

Figure 3-4: Summary of Responses to the Question "Without a shared bicycle, how would you have completed your trip?"

Mode	Lyon (%)	Paris (%)	Barcelona (%)	Average* (%)
Bus or subway	50.6	65	51	54.3
Car or motorcycle	6.7	8	10	8.1
Taxi	n/a	5	n/a	4.9
Bicycle	3.7	n/a	n/a	3.6
Walk	36.7	20	26	27.0
New trip	2.2	n/a	n/a	2.2

* - normalized to sum to 100%
n/a – not asked
Source: Lyon – *"Vélo'v: Un Service de Mobilité de Personnes à Transferer?", Benoît BEROUD, Université Lyon 2-Mémoire de Master Recherche, March 10, 2007.* Paris – 2008 survey commissioned by Mairie de Paris and administered by TNS-Sofres. Barcelona – ElPeriodico.com October 2007 survey of Bicing Users by Ajuntament de Barcelona.

The majority of trips were diverted from transit with the average being 54%. About a quarter of bikeshare trips were diverted from walking with an average of 27%.

The surveys were not entirely uniform between cities:

- Only Lyon asked about non-shared bicycle use (3.7% said they would have used a non-shared bicycle if bikeshare were not available).
- Only Lyon asked about the possibility of an induced trip (i.e. 2.2% said they would not have otherwise taken the trip if not for bikeshare).
- Only Paris asked about taxi use (5% indicated they would have used a taxi if bikeshare were not available).

In order to calculate the diversion rates for each city and mode, the numbers of bikeshare trips had to be divided by the total number of trips for each mode in the area of the bike sharing system in each city. See **Appendix A** for a detailed discussion of methodology and limitations.

The bikeshare diversion rates were calculated using the following equation:

$$Diversion\_Rate = \frac{Diverted\_Trips}{Total\_Trips}$$

The resulting diversion rates are summarized in **Figure 3-5**. The following are main observations:

- All three cities have similar diversion rates from the **walking** mode.
- The diversion rate for Lyon for **transit** (1.4%) is much less than those for Paris (4.6%) or Barcelona (3.8%).
- The diversion rate for Lyon for auto (0.06%) is also much less than those for Paris (0.14%)
- or Barcelona (0.18%).
- Lyon is the only city with a diversion rate from **private bicycle** to **shared bicycle.**

Figure 3-5: Estimated Diversion Rates to Bikeshare

Mode	Lyon	Paris	Barcelona
Bus or subway	1.4%	4.6%	3.8%
Car or motorcycle	0.06%	0.14%	0.18%
Bicycle	2.6%	n/a	n/a
Walk	0.56%	0.48%	0.64%

Source: DVRPC 2009

The following is a summary of the complete methodology described above:

- Bike share user surveys in Lyon, Paris, and Barcelona: *"If the bike share program did not exist, how would you have made this trip?"*
- We know total daily bikeshare trips for these three cities
- (1) x (2) = Estimates for the volumes of trips diverted by mode
- Obtained pre-bikeshare trip volumes by mode for each city, estimated down to the bikeshare coverage area
- (3) / (4) = Estimated diversion rates for each city

2. Calculation of existing travel demand in Philadelphia

The DVRPC regional travel demand model calculates trip-making activity in the region as the first step in the conventional 4-step travel demand modeling process. The region is divided into 1,912 Traffic Analysis Zones (TAZs) for purposes of travel modeling. Demographic data such as population and employment are estimated for each TAZ from Census and other data sources.

Trip rates are estimated primarily from the 2000 Household Travel Survey that was conducted in the Delaware Valley region. In this study, participants were surveyed concerning their travel patterns and asked to keep a daily travel diary. This data was then processed in order to determine trip rates for motorized travel, walking, and biking, which were then multiplied by zonal demographic variables in order to determine the number of trips by mode in each TAZ. More details on trip generation and mode split can be found in the document *2000 and 2005 Validation of the DVRPC Regional Simulation Models*.

For the purposes of this study, the number of trips for each mode originating and terminating in each TAZ were summed (and adjusted appropriately) to generate a table of trips by TAZ for each of four modes: auto, transit (bus and rail), walk, and bike.

3. Application of rates to estimate bike share demand: high, middle, and low scenarios

The diversion rates in **Figure 3-5** were multiplied by the number of trips in each Philadelphia TAZ in order to accomplish the principal task of **Phase II** of this exercise: **to estimate the demand and potential usage of a bikeshare system in Philadelphia**.

As indicated in **Figure 3-5**, there is a significant amount of variation in the diversion rates for peer systems. For this reason, bikeshare trips were estimated under three scenarios: high, middle, and low levels, determined and applied to each TAZ as follows:

- High – highest calculated diversion rates for each of the four modes (i.e., 4.6% transit diversion rate, 0.18% auto/motorcycle diversion rate, etc.)
- Middle – middle calculated diversion rates for each of the four modes (3.8% transit diversion rate, 0.14% auto/motorcycle diversion rate, etc.)
- Low – lowest calculated diversion rates for each of the four modes (1.4% transit diversion rate, 0.06% auto/motorcycle diversion rate, etc.)
- There was only one entry (Lyon) for diversions from private bicycle trips. For this reason, the low and high scenarios assumed a decrease or increase, respectively, of Lyon's diversion rate by 30%. The high scenario also increased the total number of bike trips in each TAZ (to which the diversion rate was applied) by approximately 50% to account for growth in bicycle usage in Philadelphia since the 2000 Household Travel Survey (as documented by a limited number of subsequent counts).
- As noted previously, only survey data from one city (Lyon) included a rate of new or induced trips (2.2%). Accordingly, the total estimated number of diverted trips for the middle scenario was multiplied by 2.2% to estimate the number of induced trips based on the Lyon data. This figure was decreased by a factor of ½ (1.1%) for the low scenario and increased by a factor of 2 (4.4%) for the high scenario.

Figure 3-6 summarizes the final diversion rates used for the low, middle, and high scenarios.

Figure 3-6: Diversion Rate Details for Low, Middle, and High Demand Scenarios

Mode	Low	Middle	High
Bus or subway	1.4%	3.8%	4.6%
Car or motorcycle	0.06%	0.14%	0.18%
Bicycle	1.8%	2.6%	3.4%
Walk	0.48%	0.56%	0.64%
New trips (% of total diverted trip volume for all above modes)	1.1%	2.2%	4.4%

Note: For trips diverted from private bicycles, the high scenario further reflects a doubling of the base TAZ-level bicycle trip volumes to which this 3.4% rate was applied in order to reflect anecdotal doubling of citywide bike trips since the 2000 Household Travel Survey

4. Results Summary

The outcome of **Phase II** yielded an estimate of bike share trips for every TAZ in the City of Philadelphia under the three demand scenarios: high, middle, and low. **Notably, these demand estimates assume the provision of a Philadelphia bikeshare system comparable in scale and scope to those of the peer European cities from which diversion rates were derived.**

Taken together, the three estimate levels yield a wide range for potential daily demand. For use of these numbers in subsequent tasks of the broader Philadelphia Bikeshare Study, it likely makes most sense to focus on the middle-range estimate.

The final task here was to combine the results of **Phases I** and **II** and prepare estimates for bikeshare demand within the specific TAZs that comprised the identified core (and expanded) market areas. **Figure 3-7** summarizes the aggregate estimated demand for each scenario for the two market areas. Note that because the transportation data from which the trip estimates are derived included a mix of weekday and factored daily data, these numbers are best understood as daily trips.

Figure 3-7: Estimated Daily Bikeshare Trips in Philadelphia by Demand Scenario

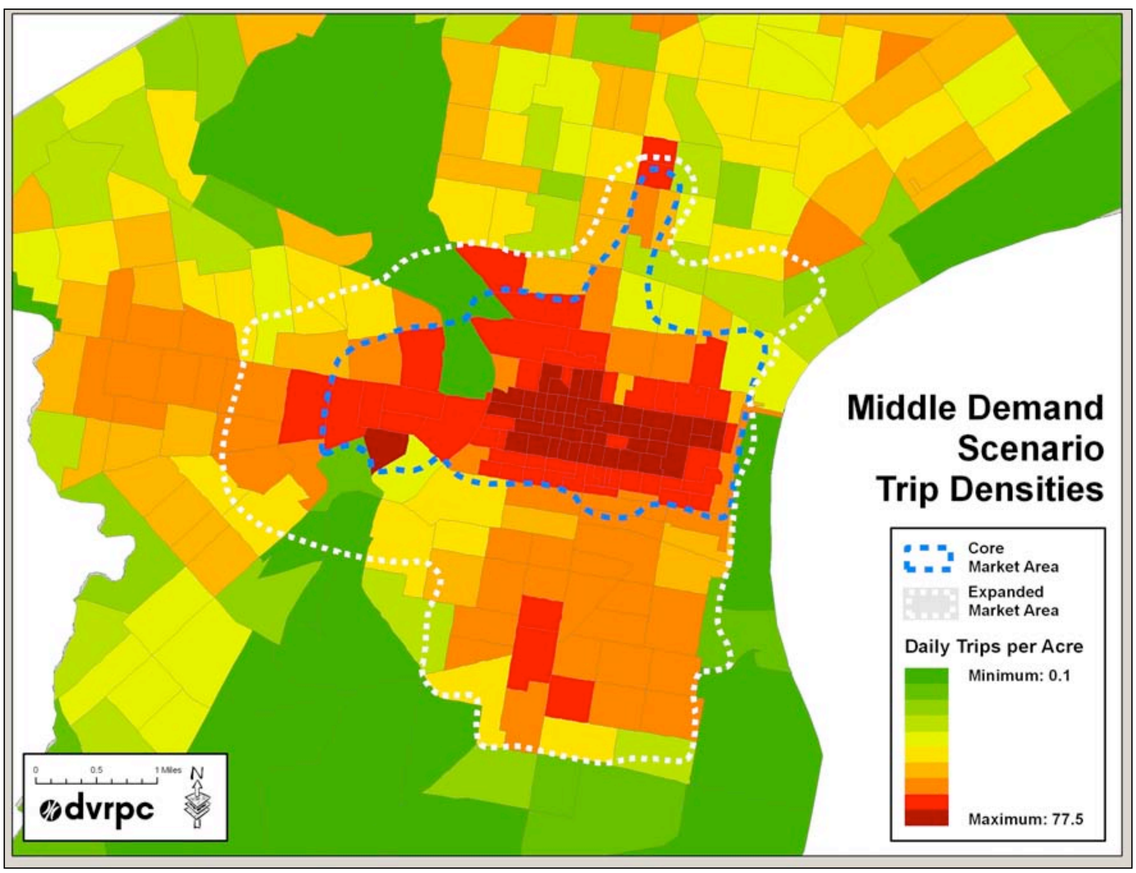
Market area	Demand scenario	Estimated daily bike share trips
Core (2000 population: 98,415)	Low	5,900
	Middle	14,200
	High	18,200
Expanded (2000 population: 317,710)	Low	7,500
	Middle	18,200
	High	23,200

Source: DVRPC 2009

To place these figures into context, population numbers for both market areas from the 2000 US Census are also indicated in **Figure 3-7**. For purposes of comparison, the estimated population for the bikeshare service area in Lyon (which includes the City of Lyon as well as neighboring Villeurbanne) is just over 610,000, with roughly 20,000 daily bikeshare trips.

Figure 3-8 summarizes these trip estimates at the TAZ level for the "Middle Scenario," using a measure for bikeshare trips of riders per acre. (See **Appendix A** for corresponding maps of the Low/High Estimates.) It also bears noting that when these trip densities are mapped, the resulting distribution of usage corresponds quite closely with the core and expanded market areas defined in **Phase I**. This provides a visual "sanity check" for the results of the two phases.

Figure 3-8: Spatial Comparison of Trip Densities for "Middle Scenario"



3.5. Discussion of Outcome

The DVRPC results have been presented as a series of low, medium, and high projections. As such, it is important to understand the factors that could lead to any of these sets of diverse results.

A. Summary

To summarize, the DVRPC results were based on diversion rates (from car/transit to bikeshare) from three sample cities (Paris, Lyon, and Barcelona) applied to Philadelphia background statistics. The "low" result applies to Philadelphia the lowest of the mode-specific diversion rates from the three cities; the "medium" uses the median value; the "high" uses the highest.

Figure 3-9: Low(red), Medium (blue), and High (green) Mode Specific Diversion Rates: Sample Cities

Mode	Lyon	Paris	Barcelona
Bus or subway	1.4%	4.6%	3.8%
Car or motorcycle	0.06%	0.14%	0.18%
Bicycle	2.6%	n/a	n/a
Walk	0.56%	0.48%	0.64%

While some of the variation amongst the cities as shown in **Figure 3.9** is certainly due to geographic, climatic, and cultural differences, some can also be attributed to a number of programmatic issues, as discussed below:

Pricing: As with any consumer product, the price has a direct impact on demand. With bikeshare, most cities generally offer a variety of long-term and short-term passes, and some also provide a free "grace period"—usually a half-hour—during which no fee is charged, which also affects overall usage.

Spacing/Availability of Bicycles: The physical availability of bicycles on a block-by-block basis also impacts the overall demand by establishing the practicality of certain trip patterns. Similarly, the efficiency of bicycle redistribution also affects ridership, as the lack of bicycles at common origin points—or full stations at destinations—greatly helps determine the perceived convenience of the system.

Infrastructure: Also very important is the quality of bicycling infrastructure in the bikeshare deployment area, particularly since such systems represent the introduction of relatively novice riders (and out-of-town visitors) to the surrounding street grid.

In order to approach the "high" projections, Philadelphia would have to "score" exceptionally well with respect to each of these issues, potentially requiring a substantial subsidy, exceptional availability of bicycles, and a very aggressive commitment to bike infrastructure (probably at the expense of traffic capacity) in and around Center City. **In essence, the high projections would mean that Philadelphia would outperform each of the sample cities, and therefore they should not necessarily be interpreted as the "target."** It is more reasonable—given political and financial realities—to view the **low** and **medium** projections as the lower/upper bounds of an appropriate range of potential outcomes.

It is also important to consider that the population of Philadelphia's "expanded" core market area is only about half that of Lyon's service area, also pointing toward the lower projections as an appropriate benchmark.

B. Notes on Pricing

Pricing is a very complex issue: Systems with artificially low user-costs often have to make up the difference with a dedicated public subsidy or funding from a street furniture contract, while those with higher costs tend to attract fewer riders. The optimal supply-demand point depends both on the availability of a wider subsidy in combination with the broader objectives of the system (i.e. traffic mitigation, environmental improvement, etc.). Further complicating this issue is the variety of operation models available; for instance, the value of an exclusive advertising contract for public implements could, in effect, serve as the public "subsidy" to lower the user-cost in privately-operated contracted systems.

As noted above, a further complexity is the treatment of occasional users, including whether to allow a "complimentary" time period before charges are incurred; this represents a critical decision in Philadelphia where numerous tourist attractions are located within short biking distance of one another.

There are several possible means of addressing the issue of pricing as this process moves forward:

Market Study: Some cities have conducted a detailed market study (including surveys and focus groups) to try to pre-determine the optimal pricing scheme as accurately as possible. However, this can be a costly and time-consuming process, potentially delaying implementation of the system and often failing to account for long-term significant changes in consumers' overall approaches to transportation and sustainability.

"Trial-and-Error": This option represents deploying the system at "best-guess" pricing points, based on experiences of other cities and estimations of the optimal target demand profile. This tactic would assume periodic adjustment of fares/pricing schemes to respond to actual demand patterns.

C. Implications for Philadelphia

The following matrix identifies—at a general level—the combinations of factors that could likely steer Philadelphia toward any one of the sets of DVRPC projections.

Figure 3-10: Usage Predictions as a Function of Program Characteristics (Illustrative only)

	Low Projections	**Middle Projections**	**High Projections**
Price	No subsidy No grace period	Modest subsidy Short grace period	Strong subsidy Longer grace period
Availability	Poor redistribution Stations > ½ mi apart	Average redistribution Stations ¼ to ½ mi	Frequent redistribution Stations < ¼ mi apart
Infrastructure	No/Little improvement	Modest improvement (same traffic capacity)	Aggressive treatment (reduce traffic lanes)

As noted above, the high projections should not necessarily be considered the appropriate target; and achievement of the low or medium figures should not be considered unsuccessful.

These issues are discussed in greater detail in **Chapters 4** and **5**. Generally, however, they can be summarized as follows:

Pricing: There are many factors to consider with respect to determining an appropriate pricing structure (and types of passes available), but, in essence, the availability of a subsidy to "jumpstart" the system could lead to higher short-term usage rates than unsubsidized models. Again, this also depends on whether the system is publicly or privately operated.

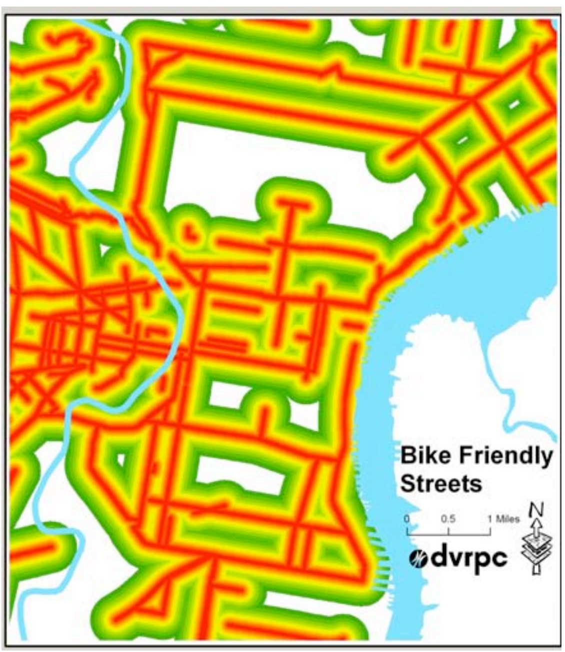
Spacing/Availability of Bicycles: The potential distribution of bicycles throughout the core market area depend on two main factors:

- Capital budget
- Availability of land for stations

Capital budget is largely linked to the pricing issue. The availability of land is based on physical development characteristics as well as land ownership issues.

Infrastructure: Figure 3-11 illustrates that Philadelphia's impressive system of bike lanes in large part does not extend into the constrained streets of the core market area. There have been a number of recent studies exploring means of addressing this issue, which are documented and discussed in **Chapter 4**.

Figure 3-11: Illustration of "Gaps" in Core Area Bicycle Network



Although there is some belief in the local bicycling community (as also suggested by some literature) that a vast increase of bicyclists alone (as potentially represented by bikeshare) would improve bicycle safety in Center City by increasing their visibility and, hence, driver awareness, one of the main questions to be debated is whether such large bicyclist numbers would ever materialize *without* significant improvement in bicycling infrastructure.

This chapter has helped to set an outline for the achievement of optimal bikeshare conditions in Philadelphia. **Chapters 4** and **5** further define these challenges and generate specific recommendations for how best to move forward.

4 – Local Factors and Key Challenges

4.1 Overview

The previous two chapters of this Philadelphia Bikeshare Study have entailed reviewing precedent bikeshare programs as well as projecting an order-of-magnitude of potential usage for Philadelphia. As part of these tasks, a number of issues have been raised that require further deliberation before the program can be considered viable.

In particular, these key issues include:

- **Quality of Infrastructure in the Core Area**, specifically with respect to bike lanes and connecting paths.
- **Potential Interface with Public Transit**, both with respect to interoperability on the same streets (i.e. as buses and bikes are often in conflict) and opportunities for furthering each other's objectives.
- **Size and Scale of a Potential Bikeshare Program**.
- **Funding Method**, in particular, what are the applicability and drawbacks (specific to Philadelphia) of the various public/private operating scenarios?
- **Addressing of Liability Issues**, which is a critical concern given the large differences in healthcare/litigation culture between the United States and many of the sample precedent cities of Europe.

Each of these issues is discussed individually in the following five sections. **Chapter 5** (Recommendations) establishes the preferred means of addressing these and/or a range of acceptable outcomes (i.e. in the event of an open-ended Request for Proposals for provision of the service).

4.2 Infrastructure: Bike Lanes in Core Area

As discussed in **Chapter 3**, one of the significant handicaps of Philadelphia's existing bicycle network is the relative absence of bike lanes in the city core, which has been identified as the most viable focal point of a Philadelphia bikeshare system. This absence of bike lanes is due to two main factors:

- Tightness of the historic street network.
- Heavy vehicular demand on Center City Streets, including traffic, parking, loading, and transit.

However, it is presumed that a good, safe network of bicycle facilities in and around Center City is one of the main prerequisites of successful bikeshare, owing to the following:

Safety: Although an Oregon Department of Transportation study linked an increase in per-rider safety levels with an increase in the overall the number of bicyclists—a benefit stemming from increased visibility, more consistent presence, and "traffic-calming" effect—such an increase in bicyclists also represents a larger total number of potential casualties.

Perceived Safety: As the concept of bikeshare is largely targeted at relatively novice riders who do not generally own their own bicycles—or at least do not regularly use them in the city core—it remains to be seen whether this target market would be comfortable bicycling on Center City's tight, congested streets *without* clear, adequate bike facilities.

System Image: One of the "worst-case scenarios" for a new bikeshare system would be a widely publicized incident/injury related to the bikeshare system in the early phases of its deployment. While such incidents are ultimately inevitable, the act of deploying a bikeshare system without a linked set of improvements to safe bike infrastructure could open up the system to severe criticism in the early going, threatening its ongoing viability.

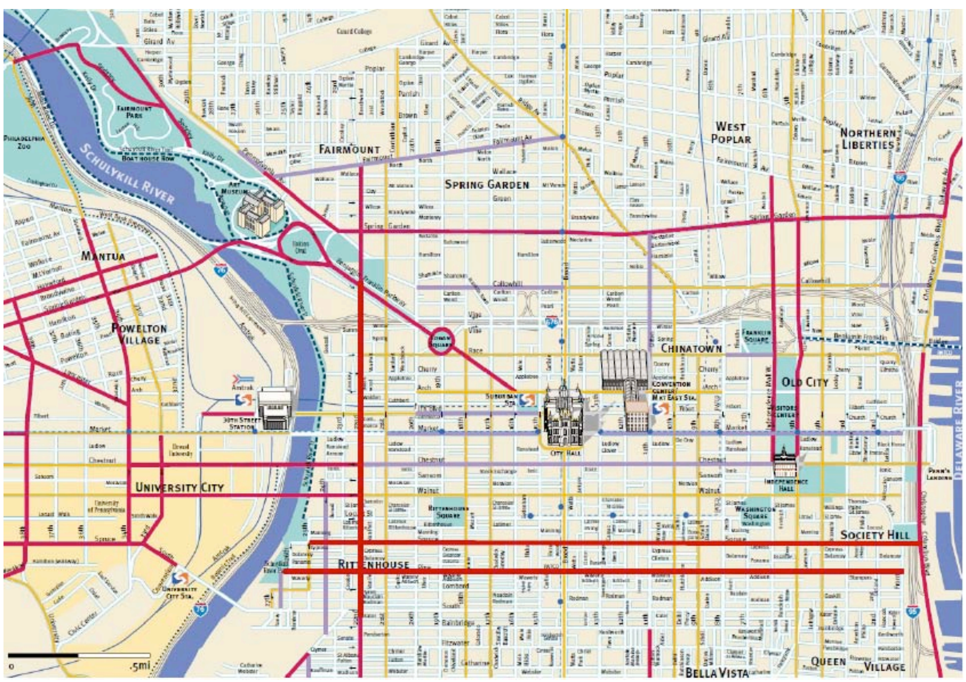
There is also concern that, without upgrades to the designated bicycle system in Center City, the introduction of novice bicycle riders to the downtown area may increase the numbers of bicyclists on the already-stressed sidewalks.

In order to more concretely assess the importance of enhanced infrastructure, the following sub-section compares the present bike lane/path system in Center City with that of the core areas of the six main sample cities previously cited.

A. Comparison of Philadelphia's Bike Network with Peer Cities

Figure 4-1 shows the current distribution of bike lanes in and around Center City. It is evident from this illustration that the core target bikeshare area is also the sub-section of the city most lacking in designated bike facilities.

Figure 4-1: Bike Lanes in Center City Philadelphia (shown in red)



Source: Fairmount Park Commission Website (updated with recent upgrades)

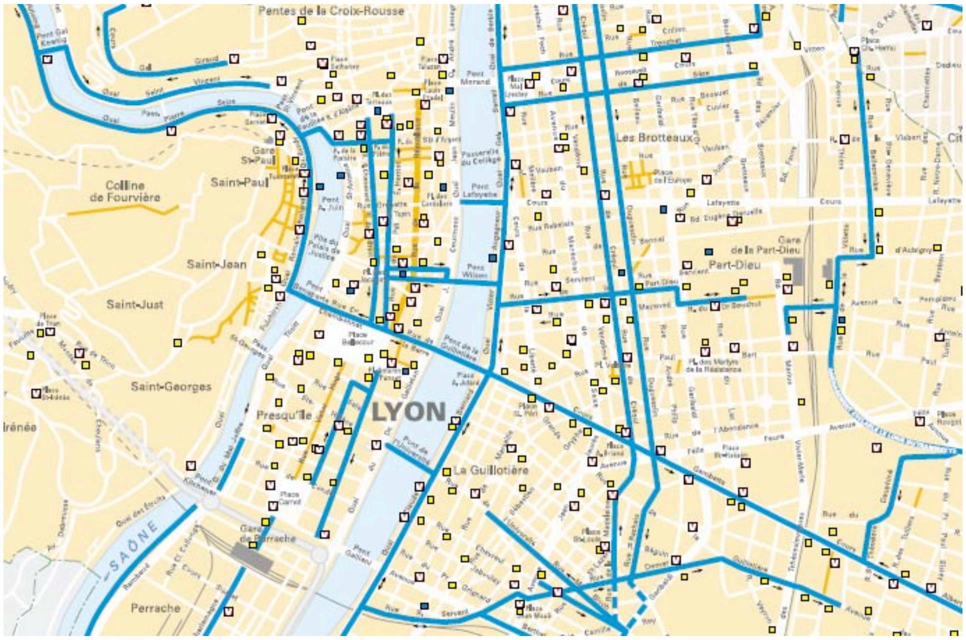
The primary reasons for this "gap" have been noted above (i.e. tight streets; heavy vehicle demand), yet, due precisely to the heavy concentration of traffic and complex vehicle movements, this is also the area of the city where designated facilities for bicyclists would be most useful. As a result, it is speculated that an aggressive effort will be needed to shift the balance of the core street system toward more favorable conditions for bicyclists.

By comparison, the bicycle networks in the core areas of existing bikeshare cities are better developed, as demonstrated in the following illustrations.

The central area of **Lyon**, for example, is very well served by a system of bike lanes, including several long continuous corridors that crisscross the main commercial/tourist districts (see **Figure 4-2**).

Paris, likewise, is also well-served by an extensive, interconnected bicycle network (see **Figure 4-3**). This includes both on-street lanes in conjunction with off-street paths of a more recreational nature.

Figure 4-2: Bike Lanes in Central Lyon (shown in blue)



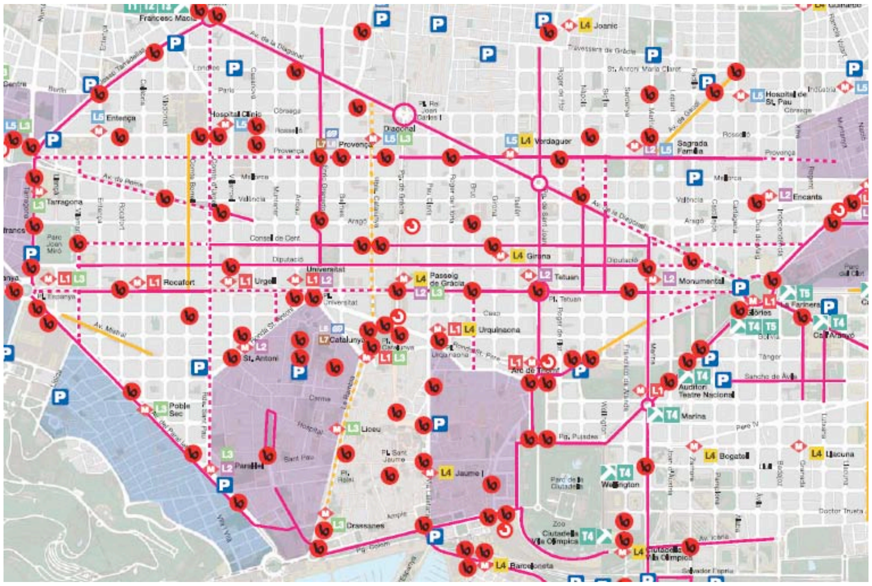
Source: www.en.lyon-france.com

Figure 4-3: Bike Facilities in Central Paris (shown in red

Source: www.paris.fr

Barcelona, too, has an extensive network of bicycle facilities in and around its central core (see **Figure 4-4)**. Of particular note is the strong relationship between Barcelona's bicycle network and its bikeshare stations, most of the latter of which are located directly on, or in very close proximity to, the primary designated bicycle routes.

Figure 4-4: Bike Lanes in Central Barcelona (shown in pink; bikeshare stations are red circles)
Source: www.bcn.cat



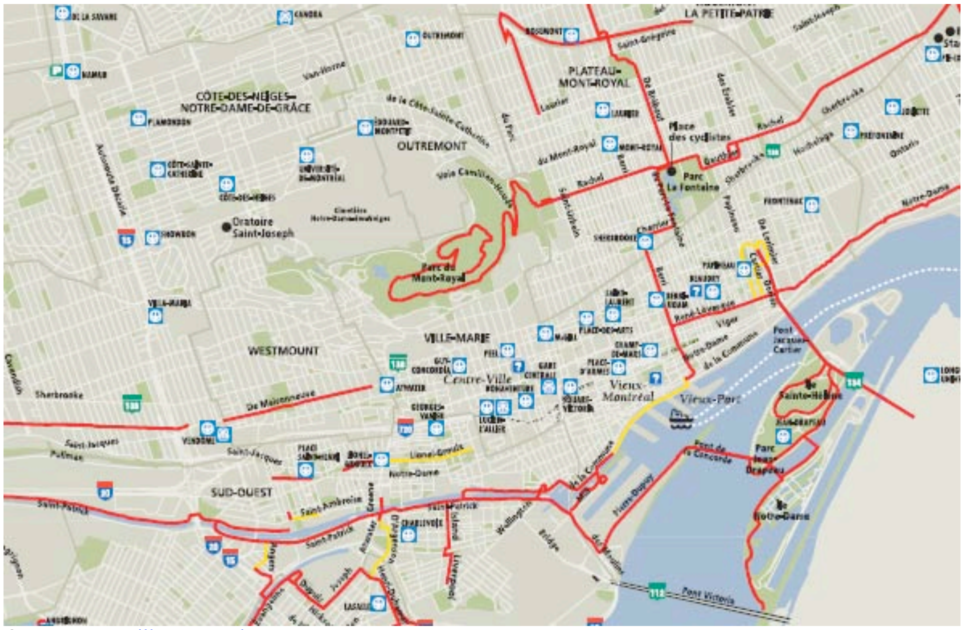
As shown in **Figure 4-5**, **Montreal's** bicycle network likewise includes generally strong coverage in the vicinity of its central core. However—like Philadelphia—the very central-most areas of Montreal's central business district consist of relatively constrained, high-demand streets that are pressed to accommodate a wide variety of transportation modes. As a result, there are relatively few designated facilities within this area.

However, two factors make this somewhat less of an issue in Montreal than it would be in Philadelphia:

- A longer tradition of shared functions (and respect for various users) on constrained downtown streets.
- Differing "peak" seasons for bicycle and motorized-vehicle traffic: While bicycle activity in Montreal peaks during the mild summer months when vehicular traffic is lowest (due to summer vacations, school breaks, etc.), bicycle use is lower during the colder parts of the year when vehicular traffic is at its highest levels.

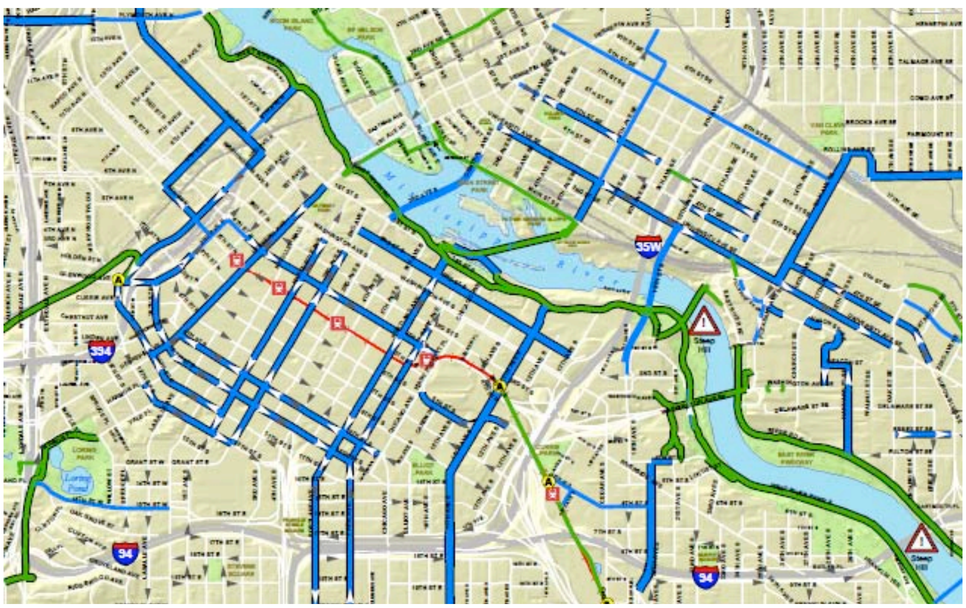
Given Philadelphia's comparatively milder year-round climate, bicycle use remains relatively strong even during the non-summer, high-vehicle-demand months.

Figure 4-5: Bike Lanes in Central Montreal (shown in red)



Source: www.ville.montreal.qc.ca

Figure 4-6: Bike Facilities in Central Minneapolis (lanes in blue; paths in green)

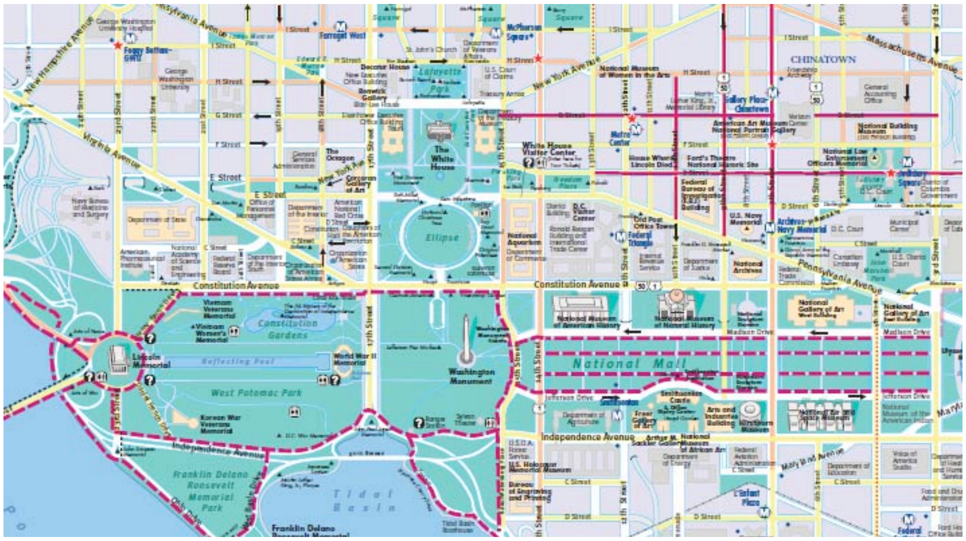


Source: www.ci.minneapolis.mn.us

As shown in **Figure 4-6**, **Minneapolis**—for a city that has a relatively seasonal bicycle volume—has a very strong central-area bike lane network. This includes a combination of on-street bike lanes and riverside/recreational paths.

In **Washington DC**, although the formal network of bike lanes is not as extensive as those of its peers, the most appealing feature of its bicycle network is the emphasis on off-street, two-way paths (see **Figure 4-7**). Such facilities provide patrons of Capital Ride with a comfortable, traffic-separated circulation alternative in the vicinity of the congested National Mall.

Figure 4-7: Bike Facilities in Central Washington DC (lanes in solid pink; paths in dashed pink)



Source: www.ddot.dc.gov

In addition to total mileage of bicycle infrastructure, also significant—as demonstrated in these examples—are the *types* of facilities involved. Most of the North American examples consist of standard on-street bike lanes in combination with recreational-type off-street paths where possible (often alongside rivers and through parkland).

In Europe, by contrast, it is typical for there to be more extensive networks of off-street paths running directly alongside (and at the same elevation as) the sidewalks...While commonplace in Europe, these are generally not accepted practice in the United States (including Philadelphia). While a shift toward such facilities is unlikely in the near term (especially given Philadelphia's already-narrow sidewalks), it further underscores the importance of making any bike lanes as safe, visible, and comfortable as possible.

While it is not possible to conclude that Philadelphia is unsuited to bikeshare due to its lack of core bike lanes, this concern definitely suggests that efforts are needed to expand/improve Center City bike infrastructure if a Philadelphia system is to live up to its full potential.

B. Existing Proposals for Central Philadelphia Bike-Network Expansion

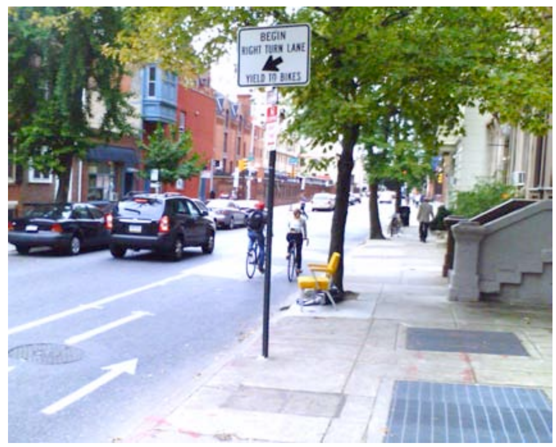
Given the relationship between potential bikeshare success and adequacy of bicycle infrastructure, this sub-section offers a review of known efforts/studies that currently propose enhancements to the bike network in and around Center City.

Spruce and Pine Streets Bike Lanes: Recently implemented in a paint-only "trial" phase, the introduction of a pair of 9-foot-wide bike lanes to Spruce and Pine Streets fills one of the key needs in Center City: continuous east-west access across the core. This project entailed taking the controversial step of converting one existing traffic lane on each street to a bike lane, leaving each with a bike lane, one traffic lane, and a parking/loading lane.

Bike lane “exceptions” exist in the areas adjacent to places of worship for specific times on weekends (i.e. drivers are permitted to use the bike lane for parking); otherwise, the bike lane is intended to be clear of obstruction. However, since the bike lanes are indeed wide enough to accommodate cars, there is speculation that vehicle parking/loading within the bike lane will be a significant issue, especially given the lack of (during this phase) any physically defined separation between the traffic and bike lanes. Another issue is the condition of paving on these streets; some people suspect bicyclists will be deterred due to potholes and pavement cracking/warping.

Nonetheless, **it is the opinion of the consultant team that this project represents a necessary shift in the circulation priorities of Center City**, i.e. away from single-occupant car commuting toward a more diverse set of high-capacity progressive transport options. It is therefore strongly hoped that the City maintains and enhances these corridors as permanent bikeways (which appears to be supported by the current mayor’s administration).

Figure 4-8: Spruce Street (left) and Pine Street (right) with New Bike Lanes



Philadelphia Pedestrian and Bicycle Plan: The Philadelphia City Planning Commission is currently undertaking a comprehensive study of potential bike routes through many key city neighborhoods, including Center City. The recommendations of this process should provide a blueprint for how to vastly improve connections to and through the core of Philadelphia. It is important that the City prioritize the upgrades suggested by this plan in conjunction with the implementation of the bikeshare program.

West Market Street / John F. Kennedy Boulevard Circulation Options Study: Center City District is currently conducting a study—with involvement from both the Mayor's Office of Transportation and the Philadelphia Department of Streets—to re-envision the functionality of both Market Street and JFK Boulevard between 15th and 20th Streets. Although this study represents a broad traffic analysis examining both one-way and two-way circulation alternatives, one of the very probable outcomes (in any scenario) will be the inclusion of designated bike lanes (possibly island-separated) on one or both these key corridors. This would represent a critical piece of east-west circulation through the commercial/office heart of the city.

Figure 4-9: Sample Island-Separated Bike Lane, 9th Avenue New York

Source: Jack Boorse, PB Americas Inc.

Center City Greenway Study: Pennsylvania Environmental Council has conducted an intriguing study examining a number of potential options for connecting together the East Coast Greenway (between the Schuylkill and Delaware Rivers) through Center City. In addition to the Spruce/Pine pair, this study examined East Market Street, Spring Garden Street, Washington Avenue, and the Benjamin Franklin Parkway, many of which warrant further consideration in light of potential rapid expansion of bicycle use in and around the city core.

Benjamin Franklin Parkway Enhancements: The programmed modifications for the Ben Franklin Parkway include significant upgrade to bicycle facilities between 20th Street and Eakins Oval. As part of this vision, bike lanes will be relocated to the outer ("local") traffic sections---which will be downsized to one traffic lane during off-peak periods---and also be widened to six feet. In conjunction with PennDOT's rebuilding of the 20th Street viaduct, the transitions to/through the Logan Circle area will also be enhanced.

South Street Bridge: The rebuilding of the South Street Bridge promises upgraded, more generous bicycle facilities vis-à-vis the former condition. This design will include wide bike lanes with a "double-striped" separation from the traffic lanes, along with better transitions at either end. The visibility of the bike lanes will also be improved through the application of a green-tinted aggregate treatment, creating a sharper delineation between bicycle and motor vehicle spaces.

Logan Square Neighborhood Plan: The 2008 Logan Square Neighborhood Plan proposed several ideas for improving connections between the Ben Franklin Parkway and the core of Center City. These focused mainly on several non-standard concepts for off-street paths at Love Park and the northern apron of City Hall.

North Broad Street: Several alternatives from the City Planning Commission's North Broad Street Transportation and Access Study envisioned bike lanes extending northward from City Hall along Broad Street. These concepts, however, would require the elimination of either the left-turn lane or one of the parking lanes in this area, and therefore were not recommended by the study's authors.

Ideally, the formal bicycle circulation system through Center City would offer safe, delineated bicycle facilities running north-south and east-west at a spacing of at least every few blocks. Although some of the proposals above begin to address the existing deficiencies, the achievement of a denser web of downtown bicycle facilities will require aggressive actions including the potential conversion of traffic and/or parking lanes to bicycle lanes. Optimally, these would follow the same timetable for implementation as the proposed bikeshare system.

4.3 – Transit: Challenges and Opportunities

One of the key assets of central Philadelphia is the breadth of its transit system, both with respect to its key rail "spines" and the density/distribution of its supporting bus services.

The relationship between bicycles and transit is complex. On the one hand, there is strong potential for each to complement the other as alternate sustainable modes, with linked bike-transit trips representing a key potential market for bikeshare. At the same time, there are also key operational conflicts that arise when bicycles and buses utilize the same streets.

This section discusses the general layout of Philadelphia's transit system in the context of a potential bikeshare system. It explores the operational challenges that would need to be addressed as well as the "partnership" opportunities that should be pursued.

A. Challenges: Managing Bus/Bike Conflicts

The main challenge with respect to bus/bike interaction is adequate management of potential conflicts on shared streets, particularly in the constrained central core. This issue could be of particular concern to SEPTA if the bikeshare program succeeds in adding significant numbers of bicyclists to city streets. As a result, it is important to carefully manage the evolution of bus/bike conflicts as the city bicycle infrastructure is developed, through techniques such as those described below.

Buses/Bikes on Different Streets: The ideal means of minimizing the potential growth in bus/bike conflicts would be to—through specific infrastructure upgrades--"assign" buses and bikes to different streets altogether. This was one of the primary reasons why the Spruce/Pine pair was selected as a pilot bicycle corridor, with only one bus route between the two streets.

Buses/Bikes Physically Separated on Same Streets: Since the primary locations of conflict between buses and bikes are the bus stops themselves, it is important to examine methods of arranging bus and bike facilities such that they do not overlap at these critical locations. One possible means of addressing this would be to locate bike lanes, wherever possible, on the **left** rather than right sides of streets (see **Figure 4-10**).

Figure 4-10: Sample Left-Side (and Traffic-Separated) Bike Lane, 9th Avenue New York

Source: Jack Boorse, PB Americas Inc.

"Warnings" on Bus-Stop Approaches: Where bus-stop conflicts cannot be avoided, it is important to clearly denote to novice bicyclists the importance of proceeding very carefully through all bus-stop zones, i.e. to make them aware that bus passengers may suddenly debark from the back/front doors of a stopped bus directly into their path. The addition of clear markings—potentially color-coded—could serve as a constant reminder to novice bicyclists to take extreme caution through the bus stop zone.

While some cities have attempted to separate the bike lanes from bus boarding/discharge areas by introducing a "boarding island" between the traffic lanes and the bike lane, the tight dimensions of most Center City streets largely precludes this approach in Philadelphia's core area.

Management of Turn Conflicts: Center City consists of a number of complex intersections where conflicts between cars/buses, bicyclists, and pedestrians are very significant. As such, it is worthwhile to examine opportunities for managing these movements through the use of **mode-specific traffic signals**. In particular, there are some opportunities within Center City to provide buses with their own "jump" signal to give them priority over other traffic, and to allow them to make oft-complex maneuvers during a short bus-only green phase completely separated from those for cars, pedestrians, and bicycles. This concept is being explored at 15th/Market and could potentially be applicable to other locations where bus/bike safety concerns are high.

Given the potential influx of new bicyclists on Center City streets concomitant with introduction of bikeshare, the careful management of bus/bike conflicts through the above types of measures will be of increased importance. Furthermore, the expansion of the formalized Center City bike infrastructure network could be aimed to encourage bicyclists onto the safest routes, i.e. those with no buses and/or with well-managed conflict points.

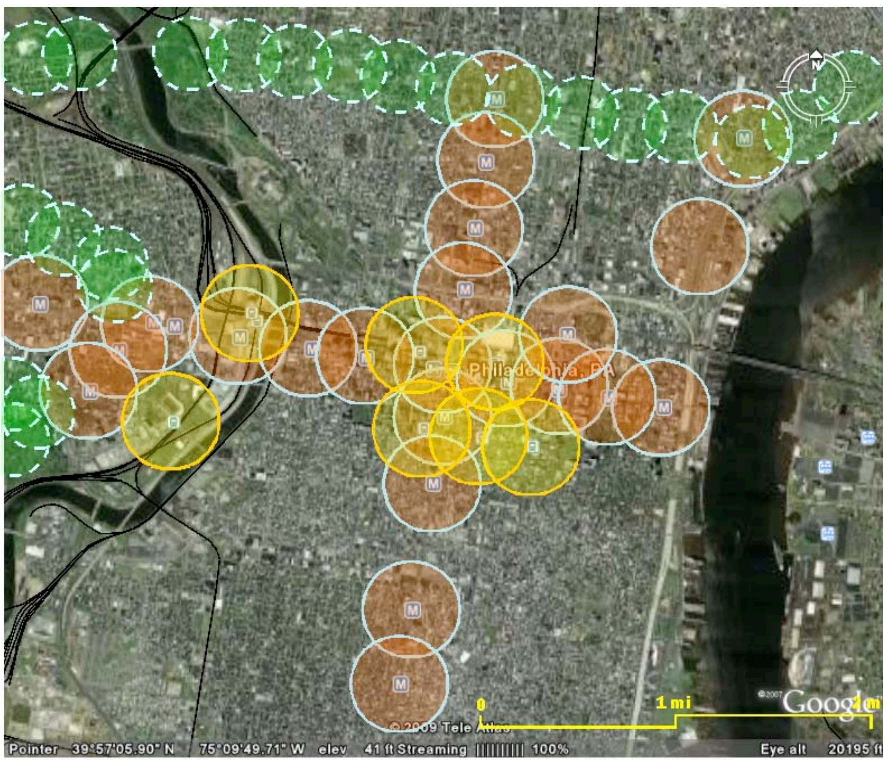
DVRPC’s recent report entitled *Bicycle-Bus Conflict Area Study* has examined many of these specific issues in considerable detail. This report should be used as a reference when defining the specific physical qualities of the emerging bicycle network.

B. Opportunities: Bikeshare as Rail “Feeder”

Philadelphia's most useful transit corridors are the two main rapid-transit spines that crisscross the city: the Market-Frankford El and the Broad Street Subway. Many neighborhood bus routes are oriented to “feed” into these corridors to facilitate complex trip patterns in an efficient manner.

While many of these “feeder” bus routes are packed to capacity during peak periods, it is rare that the two main rail spines themselves are filled to crush-load capacity. Therefore, it is logical to expect that bikeshare could help to reduce some of the peak pressure on feeder bus routes by replacing some degree of the cross-town trips that connect to the two main rail corridors.

Figure 4-11: Philadelphia Rail Transit Stations with Standard Walk Buffers



base image: Google Earth

While the potential trip patterns set up well for this type of synergy between buses and bikes, several basic infrastructure issues would need to be addressed in order to maximize the value of this interaction:

Bikeshare Stations at Subway/El Stops: Implicit to this type of transfer operation would be the incorporation of large bike stations at the subway and el stops.

While most **Broad Street Subway** stops consist of enough *underground* concourse space to potentially accommodate sizable bike stations, the inconveniences and potential liabilities of navigating stairs or elevators with the bicycles likely preclude this as a viable option. Instead, it is likely that space for bike stations would have to be found at surface level, potentially by using portions of the sidewalk and/or parking lanes, or vacant lots and adjacent park/plaza areas.

The core underground stations of the **Market-Frankford Line** along Market Street consist of very little available space at *either* the surface or underground levels. As a result, similar re-use of parking lanes or plaza spaces would likely be the best option for bike-station location. The aboveground stations of the El outside Center City generally have generous spaces beneath the stations or within their enclosed foyers for potential accommodation of bikeshare.

Neighborhood Bikeshare Stations: The second key element of this relationship would be the strategic placement of bikeshare stations within neighborhoods that are within reasonable biking distance of the subway/el, to reach the largest potential market of bike-transit commuters. These would likely be relatively small stations (in comparison with those at the subway/el stops) widely distributed throughout the designated target areas.

In addition to these facilities, there are several programmatic elements that could further help optimize this relationship:

Joint Marketing: It will be important to actively promote the bikeshare-transit travel option, through marketing elements such as visual advertising within trains and subway/el stops and also at bus shelters nearest the neighborhood bike stations.

Integrated Fares/Discounts: Several of the peer systems have integrated their bikeshare payment apparatus with that of public transit. It would be similarly worthwhile to include bikeshare as a component of SEPTA's proposed Smartcard program. Other fare advantages could include bikeshare discounts for SEPTA pass holders, or free/discounted transfers to SEPTA with proof (printed or electronic) of bikeshare usage.

While this study recommends a basic approach toward facilitating the mutual benefits of transit and bikes, it will be important as this process moves forward to continually engage SEPTA as a key partner. This is particularly relevant in two respects: the potential incorporation of bikeshare stations at SEPTA-owned property; and SEPTA's capacity for helping to encourage combined bike/transit trips through fare incentives and advertising.

4.4 Bikeshare: Target Scale and Phasing

There are five demonstrated ways to determine the potential scale of program, derived from best practices throughout the industry. The methods provide ranges for the amount of bicycles and stations that should be provided for a reasonable level of service or a “feasible” bikeshare system. These methods are strictly for the sizing of the system and do not take into account pricing, infrastructure, redistribution, maintenance, marketing, or public subsidy applied to the program. The methods are as follows:

- Residents per Bike
- Stations per Square Mile
- Station Spacing in Meters
- Equation from JCDecaux
- Expected Daily Trips

These methods have been applied to the “core” and “expanded” service areas as defined by DVRPC in **Chapter 3**. The following data has been used in the application of these methods:

Figure 4-12: Service Area Statistics for Philadelphia

	Area	Population (Census 2000)
Core Service Area	5.29 square miles	98,415
Expanded Service Area	14.5 square miles	317,710
City of Philadelphia	135 square miles	1.5 million

Source: DVRPC

All the following calculations are rounded to the nearest tens. Also, it is assumed that stations consist of an average of fifteen bicycles per station, which is the general average observed across the peer systems.

1. Residents per Bike

This standard assumes the ratio of 150 residents per bicycle provides an adequate level of service. This standard can be applied two ways: using the population for the specific service area or the population for the full city. The best practices in other cities recommend that the total city population should be used as the system to accessible to all and these citizens can act as a proxy for the out-of-city commuters and tourists who may use the system.

Source: Stationnement de Montréal

- *Core Market Area*: 40 stations, 660 bicycles
- *Expanded Market Area*: 140 stations, 2,120 bicycles
- *City of Philadelphia*: 670 stations, 10,000 bicycles

2. Stations per Square Mile

This standard assumes twenty to forty stations per square mile are needed in order to provide a reasonable level of service.

Source: JCDecaux and Cemusa

- *Core Market Area:* 110 to 210 stations, 1,650 to 3,150 bicycles
- *Expanded Market Area:* 290 to 580 stations, 4,350 to 8,700 bicycles

3. Station Spacing in Meters

This standard assumes there should be a density of one station every 300 meters within the service area in order to provide adequate service.

Source: APUR Study Paris

- *Core Market Area:* 150 stations, 2,250 bicycles
- *Expanded Market Area:* 410 stations, 6,150 bicycles

4. Equation from JCDecaux

This equation is used by JCDecaux to determine the number of stations needed in a given service area. The equation is as follows:

$$\text{\# of stations} = \left(\frac{5300\sqrt{\text{market area in sq mi}}}{\text{1000 feet}} + 1 \right)^2$$

Source: JCDecaux

- *Core Market Area:* 170 stations, 2,550 bicycles
- *Expanded Market Area:* 450 stations, 6,750 bicycles

5. Expected Daily Trips

In **Chapter 3**, DVRPC defined core and expanded market areas for Philadelphia's bikeshare system. Using general travel demand and expected diversion rates, DVRPC was able to predict potential daily use for a bikeshare program in each of these market areas. Below is the chart defining these estimates in accordance with low, middle, and high scenarios.

Figure 4-13: Demand Scenarios for Core and Expanded Market Areas

Market Area	Demand Scenario	Estimated Daily Bikeshare Trips
Core	Low	5,876
	Middle	14,186
	High	18,174
Expanded	Low	7,542
	Middle	18,198
	High	23,239

Source: DVRPC

However, it is important to note from **Chapter 3** that "these demand estimates assume the provision of a Philadelphia bikeshare system comparable in scale and scope to those of the peer European cities from which diversion rates were derived." Therefore, daily usage per bike of the peer European bikeshare systems can be used as a proxy to determine the size of the system necessary to achieve these levels of estimated daily bikeshare trips.

Figure 4-14: Average Daily Uses per Bicycle in Select Cities

System	Average Daily Uses/Bicycle
Vélo'v- Lyon	4
Vélib'- Paris	8
Bicing- Barcelona	11
Average	7.67

Source: Stationnement de Montréal

Using these average daily uses per bicycle and the estimated daily trips, assumptions can be drawn regarding the amount of bicycles necessary to provide a reliable level of service for the bikeshare system in Philadelphia. The average of the three (Lyon, Paris, and Barcelona) system's daily uses per bicycle can be used to calculate the scale of Philadelphia's bikeshare system, as follows:

1. *Core Market Area:*
   - Low: 50 stations, 770 bicycles
   - Middle: 120 stations, 1,830 bicycles
   - High: 160 stations, 2,370 bicycles
2. *Expanded Market Area:*
   - Low: 70 stations, 980 bicycles
   - Middle: 160 stations, 2,370 bicycles
   - High: 200 stations, 3,030 bicycles

These five methodologies described above provide a diverse range of estimates to consider, as follows:

Figure 4-15: Order-of-Magnitude Bicycle and Station Estimate for Philadelphia

	Stations	Bicycles
Core Market Area	50 to 160	770 to 2,370
Expanded Market Area	130 to 580	1,890 to 8,700
City of Philadelphia	670	10,000

These order-of-magnitude estimates are further discussed and refined in **Chapter 5**.

The needed capital costs for these systems have been estimated at $1,000 to $3,000 per bicycle. Therefore, the potential cost ranges for these estimates are as follows:

- *Core Market Area:* approximately $1.5 million to $7.1 million
- *Expanded Market Area:* approximately $1.9 million to $26.1 million

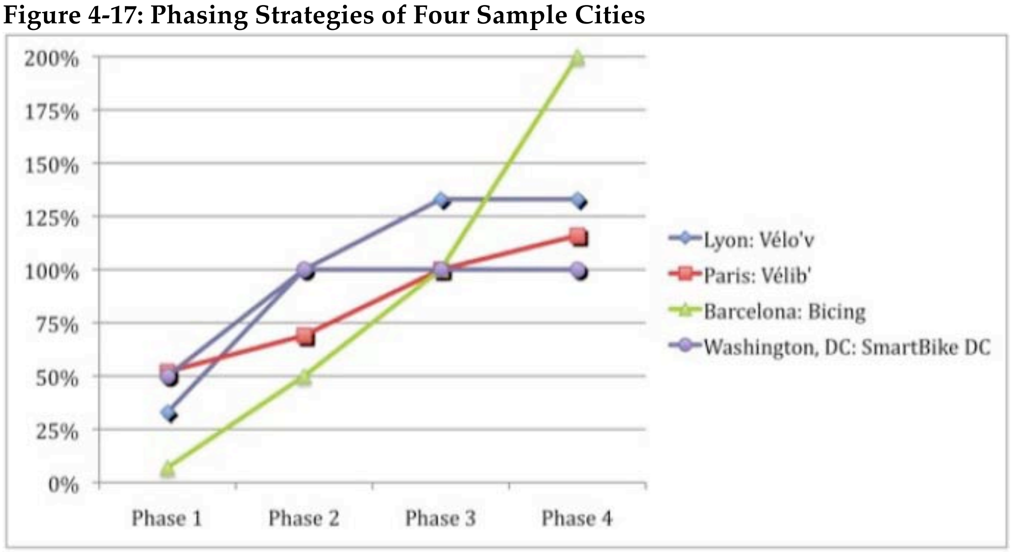
Paired with the DVRPC demand estimates, the cost estimates yield:

Figure 4-16: Cost Ranges for Order-of Magnitude Estimates

Market Area	Demand Scenario	Estimated Daily Bikeshare Trips	Number of Bicycles	Cost Estimate (~$ in millions)
Core	Low	5,876	770	0.77 to 2.3
	Middle	14,186	1,830	1.8 to 5.5
	High	18,174	2,370	2.4 to 7.1
Expanded	Low	7,542	980	0.98 to 2.9
	Middle	18,198	2,370	2.4 to 7.1
	High	23,239	3,030	3.0 to 9.1

With respect to phasing, the most successful programs such as in Lyon, Paris, and Barcelona launched their systems with approximately 50 percent of their proposed bicycle fleet (see **Chapter 2**).

Figure 4-17: Phasing Strategies of Four Sample Cities



Source: Provider websites

As illustrated in **Figure 4-17**, all the evaluated systems, with the exception of Washington DC, implemented their fleets in three or more phases. In all these cases, the latter phases represented a jump beyond the initial projected fleet size (i.e. the 100% level) based on strong demonstrated user demand.

The lessons for Philadelphia include:

- Introduction of bikeshare through at least two or three phases has been the standard; none of the large peer examples attempted to deploy the entire fleet in a single stage.
- The first phase needs to represent a viable "minimum" number and distribution of bicycles, based largely on local projected usage patterns.

Chapter 5 outlines—at least within general guidelines—an appropriate phasing strategy for Philadelphia, linked to both the priority/high-probability usage patterns as well as the supporting infrastructure.

4.5 Funding: Operating Models and Their Applicability

Bikeshare programs are diverse in their size, location, and implementation. To this point, the most successful and popular bikeshare programs have been predominately operated by private vendors through advertising/street furniture contracts. Only within the past two years have new methods of funding/operating been applied to large-scale programs. The following discussion describes the six primary methods of funding/operating that have been demonstrated in large-scale applications. For more information regarding the specific vendors and operators, please see **Chapter 2**.

Figure 4-18: Vendor, Operator, and Funding Opportunities

Reference Below	Vendor	Operator	Funding	Example
1	Private	Private	Advertising	Lyon/Paris
2		Private	Private	Chicago- St. Xavier Uni.
3		Private	Public	Barcelona
4	Public	Public	Public	Montréal
5		Public	Private	Boston
6		Non-Profit	Public/ Private	Minneapolis

<u>A. Private Vendors and Operators:</u>

Until 2008, private contractors, such as JCDecaux and Clear Channel, dominated the bikeshare market with the majority of bikeshare programs implemented and operated by private contractors. The following are three methods of implementation based on three varying structures of "vendor-operator-funding."

1. *Private Vendor- Private Operator- Advertising Funding:* The most well-known structure for implementing bikeshare programs, this method can be found in Lyon, Paris, and Washington, DC, to name a few. This method is typically tied to a street furniture contract. The city receives a bikeshare program while providing the vendor with specific marketing rights, ranging from a specified number of billboards to full advertising rights. The private vendor and operator (typically the same entity) will provide the upfront capital and operating costs for the bikeshare program as well as the infrastructure and operating structure. Characteristically, the contract involves revenue sharing between the city and the operator. It is imperative to ensure that both parties have their interests adequately represented as some private organizations are not mobility-based organizations, and do not necessarily have goals aligned with the benefits of bikeshare.

Advantages:

- o A proven method that can draw upon experienced vendors/operators
- o No upfront capital investment needed from city

Disadvantages:

- o Limited options if dissatisfied with service
- o Loss of advertising revenue
- o Operator not mobility-driven
- o No requirement for data-sharing between operator and city

Remedies:

- o Incentives for operator to provide good service (revenue sharing)
- o Ensure contract includes well-defined terms (size and service of system, options for expressing dissatisfaction, data-sharing, etc.)

2. *Private Vendor- Private Operator- Private Funding:* Funding a program with private money while using a private vendor/operator enables flexibility with planning/implementing the program and helps align the operator's goals with those of the funding provider. This is the method used in Chicago to implement the "Green Bike Program" on the St. Xavier University campus with Veloway, a subsidiary of Veolia Transportation. This system, however, is quite small; the costs for implementing a large system in this manner would be very high vis-à-vis other methods.

Advantages:

- o A proven approach that could draw upon experienced vendors/operators
- o High degree of control over implementation

Disadvantages:

- o Limited options if dissatisfied with service
- o Upfront capital investment costs could be high

Remedies:

- o Incentives for operator to provide good service (revenue sharing)
- o Ensure contract includes well-defined terms (size and service of system, options for expressing dissatisfaction, data-sharing, etc.)
- o Draw from diverse funding sources

3. *Private Vendor- Private Operator- Public Funding:* Implementing a program with a private vendor/operator using public financing requires significant upfront investment, yet enables the city and vendor to have a close operating relationship. One additional positive of this structure is that the city can hold onto the valuable resource of advertising. This method was implemented in Barcelona for the Bicing program: The city of Barcelona funds the bikeshare system (installed and operated by Clear Channel) through revenues generated from parking fees, a specific city tax, and their standard street furniture contract.

Advantages:

- o A proven method that can draw upon experienced vendors/operators
- o Direct control over funding, implementation, and service
- o Retain street furniture contract as a general revenue-generator

Disadvantages:

- o Limited options if dissatisfied with service
- o Upfront capital investment costs could be high

Remedies:

- o Ensure contract includes well-defined terms (size and service of system, options for expressing dissatisfaction, data-sharing, etc.)
- o Draw from diverse funding sources

B. Public Vendors and Operators

Public vendors and operators have just recently entered into the bikeshare market and now provide cities with additional implementation options. Public entities (compared with private, profit-driven companies) are typically more interested in implementing a program for the overall benefits of bikeshare. Public entities can constitute anything from actual city governments to quasi-public agencies (such as a parking authority or transit operator) or even a dedicated non-profit organization.

1. *Public Vendor- Public Operator- Public Funding:* This structure provides the city with absolute control over the program size, operation, and benefits; however, the city would also be responsible for all the costs incurred in the implementation and operation of the program. In Montréal, the parking authority (Stationnement de Montréal) and the city government have together funded, designed, installed, and initiated operation on the first large-scale bikeshare program in North America.

   Advantages:
   - o Operator devoted to cause: mobility
   - o Direct control over funding, implementation, and service
   - o Access to federal funding and public financing (public bonds, etc.)

   Disadvantages:
   - o Limited experience with operations
   - o Upfront capital investment costs could be high
   - o Unknown/highly variable operational costs

   Remedies:
   - o Conduct market study to estimate costs and revenues, to the degree possible
   - o Employ a public vendor with demonstrated experience to actually operate the system

2. *Public Vendor- Public Operator- Private Funding:* Some cities have started requiring vendors/operators to obtain private financing for their bikeshare programs. In Boston, for example, the 2009 Request for Proposals states that preference would go to any operator that "provides a turnkey system which serves a sizable region within the Greater Boston Metropolitan area at no cost to the municipalities, institutions, or private landowners involved." As a result of this criteria, it was Public Bike Systems, the bikeshare organization of Stationnement de Montréal, which was awarded the Boston contract.

   Advantages:
   - o Operator devoted to cause: mobility
   - o No burden to determine funding opportunities
   - o Direct control over implementation and service

   Disadvantages:
   - o Limited experienced public vendors/operators from which to choose
   - o Limited methods to fund programs

   Remedies:
   - o Conduct market study to estimate the costs and revenues (to gauge the potential applicability of this approach)
   - o Choose vendor with experience

3. *Public Vendor- Non-Profit Operator- Public/Private Funding:* Combining many different options for operations and funding, the combination of a public vendor, a non-profit operator, and a variety of funding sources could provide the greatest overall flexibility for initiating a sustainable program committed to the ultimate benefits of bikeshare. In Minneapolis, this type of flexible structure is being employed to meet the targeted 2010 launch date of a thousand-bike program. In terms of funding, for instance, Minneapolis is using public funding through the "Bike/Walk Twin Cities Federal Demonstration Project" plus a contribution from the Mayor's budget, in addition to funding from private institutions such as local universities. This varied financing will be used to purchase a system from Public Bike Systems of Montréal that will ultimately be operated by a non-profit organization associated with the City of Lakes Nordic Ski Foundation.

   Advantages:
   - Operator devoted to cause: mobility
   - Draws from a variety of local funding sources including private institutions and attractions that are fully incorporated into the citywide system
   - Access to federal funding

   Disadvantages:
   - Limited experienced public/non-profit vendors/operators from which to select
   - Requires the creation or engagement of a non-profit institution to implement
   - Upfront capital investment costs could be high
   - Unknown/highly variable operational costs

   Remedies:
   - Conduct market study to estimate costs and revenues, to the degree possible
   - Choose vendor with experience
   - Continue to develop stakeholder involvement to support ongoing funding and expansion

With the number of potential operating models available, the City at some point will have to determine which method best fits the current political climate of Philadelphia, and/or issue a non-binding Request for Proposals to better gauge the interest of potential providers. As there are inherent difficulties and advantages to each model, it may be advisable to retain all available options until the full cost/implementation details can be better approximated, through further research that could include a detailed market study/survey, the RFP process itself, and/or further investigation into challenging areas such as insurance/liability (as discussed in the next section).

4.6 Liability: Potential Solutions

Liability is an important issue for any North American bikeshare program. As previously demonstrated in **Chapter 2**, there are no directly applicable best practices for liability coverage as the established large-scale programs are currently limited to areas with non-analogous insurance culture (i.e. typically nationalized coverage). It is therefore important to look at the variety of potential carriers of liability coverage in the United States.

Figure 4-19: Liability Alternatives

Method	Opportunity	+ and -	Precedent
City Insurance Policy	City incorporate bikeshare coverage into general City policy	+) Ensure full coverage -) Expose City to significant risk	None
Transit Operator	SEPTA/PATCO, etc. incorporate coverage into current policy	+) Experienced at liability coverage -) Cost	Vancouver has recommended this method.
Non-Profit Organization	Existing institution (carsharing) or new entity	+) Separate from City -) Cost and management	Minneapolis
Vendor or Operator	Vendor required to provide coverage	+) Cost covered by Operator -) City could still be held liable	Boston's RFP specified this method.

As this is a critical issue that extends beyond the expertise of this project team, it is strongly recommended that a lawyer or insurance provider be consulted to determine the precise details of potential liability issues.

As a generalized introduction, however, there are a variety of methods/arrangements that the City of Philadelphia could potentially draw upon to enable sufficient coverage of liability issues, as described below.

1. *City Insurance Policy*: The City could potentially incorporate the bikeshare system's liability coverage into its current general insurance policy. The advantage of this approach is that it would ensure full coverage; the downside is that it could potentially expose the City to significant risk and high ultimate costs. This method has never been used before for a large-scale bikeshare program.

2. *Transit Operator*: It is possible that the bikeshare program could work in close coordination with a local transit provider (i.e. SEPTA and/or PATCO) and incorporate the liability/insurance coverage into their already existing plans. This approach has been recommended for Vancouver's future bikeshare system, based on its synergy with the city's transit network as well as the transit operator's existing experience in providing insurance coverage for customers.

3. *Non-Profit Organization:* A non-profit organization, such as a carshare operator, could also potentially handle the liability and insurance coverage for a related bikeshare program. As an alternative transportation provider, all carshare operators have had to work with insurance agencies to determine new methods of coverage for their users. With this experience, a carshare operator may be in the position to fully integrate carshare and bikeshare liability coverage.

Another non-profit option would be to create/engage a bikeshare-focused advocacy group to assume the costs and administration of user insurance coverage and general liability. This method is being applied in Minneapolis, where a new local non-profit organization is being created in order to provide insurance for the bikeshare system (as well as to operate it).

4. *Vendor or Operator:* If a private (or even public) operator is selected to implement Philadelphia's bikeshare program, the City could potentially require the vendor itself to incorporate its own private insurance coverage. However, in certain circumstances, the City, as the ultimate overseer of the program, could potentially still be held liable in the event of an accident on city streets. Private vendors in Europe and Canada have not been asked to provide such insurance coverage; therefore, this would be an uncharted step that may hinder some operators from entering the Philadelphia market.
5. *User's Responsibility:* As evidenced in Washington DC, it is possible to require the bikeshare user to provide insurance coverage as indicated in a waiver signed by users. While this is one potential insurance method that is currently in use in North America, the City could still be held liable in various situations.

With few analogous best practices from which to learn, it is difficult at this point to recommend a specific strategy for Philadelphia with respect to insurance and liability coverage.

As mentioned above, however, it is very strongly recommended that the City engage an attorney or insurance specialist to examine this subject very closely **prior to initiating a Request for Proposals**, in order to fully and accurately assess the complete range of coverage options as well as the potential damages and costs associated with each.

5 – Recommendations

5.1 Overview

As demonstrated thus far, the context of central Philadelphia is very supportive of the bikeshare concept, in terms of its potential to generate both everyday users and less-frequent visitors. However, the success of the program will be dependent upon a number of key factors:

- Funding: Public and/or private.
- Infrastructure: Upgrade of bike-lane system in Center City and University City, as well as other key areas.
- Marketing and User/Safety Education

The purpose of this study has been to assess the potential viability of bikeshare in Philadelphia. On the whole, the conclusion has been relatively positive given that central Philadelphia contains:

- The population and employment densities needed to support a bikeshare program.
- The public sector and institutional-sector enthusiasm needed to initiate such a program.

However, there are a few key elements still in need of substantial, nearer-term enhancement in order to enable the program to live up to its full potential in a positive light:

- **Safety**: This is by far the most critical aspect of enabling a successful, well-regarded bikeshare program in Philadelphia. Failure to address key safety issues—such as development of safe bicycle-specific infrastructure and expansion of bicyclist/driver education programs—could result in initial skepticism about the applicability of the concept, and/or denouncing of the program as a public liability.
- **Marketing of Benefits:** As motorists and bicyclists are often in conflict, it is important to educate the wider public of the potential role of bikeshare in the context of overall congestion mitigation, social equity, and air-quality benefits, in order to prevent the program from being viewed as a "niche" amenity for bicyclists only. This will require justification of any ongoing public resources that are devoted to the project (depending on operating model).

Pending adequate attention to these issues, it is very reasonable to expect positive results and reactions in Philadelphia.

This chapter describes the preferred features of a Philadelphia bikeshare program as determined—to the degree possible—through this study/stakeholder-involvement process as well as the accompanying analyses. It is important to note that these are general target guidelines only, as the specifics should be developed through a Request for Proposals (RFP) process or further detailed study, as described in this report.

This chapter also identifies key supporting actions—specifically with respect to infrastructure and marketing—that should accompany further advancement toward bikeshare implementation.

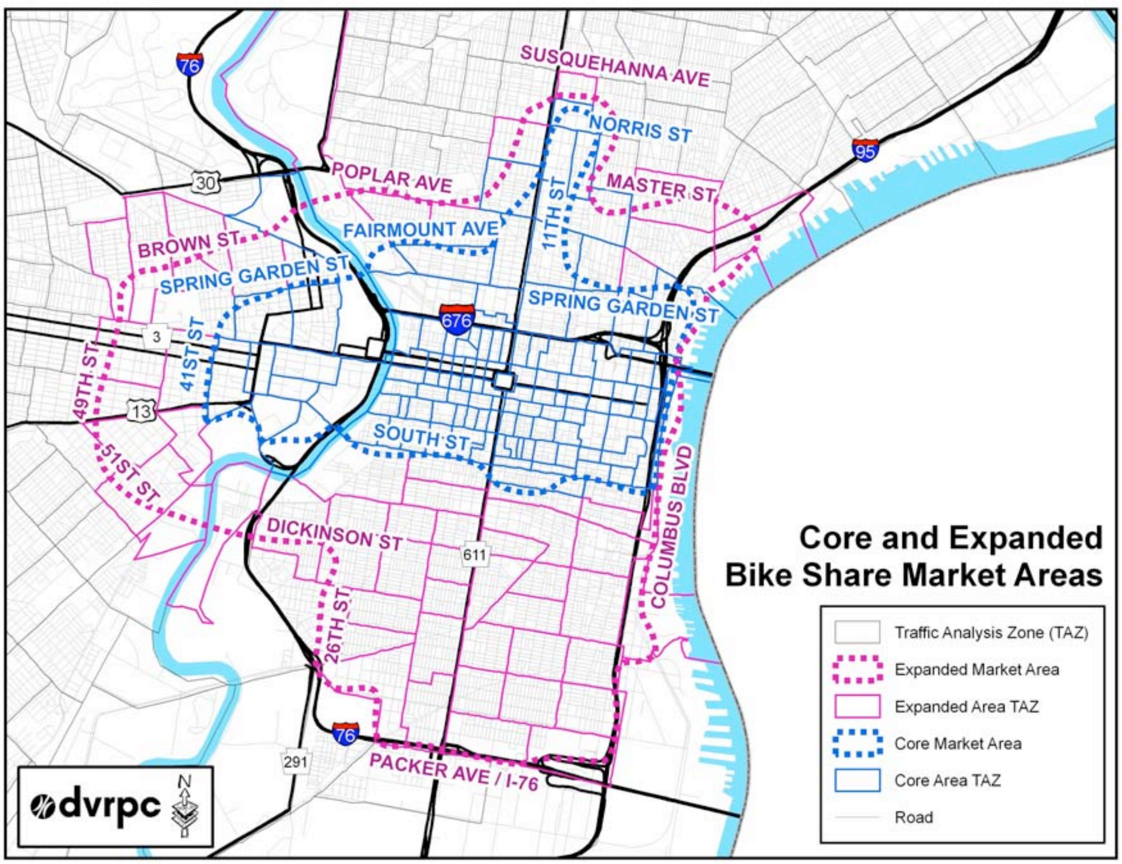
5.2 Programmatic Recommendations

Based on the analyses detailed earlier in this report, the following discussion articulates a target size and phasing for a bikeshare program appropriate to the Philadelphia market. Note that these are general targets to be backed up by individual assessments of potential vendors/operators. However, they serve as useful guidelines to illustrate the potential scope of the project and its probable costs.

A. Core and Expanded Service Areas

Based on the DVRPC demand analysis presented in **Chapter 3**, the proposed general target "core" and "expanded" bikeshare areas are illustrated in **Figure 5-1**. Note that these are not intended to serve as inalterable rigid borders; the specific edges of various phases will be dependent on a variety of physical and political factors as the system is deployed.

Figure 5-1: Proposed Core and Expanded Bikeshare Areas



The core market area covers most of Center City plus the general expanse of the University of Pennsylvania and Drexel University in University City, as well as a further extension up the Broad Street corridor to Temple University. It is within these areas—according to the demand analysis—that the highest concentrations of potential bikeshare users are located.

The expanded market area encompasses the dense residential neighborhoods contiguous to the core, including most of South Philadelphia, University City, Fairmount, and Northern Liberties. Like the core, these neighborhoods also demonstrate the potential for significant bikeshare use, though not necessarily with the same diversity of trip patterns (and, consequently, trips per day) as the primary core.

These two distinct areas lend themselves to two separate phasing strategies owing to the predicted amount/type of bikeshare usage, as discussed in the following sub-section. An additional "third" extended market area (not shown) would assume further expansion along key corridors (primarily transit lines) and into neighborhoods contiguous with the secondary service area.

B. Program Scale and Phasing

Because the core area represents the highest potential level of bikeshare use—due to its concentration of activity and its variety of potential trip patterns—**Phase 1** would entail deploying bikeshare throughout the central core based on proven "viability" standards.

As noted in **Chapter 3**, there have been a variety of methods previously cited for calculating the appropriate "adequate" level of bikeshare deployment in various peer cities. However, when comparing the results of these standard "supply-side" equations (i.e. as formulated by the vendors and peer cities) with those of the DVRPC "demand-side" model, the best match is obtained when the widely-accepted "stations per square-mile" criterion is applied, as follows:

Demand: DVRPC "middle" projection for the core = 1,830 bikes

Supply: 20 stations per square mile * 5.29 square miles * 15 bikes/station = approx. 1600 bikes

This relative consistency suggests that a general target of approximately **1,750 bikes** in the core area would be appropriate, in terms of both the projected usage and the distribution of infrastructure. It is important to note that the DVRPC projections in large part depend on an accepted minimal level of widespread deployment (i.e. 20 stations per square mile) in order to be fully realized, as distribution at lower intensities has generally proven inadequate to support fully optimized bikeshare operation in key "destination" areas.

The second phase—pending success of the first—would be to extend the bikeshare imprint into the "expanded" market area denoted in **Figure 5-1**. As this area basically comprises residential "origin" neighborhoods, it is recommended that the bikes be strategically distributed according to a general accessibility-based standard, specifically that all residents should be within a 10-minute walk (around 1250 feet) of a bikeshare station. Based on this, the following calculation helps estimate the number of bikes needed for **Phase 2**:

A. The circular area representing a 10-minute walk to any bike station encompasses approximately 0.18 square miles, suggesting a minimum distribution of 6 stations per square mile.

B. 6 stations per square mile * 9.2 square miles * 15 bikes/station = approx. 750 bikes

This would represent a "soft" introduction to bikeshare in the expanded, mostly-residential market area. It is important to note that it would not be expected that the **Phase 2** bike stations would achieve the same degree of daily use as those in **Phase 1**, since the more limited mix of land uses in these areas would suggest a more predictable set of trip patterns, in large part commuting to/from work, school, and/or transit facilities. To some degree bike stations could be more densely distributed in mixed-use neighborhood centers.

However, given continued redevelopment of the **Phase 2** neighborhoods to include a variety of commercial and entertainment uses to supplement the residential base—in addition to the firm establishment of bikeshare—it is very possible that the trip patterns in these areas will eventually diversify to the extent they may warrant a bike-station density potentially equal to that of the initial core. This possible outcome has been denoted as **Phase 3**, although by this point any decisions on expansion/intensification will have to take into account the trip/usage patterns observed in **Phases 1** and **2**, which may suggest greater benefit from extending the program into additional neighborhoods.

Finally, a potential **Phase 4** would entail strategic expansion along key transit corridors and into further adjoining neighborhoods, as well as any opportunistic prospects for expansion into areas with private financial backing and/or the support of key significant stakeholders.

Figure 5-2: Proposed Preliminary Phasing of Philadelphia Bikeshare System

	Description	Bicycles Required	Cost ($) of Bikes/Kiosk
Phase One	Core Market Area	1,750	4.4 million
Phase Two	Expanded Market area with lower station density	750	1.9 million
Phase Three	Expanded area with increased station density or geographic expansion	2,000	5 million
Phase Four	Opportunistic expansion	TBD	TBD
	TOTAL	**4,500 bicycles**	**$ 11.3 million**

The projected costs for these various phases have been developed using a standard cost-per-bike rate of $2,500. This cost is inclusive of bikes and kiosks, but does not include operating costs and additional amenities. These costs are planning-level only and should be exposited in detail before specific funding sources are pursued. In terms of additional start-up and operating costs, the Minneapolis Bikeshare business plan offers the clearest estimates—28% additional start-up capital and $1,600 per bicycle annual operating costs—although these cannot be assumed to be directly applicable to Philadelphia.

Although the capital cost for **Phase 1** has been estimated at $4.4 to $5.6 million, it is important to note that this is not necessarily a direct out-of-pocket cost to the City. As discussed in **Chapter 4**, there are a number of potential operating scenarios that would combine public and private resources and draw upon a variety of revenue streams.

Applying the Minneapolis operating-cost estimate would lead to generalized annual costs of $2.8 million for **Phase 1**, $4 million for **Phase 2**, and $7.2 million for **Phase 3**. However, these could be largely offset by annual user revenues which are highly variable based on cost structure---These can only be usefully estimated by market study or vendor proposals, but utilizing Minneapolis' user-revenue coverage estimate of 76% (for illustrative purposes only) would lead to a budget "shortfall" of $675,000 for **Phase 1**, $1 million for **Phase 2**, and $1.75 million for **Phase 3**.

C. Siting of Bikeshare Stations

Once the number of bicycles and stations necessary for a viable bikeshare system is determined the next step is to set siting requirements for the stations. Regardless of the type of operator for the system, optimal siting requirements ensure that the stations are accessible and safe.

Bikeshare stations are relatively compact and very efficient in their use of space. Six bikes require approximately 200 square feet of road space, about the size of one car parking space. A typical station of 15 to 20 bikes plus a kiosk is typically 45 to 75 feet long, equal to two to four car parking spaces.

There are a variety of contexts where stations can be sited, each with its own advantages and disadvantages. An efficient yet comprehensive process for approving each site should be agreed upon prior to allowing a vendor to commence construction. The urban fabric of Philadelphia accommodates many opportunities for appropriately siting stations. The following is a list of types of feasible locations with examples of each:

- In-street vehicular spaces
  - Follows the precedent of spaces designated for carsharing
  - Recommended for residential areas of the city
- Transit hubs
  - 30th Street Station
  - Suburban Station
  - Key subway stations
- Public squares and plazas
  - Rittenhouse Square
  - Love Park
- Private squares and plazas
- City parks and recreation centers
  - Fairmount Park (Mann Center, Boathouse Row)
  - Schuylkill River Park
- Attractions and destinations
  - Independence Mall
  - Penn's Landing
  - Parkway museums
  - Sports Complex
- Parking garages
  - PPA garages
  - Hotel garages
  - Hospital garages
- "Leftover" spaces
  - Bumpouts
  - Triangles (i.e. large traffic islands)

Each space may require approval by various City entities, which is why it is imperative to engage City departments early on in the process. Some departments that may need to be consulted for approval are the following:

- Philadelphia Department of Streets
- Philadelphia City Planning Commission
- Philadelphia Parking Authority
- Department of Licenses and Inspections
- Department of Parks and Recreation
- Philadelphia Historical Commission
- Philadelphia Art Commission

Advances in bikeshare technology have introduced a degree of flexibility in the siting of stations. Some vendors have developed modular, drop-down stations that require minimal invasive construction. With these new developments, problematic stations can be removed or altered if necessary.

It is recommended that the City take an active role in defining siting requirements and also reserve the right of approval for the departments listed above.

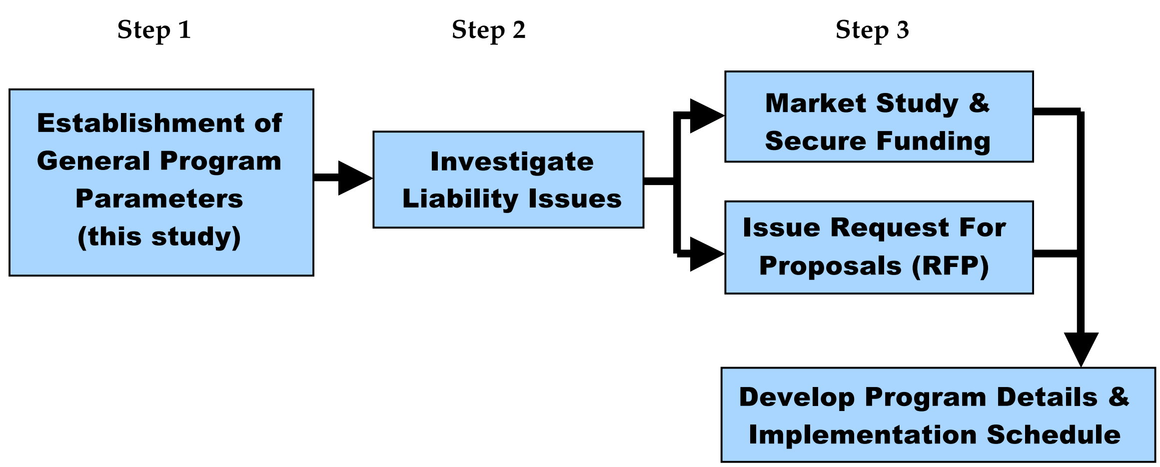
The following section describes the procedural "next-step" recommendations for further development of bikeshare for Philadelphia, including a discussion of how an optimal RFP might be constructed to attract a variety of potential bidders and encourage innovative financing schemes.

5.3 Procedural Recommendations

The basic preferences of a Philadelphia bikeshare program have been defined through the course of this process. In conjunction with the planning analyses (DVRPC) that have been conducted to estimate demand, these preferences can be articulated into a clear set of program parameters as presented in **Section 5-2**.

However, there are a number of different broad methodologies through which these parameters could be potentially achieved, as illustrated in **Figure 5-3**.

Figure 5-3: Summary of Next Steps and Procedural Options



According to the outline in **Figure 5-3**, **Step 1** has been completed through the conducting of this current study. **Step 2**—which is strongly recommended as an immediate next step—is to engage an attorney or insurance expert to gauge the local liability issues associated with the potential bikeshare program, and to articulate specific options for providing coverage.

Step 3—which could potentially overlap with **Step 2**—entails one of two potential tracts. The Market Study tract should be pursued if the political climate dictates that a public or non-profit approach to implementation is needed. The Request for Proposals tract is more open-ended in that all potential operators—public, private, non-profit, institutional—could be evaluated side-by-side, with the market study and funding/revenue projections left up to the individual bidders.

While the Market Study tract is largely self-explanatory—with the main objective of projecting revenues and setting optimal pricing—the RFP tract would require a clear set of guidelines to which all bids should calibrated. These would be based on the program objectives and target size/phasing introduced in **Section 5.2**. This sub-section discusses the standard essential elements of bikeshare-related RFP's based on the experiences of other cities.

In general, proposals should be non-binding and commit to a set menu of basic service standards as established **in Section 5.2**. Basic equal-opportunity clauses should be included. The time frame of by-right operation should be limited to 5 years to allow adjustment to and reconsideration of the basic service parameters.

A. Request for Proposals Elements

A comprehensive request for proposals (RFP) is instrumental in ensuring appropriate and innovative responses from vendors and potential operators. It is recommended that the City prepare and administer a RFP including the elements outlined below. These recommended elements have been extracted from RFPs from the following cities:

- Arlington
- Boston
- Brisbane, Australia
- Chicago
- Minneapolis
- Portland
- Tel Aviv, Israel
- Vancouver, Canada

The recommended elements are divided into two different segments: information to be provided by the respondents, and information to be provided by the City. "Information to be provided by respondents" outlines what specific information the City should require from potential vendors and operators who bid.

Information to be Provided by City:

- Recommended/Required Bicycle Components:
  - *The bicycle design should include the following:*
    - Step-through frame
    - Adjustable seat
    - Front basket
    - High stability kickstand
    - Heavy duty material
    - Chain guard
    - Bicycle bell
    - Secondary lock
    - Disc brakes
    - Lights (automatically activated)
    - Fenders
    - 3 speed derailleur
    - Puncture resistant tires
    - Bicycle-specific parts (non-interchangeable with other bicycles)
    - Other theft/vandalism thwarting methods (GPS tracking, etc.)
- Overview of Program Scope:
  - *Size of service area*
  - *Phasing*
  - *Amount of bicycles/stations*
- City's Provision of Right-of-Way:
  - *The City of Philadelphia will assist in the provision of public space in order to site the bikeshare station.*
  - *The City will maintain all rights to determine appropriate siting of the stations.*
- Required Hours of Operations:
  - *The system will operate 365 days a year, 24 hours per day.*
  - *The system must be able to completely shut down should weather or other incidents require its closure.*

- <u>Specific Performance Standards:</u>
  - *95% of bikes must be operational at all times.*
  - *The operator is required to share data regarding the usage of the system, as outlined in the RFP.*
  - *Any vandalism to the system must be remediated by the operator within a specific time period.*
  - *Distribution standards for stations and bicycles will be set between the operator and the City, i.e. percentage of time station spent full/empty, etc.*
- <u>Outlined Contract Incentives and Adjustments:</u>
  - *The City should specify revenue sharing or specific incentives for private operators to provide appropriate accessibility/mobility.*
  - *The City and the operator reserve the right to adjust the contract in the future in terms of expansion, termination, etc.*
- <u>Required Operator Qualifications:</u>
  - *The City should include specific requirements for vendor experience in mobility services and customer service.*
- <u>Provision of Important Reference Documents:</u>
  - *The City should provide the following documents for reference in the RFP:*
    - This study
    - Transit maps
    - Target implementation zone
    - Infrastructure maps
- <u>Outreach to Local Institution/Stakeholders:</u>
  - *The City should encourage bidders to reach out to local stakeholders and seek their support.*
- <u>Implementation Targets:</u>
  - *The City should outline specific targets for implementation such as:*
    - The desired timeline for implementation should be within 6 months of the awarding of the contract.

Information to be Provided by Respondents:

- <u>Maintenance Plan for Bikes and Stations:</u>
  - *The plan should provide an outline for frequency of repairs and tune-ups.*
- <u>Plan for Bike Redistribution:</u>
  - *Will a vehicle be needed?*
  - *How many people employed?*
- <u>Method for Data Collection and Sharing:</u>
  - *Operator must provide the following information to the city on a monthly basis:*
    - Vehicle miles traveled (per bicycle)
    - Number of trips and duration
    - Number of rentals and returns per station
    - Number of customers per membership types
    - Number of rentals per station/bike/day/hour/etc.
    - Number of bikes in fleet at the end of each month
- <u>Comprehensive Marketing/Branding Plan:</u>
  - *The plan should include the administration of an annual customer/user survey.*
- <u>Detailed Financial Plan:</u>
  - *The financial plan should include the following:*
    - Estimated costs (start-up, operating, expected cost to the City)
    - Estimated usage rates
    - Charging scheme and fee structure (including deposits for bicycles)
    - Revenue projections (advertising, etc.)
    - Value of assets
    - Infrastructure replacement costs

- Details of Equipment and Infrastructure:
  - *Accurate and specific details should be provided regarding the following:*
    - Bikes and locking mechanism
    - Customer Interface
    - Back-end system/Call center
    - Website
- Theft and Losses:
  - *A detailed and straightforward plan for combating theft must be outlined.*
  - *A detailed plan for dealing with theft and major vandalism must also be outlined, as well as the potential costs incurred.*
- Plan for Liability/Insurance Coverage:
  - *The coverage should include Indemnification for the city.*
- Incorporation of Innovative Design/Operational Features:
  - *Intermodality between the existing transit systems and the carsharing network in Philadelphia is a highly desirable feature for the bikeshare system.*
  - *The bikeshare kiosks should have the potential to be accessible to customers through a variety of debit and credit card networks.*
  - *The potential to integrate the bikeshare kiosks with other payment systems (i.e. car parking) should be explored.*
  - *The design of the bicycles and the stations should fit into the city's built environment and natural design elements.*
  - *A modular system that requires minimal digging and tie-in to utilities is highly preferred.*
  - *A comprehensive plan for educating users is highly desired.*
  - *The ability to provide access to low-income residents of Philadelphia is highly desired and therefore alternative payment and deposit options should be considered.*

B. Market Study

A market study for the Philadelphia bikeshare market would be a helpful tool for achieving a financially sustainable system. Conducted through focus groups and direct contact (phone or e-mail) surveys, the market study should look predominately at pricing and usage patterns since fee structure and deposit amounts vary across all successful bikeshare programs. Therefore, it is imperative that a clear understanding of the specific economics of bikeshare in Philadelphia is established.

The market study would ideally collect information about the general public interest in using a bikeshare system, how often they would use it, and how much they would pay. This information could help set the fee structure for the system such as the rates for daily, weekly, and yearly passes. It is important to note that the City need only conduct a market study if a non-profit/public operator is strongly preferred. As mentioned in the outline of the Request for Proposals, private bidders would be expected to conduct a market study analysis if the RFP process is undertaken.

C. Liability

As discussed in **Chapter 4**, best practices regarding insurance and liability coverage are mostly non-applicable. Therefore, due to the importance of the issue, it is recommended that an insurance specialist be consulted prior to the issuance of a Request for Proposals.

5.4 Recommendations for Supporting Actions

The success of any bikeshare program is dependent on the strength of the supporting infrastructure as well as the optimal execution of marketing and education activities. Without these, bikeshare is unlikely to live up to its full potential due to mixed perceptions about the safety and value of the system. The following sub-sections discuss the overall infrastructure/marketing strategies that ideally should be undertaken concurrently with continued development of the bikeshare program.

A. Infrastructure

The implementation of a bikeshare program in Philadelphia would represent the introduction of thousands of new bicyclists to Center City streets. As such, it is important to prioritize (to the degree possible) that the bicycle circulation infrastructure is adequate, such that:

- New bicyclists are safe on city streets.
- New bicyclists are provided with safe alternatives to riding on the city's narrow sidewalks.

Due to the current lack of designated bicycle facilities in Center City, it is recommended that—in conjunction with the pursuit and implementation of the bikeshare program—the city increase the density and overall extent of its designated bicycle network, especially within the target core area.

In order to accommodate key prospective trip patterns in various directions across Center City, it is essential that a minimum of east-west and north-south corridors be upgraded with bicycle facilities. The Spruce/Pine bicycle lane pair and the proposed "protected" bike lanes that are currently under study on West Market Street and JFK Boulevard represent key first steps in this direction; however, without further such action, it is likely the bikeshare program would be met with skepticism particularly by those already concerned by the intermingling of bicyclists, pedestrians, and cars on the city's constrained corridors.

It is important to conduct a broad assessment of how some of the "gaps" in the central Philadelphia bike network could start to be addressed. There are varying levels of infrastructure improvement likely needed to support both a basic, "membership-oriented" implementation of bikeshare (which assumes that all users would be familiar with local rules/conditions) and an "all-open" system accessible to both locals and visitors. The key premises of these are as follows:

- **Membership**: A basic level of clear north-south and east-west connections through the central part of the city. Assumes all users would complete a mandatory education/orientation session that clarifies the preferred city routes as well as the basic rules of bicycling in the city.
- **Open**: Clear north-south and east-west connections every 3 to 4 blocks, with inclusion of some "high-grade" recreational facilities such as off-street paths and island-separated protected bike lanes.

As discussed in **Chapter 4**, there are a number of individual studies in progress that are examining the possibility of expanding central Philadelphia's network of safe bicycle facilities. Most significantly, the Philadelphia City Planning Commission is currently completing its *Pedestrian and Bicycle Plan* representing a comprehensive examination of the city's bicycle network in several key districts (including Center City).

It is important to note that even vastly improved infrastructure would not necessarily preclude the possibility of incidents and injuries. The suggestions that follow are primarily intended as a general guideline as to what sorts of provisions would be necessary to make Philadelphia's infrastructure comparable to that of the peer successful bikeshare cities.

A viable **membership-oriented** network would ideally focus on enhancing the degree of connectivity between existing "trunk" facilities—including the Schuylkill River Trail, the Spruce/Pine pair, the Delaware River Trail (and Delaware Avenue), the Benjamin Franklin Parkway, and Spring Garden Street—by addressing at least the following current deficiencies within this framework:

- No east-west connections between Spring Garden Street and Spruce-Pine, the expanse of which includes the vast majority of Center City's commercial and cultural destinations.
- No continuous north-south connectivity within the entire river-to-river expanse except for 22nd Street, which itself is lacking a southbound counterpart.
- Gaps in the east-west connectivity to/through University City on both sides of the Schuylkill River.

As such, priority enhancements would include the following:

- Completion of planned bike facilities on the South Street Bridge and proposed facilities on the Market/JFK corridors (15th Street to 20th Street).
- At least one more east-west connector through the heart of the business district east of City Hall (i.e. Market Street, Arch/Race, etc.).
- A solution for the complex City Hall/Love Park area.
- A southbound counterpart to 22nd Street.
- An additional north-south pair somewhere between Broad Street and Delaware Avenue.
- Connection between the South Street Bridge and the Spruce/Pine pair.
- Safe connections to/through Eakins Oval to Philadelphia Museum of Art and Kelly Drive.
- Completion/extension of connections to/through University City.

The Philadelphia City Planning Commission's *Pedestrian and Bicycle Plan* is in the process of creating a blueprint for these types of critical connections, and should be used as a guide for specific placement of these key facilities.

In order to improve the prospects that potential critics could consider an open bikeshare system sufficiently safe, the density of east-west and north-south connections would have to be significantly enhanced. In particular, if tourists were to be invited to participate in the system, specific attention would have to be given to connections among popular visitor destinations, including:

- Rittenhouse, Washington, Franklin, and Logan Squares, as well as Love Park and the proposed upgraded Dilworth Plaza.
- The Benjamin Franklin Parkway, including clear, safe connections to/through Eakins Oval to the Philadelphia Museum of Art and Kelly Drive area.
- The expanded Pennsylvania Convention Center.

In addition, connections to/through nearby “destination neighborhoods” would also warrant enhancement, such as Fairmount, Northern Liberties, and Queen Village.

Finally, the quality/clarity of facilities under this scenario would have to be generally upgraded through:

- Enhanced visibility, through paint and surfacing treatments.
- Clear continuous connectivity through all complex intersections.

It should be noted that short-term occasional users have played a large part in the success of many bikeshare systems, and have been included in the DVRPC-generated Philadelphia projections. As such, it is not the recommendation of this report that tourists and other short-term guests be excluded, only that aggressive measures be taken (such as the recent implementation of the Spruce-Pine pair) to enhance the safety and functionality of the bike network for all potential users. It is important to recognize that the safe accommodation of bicyclists is a key part of transportation sustainability, even at the potential expense of motorized-vehicle traffic capacity so long as impacts to bus operations are limited or offset.

It is not the intention of this report to articulate a specific target network of bicycle facilities, but only to denote the general level of bike-lane density/connectivity that should be sought in order to better accommodate various types of potential bikeshare users. Even so, there is no guarantee that even these levels of infrastructure provision would be enough to prevent accidents. The Philadelphia Department of Streets as well as the City's liability experts should be thoroughly engaged as this process continues in order to help determine whether/when the city's bike network will be suitable for a membership-oriented or open bikeshare system.

What is definitely clear is that the current lack of bicycle facilities in the central area could significantly threaten to undermine the goals of the bikeshare program, and therefore should be afforded close attention as bikeshare progresses toward implementation. Bikeshare and enhanced connectivity are both very important keys to further development of bicycle use in the city; they should be advanced concurrently not only to due to the promise of better bikeshare safety and functionality, but also due to the opportunity to create a broad-based coalition for a better overall biking environment.

B. Education/Outreach

As discussed in **Chapter 2**, education of potential bikeshare users (as well as other users of streets and sidewalks) is imperative to the success of a bikeshare program. It is recommended that a robust education program be initiated prior to the implementation of the system. This should include working with the Bicycle Coalition of Greater Philadelphia, their Bicycle Ambassadors, the City's Pedestrian and Bicycle Coordinator, as well as the Philadelphia Police Department, to help ensure a comprehensive education and outreach campaign. The program should include:

- Targeted instruction to users of the system, i.e.
  - Correct locking of bikeshare bicycle
  - Rules for using system
- General bicycle safety messages, i.e.
  - Rules of the road
  - Proper attire (helmet, bright clothing, etc.)
- Motorist Awareness campaigns
- Pedestrian Awareness campaigns

Education of the bikeshare users can take place in many different forms---audio-visual instructions at the kiosk or when subscribing, written instructions on the handlebars of the bicycle, direct instruction through bikeshare ambassadors (on the road or at the station), voluntary or compulsory seminars or workshops, etc---but should be easily accessible and free of any additional charge. The education of motorists and pedestrians should be incorporated into signage, public service announcements, and advertisements throughout the city.

In conjunction with legislation and enforcement that supports appropriate bicycle and motorist behavior, proper education of users and non-users is paramount to the safe and successful operation of a bikeshare program.

C. Enforcement

It is recommended that the Philadelphia Police Department conduct a comprehensive behavior-change campaign for cyclists, including the targeted enforcement of common traffic violations such as red-light running, sidewalk riding, and improperly signaling turns. Increased levels of enforcement should occur prior to and periodically following the implementation of a bikeshare program in Philadelphia. In conjunction with a comprehensive education and outreach campaign to all road users, these measures should assist in keeping bikeshare and road users safe and respectful.

D. Stakeholder Involvement

Bikeshare is likely to have a positive impact on many anchor institutions in Philadelphia, encouraging mobility and accessibility for their constituents, students, clients, employees, and visitors, etc. Successful implementation of a Philadelphia bikeshare program will rely on the interest and support of many such local institutions. Therefore, it is recommended that the City reach out to key stakeholders to encourage their support and comments. The following are examples of potential beneficiaries of the system---this list is not meant to be exhaustive but only to provide a general overview of potential key partners and contributors.

Potential Beneficiaries:

- Local Attractions
    - Fairmount Park Commission
    - Greater Philadelphia Tourism Marketing Corporation (GPTMC)
    - Individual museums and other tourist sites
    - Pennsylvania Convention Center
- Educational Institutions
    - Community College of Philadelphia
    - Drexel University
    - Jefferson Medical School and Hospital
    - Temple University
    - University of the Arts
    - University of Pennsylvania
- Private Organizations
    - Amtrak
    - Large private employers
    - Philadelphia Industrial Development Corporation (PIDC)
    - PhillyCarShare/Zipcar

- Public/Quasi-Public Institution
    - Center City District
    - National Park Service
    - New Jersey Transit
    - Philadelphia Parking Authority
    - Port Authority Transit Corporation (PATCO)
    - School Reform Commission
    - Southeastern Pennsylvania Transportation Authority (SEPTA)

It is important to continuously engage these stakeholders both before and after implementation, as they represent not only beneficiaries of the bikeshare program but also potential contributors of in-kind or financial support to the system.

E. Theft and Vandalism Monitoring

Theft and vandalism to the bicycles pose a potential hindrance to the success of the system. Theft can be limited through certain technological advances, such as CCTV security and GPS tracking ability, but nonetheless must be considered a threat to the success of the program. Therefore, it is important to ensure that potential losses and major repairs are incorporated into any future business plan.

F. Equity Assurance Programs

A bikeshare system offers the potential to make the city more accessible to all citizens. Access to a low-cost and highly efficient form of transportation can increase travel options and decrease travel time for many users. As described in **Chapter 4**, a bikeshare system can act as a feeder for the transit network, and enable many people quicker, more efficient access to major activity centers. However, it is important to ensure that all citizens have access to the system, regardless of socio-economic class, which will require added attention to payment options and pricing plans.

6 - Conclusion

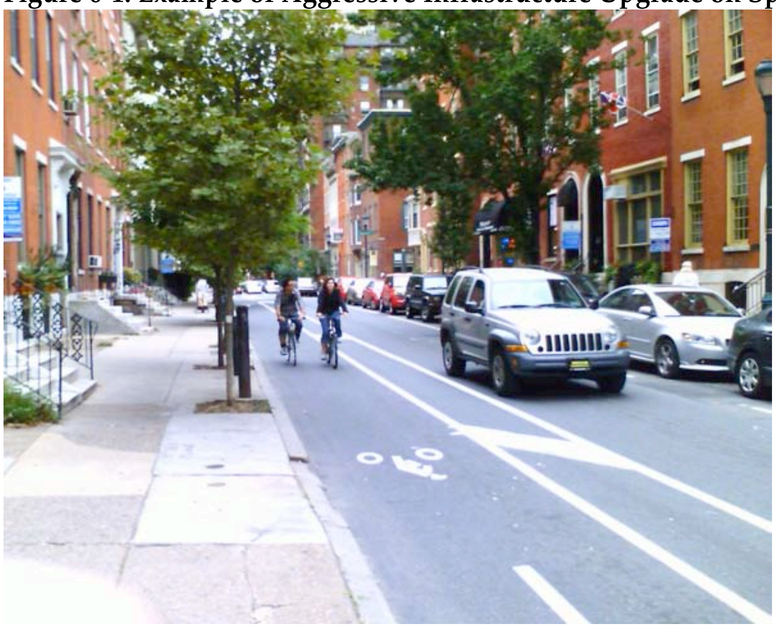
This study has verified the general viability of a possible Philadelphia bikeshare program. However, its implementation and potential success depends on a number of key specific factors:

- Adequate public funding and/or a private operator willing to invest in the system.
- Upgrade of the Center City bike-lane network to accommodate the anticipated influx of bicyclists.
- Attention to the details of education and enforcement.

The program envisioned for Philadelphia would entail an initial deployment of approximately 1,750 bicycles in a defined "core" area that encompasses the greatest opportunity for a variety of multi-directional trip patterns. This proposed level of infrastructure has proven a successful formula in peer cities with extensive levels of daily bikeshare usage.

As noted above, however, there are several key details critical to the success—both actual and perceived—of the proposed program. First and foremost, it is essential that the Center-City-area bike-lane/path network be significantly upgraded based on the forthcoming recommendations of the Philadelphia Pedestrian and Bicycle Plan, as well as other project-specific enhancements. Such improvement would help minimize the number of instances (and the perception that) bicyclists ride on the sidewalks to avoid car traffic. Without such a stated coordinated approach to the circulation network, it is likely that potential skeptics of the bikeshare program will cite bike/pedestrian conflicts as a source of excessive concern.

Figure 6-1: Example of Aggressive Infrastructure Upgrade on Spruce/Pine Streets



Along these same lines, it is important that the bikeshare program—whether operated publicly or privately—include a strong education/enforcement component that would likely represent a cooperative effort among the City, the operator, and the Bicycle Coalition of Greater Philadelphia. The reach of such a program should be extensive and highly visible, since adequate safety (and the perception of it) will be a key ingredient toward generating sufficient support and acceptance of bikeshare and its users.

The future phases of the proposed bikeshare program would represent extension of bikeshare's benefits into City neighborhoods and local commercial districts. Since the initial trips-per-day in these "expanded" service areas are unlikely to match those in the core—at least at the outset—a more cautious incremental approach should be taken to introduce bikeshare in these contexts. In such areas, it is recommended that bike stations be distributed according to an equitable "accessibility" standard that places bikeshare within adequate reach of all neighborhood residents.

Figure 6-2: A Future Sight in Philadelphia?

Bikeshare has strong potential to not only increase the overall bicycle mode-share, but also to improve the efficiency of the transportation system as a whole. For example, the linking of bikeshare trips with transit trips would represent an advantage for both modes, i.e. the reach of bikeshare trips would be extended while the transit system would benefit from new riders and/or decreased pressure on crowded "feeder" bus routes.

Philadelphia has a reached a point in its ongoing evolution into a vibrant 24-hour city where it is absolutely essential to look toward alternate and innovative means of transportation to ensure a continued sustainable growth pattern. As the central core further develops, the increasingly constrained nature of its streets will make it progressively less viable to accommodate increased numbers of residents, employees, and daily visitors through traditional transportation means; therefore, concepts such as bikeshare represent critical components of both an efficient circulation system and a healthy development environment.

Appendix A: DVRPC Bikeshare Demand Estimation Memo

Date: July 17, 2009

To: Brittany Bonnette, Frank Jaskiewicz

From: Gregory Krykewycz, Christopher Puchalsky

Subject: Process for Philadelphia bike sharing demand estimation

The William Penn Foundation is currently sponsoring a study to explore the feasibility of a bike sharing program in Philadelphia. As part of this project (under DVRPC's FY2009 Nonmotorized Planning Program), DVRPC has been asked to prepare an order-of-magnitude estimate of the demand for such a system. This task was conducted in two phases: 1) a raster-based GIS analysis to identify a primary geographic market area for a bike sharing program; 2) application of bike sharing trip diversion rates observed in peer cities to trip volumes by Traffic Analysis Zone (TAZ) in Philadelphia, in order to estimate the number of trips that would be made using shared bikes in the primary market area.

PHASE I: GIS ANALYSIS TO IDENTIFY CORE MARKET AREAS

In Phase I, various demographic, land use, and infrastructure factors understood to be favorable for bike share usage were spatially analyzed in order to define a core market area – the portion of Philadelphia most likely to support (i.e., use) a robust bike share program. The method used for this task was to conduct a weighted sum raster analysis using ArcGIS software. Under this method:

1. Ten GIS datasets were selected for which high or low values (in terms of density or proximity) are intuitively favorable for bike share usage and derived from best practices.
2. For "apples to apples" comparisons, each dataset was rasterized into a citywide grid with 10-meter cells.
3. Data was grouped into ten numerical bins using the quantile method of classification in GIS (i.e., equal numbers of records in each score category). For each raster layer, data was then reclassified into a 10-point scale, with values of 10 being assigned to the quantile/bin deemed most favorable for bike share, 9 for the next-most favorable, etc. This resulted in each cell in the citywide grid being assigned a score of 1-10 for each of the input datasets.
4. The ten layers were aggregated using a "weighted sum" to arrive at a composite "bike share score" dataset. This included assigning weights to each dataset, which determine how heavily they are "counted" in creating the composite dataset. In addition to this weighting, certain inputs (specifically retail jobs, group quarters population, and bicycle lanes) were also intentionally double-counted by virtue of their being subsets of other layers (total jobs, total population, and bicycle friendly streets, respectively) that were separately included as inputs. This was another form of high weighting for data subsets that were deemed especially favorable to bike share usage.

Table 1 summarizes the datasets used, how they were rasterized, and the weights assigned to each for the weighted sum analysis.

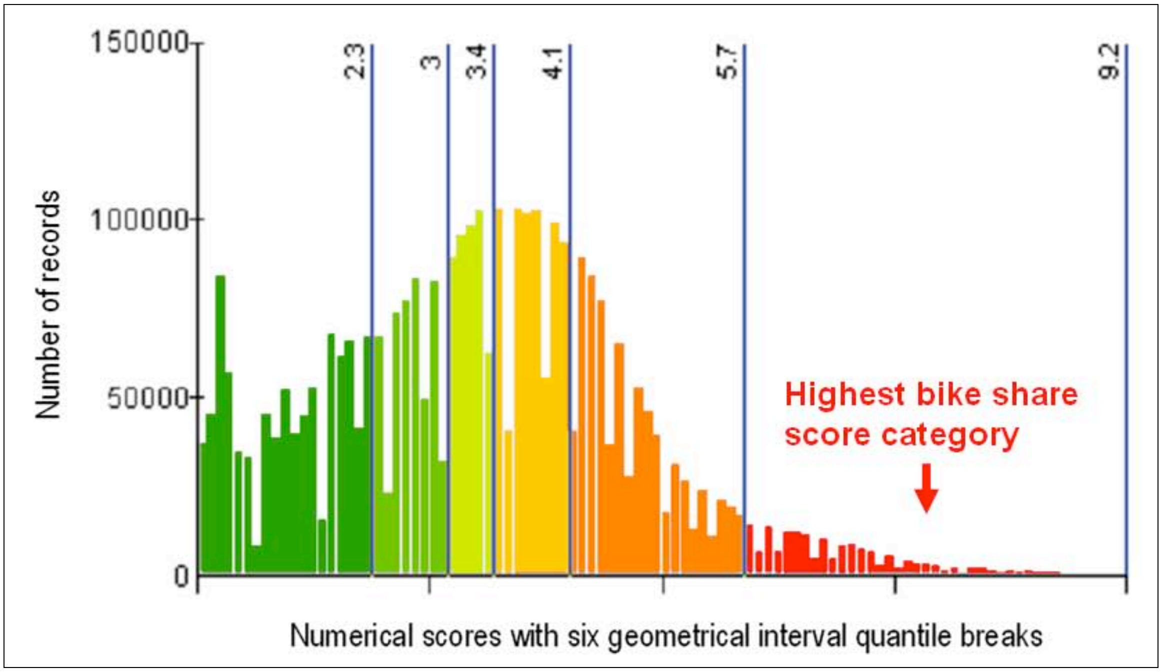
Table 1: Input factors for bike share score weighted sum raster analysis

Factor	Buffer distance used for analysis	Weight for composite score mapping
Trip origin factors		
Population density at the Census Tract level for persons 17-64 years of age	n/a	x1
Non-institutionalized group quarter population density at the Census Tract level (includes dorms & shelters, but not nursing homes or prisons)	n/a	x1
Trip attraction factors		
Job density at the Traffic Analysis Zone (TAZ) level	n/a	x1
Retail job density at the TAZ level	n/a	x1
Locations of tourist attractors (cultural, entertainment, sports, and destination restaurants from Greater Philadelphia Tourism Marketing Corp. [GPTMC] database)	Raster analysis maps the density of attractors within 500 meters (0.31 miles) of all points	x1
Proximity to parks/recreation areas	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x0.5 (assigned a lower weight due to relatively low recreation use observed for other bike share systems)
Network / facility factors		
Proximity to rail station(s)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1.5 (assigned a higher weight due to a study desire to give special weight to the role of rail stations in facilitating first/last-mile bike share trips)
Proximity to "bicycle friendly streets," including streets with bicycle lanes (Phila. Streets Department dataset)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1
Proximity to streets with bicycle lanes (Phila. Streets Department dataset)	500 meter (0.31 mile) buffer, weighted by proximity within that radius	x1
Locations of bus stops (includes surface trolley stops)	Raster analysis maps the density of stops within 500 meters (0.31 miles) of all points	x1
	Total	**10.0**

Source: DVRPC 2009

Through the weighted sum GIS process, each of the above input datasets were aggregated into a composite “bike share score” dataset, where each location in the raster grid has a numerical score (also ranging from 1 to 10). In order to identify a primary market area or areas, the next step was to observe the distribution of scores.

Figure 1: Histogram of bike share scores from ArcGIS



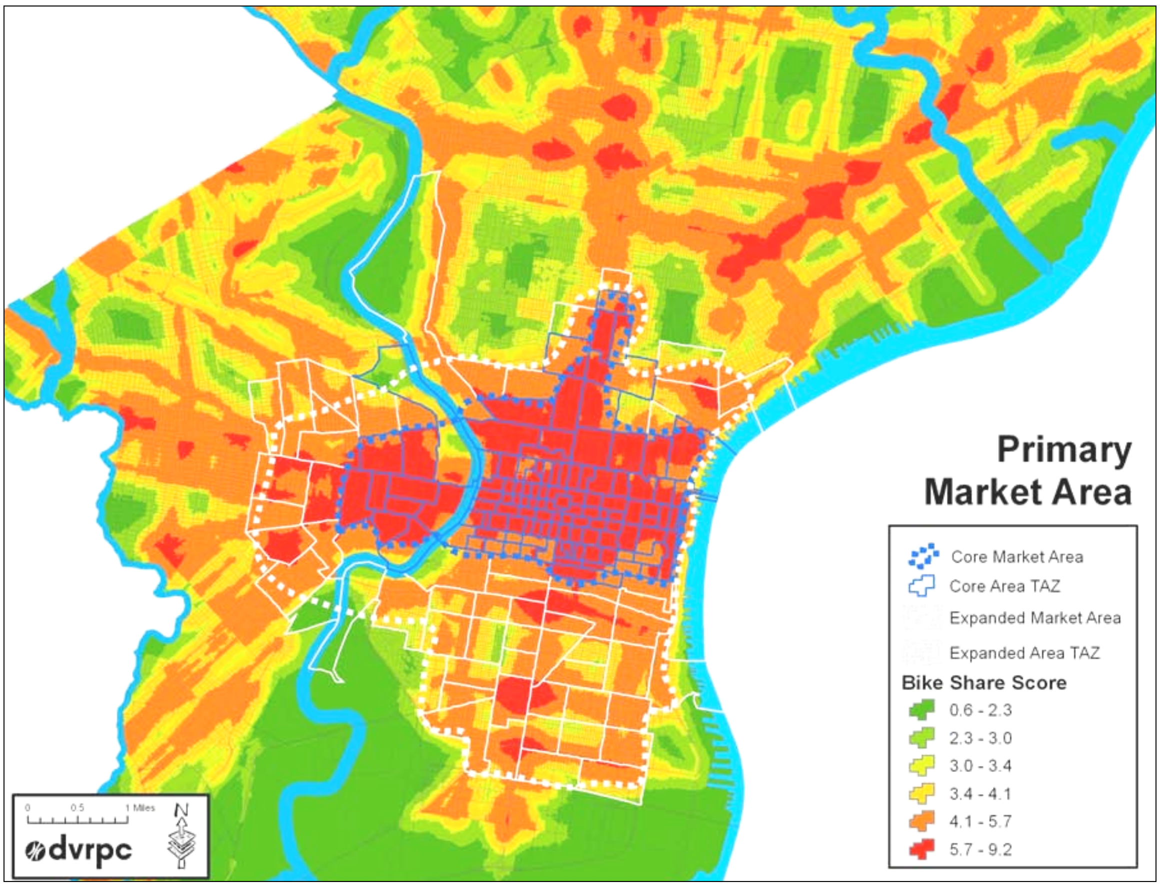
Source: DVRPC 2009

Figure 1 depicts the distribution of numerical bike share scores as they fall into six score category ranges. The method of classification used was geometrical interval, which is a modified version of the quantile method of classification (again, equal numbers of records in each category) that adjusts to account for rapid changes in the distribution (as occurs between 4.1 and 5.7 in Figure 1). The top score category range in the histogram (5.7 – 9.2) represents portions of Philadelphia with the highest bike share scores as defined under this method.

In order to define a core geographic market area, these scores were first mapped with the score category divisions defined in Figure 1. Next, we observed the largest generally contiguous grouping of areas in the highest score category (around Center City), and created an outline around these areas in GIS. This line was then smoothed, resulting in our core market area boundary. This core market area (see Figure 2) is generally bounded by the Delaware River on the east, South Street on the south, 41st Street on the west, and Powelton Avenue & Spring Garden Street on the north (with an extension along North Broad Street to Temple University).

Traffic Analysis Zones (TAZs) were identified that generally corresponded with this core market area in order to proceed with the Phase II analysis, which used TAZ-level trip data. In order to refine the analysis and enable more flexibility in implementation, an expanded or secondary market area was also identified and mapped. This broader area represents the core market area plus generally contiguous areas of the next-highest score category, with scattered pockets of the highest score category also contributing to defining its extent. The expanded market area includes additional parts of West Philadelphia, extends further north of Center City to Girard Avenue and including Fishtown and portions of Kensington, and nearly all of South Philadelphia river to river. Figure 2 depicts the two market areas, as well as the TAZs that most closely correspond with them.

Figure 2: Bike share score raster mapping with identified core and expanded market area boundaries



Source: DVRPC 2009

PHASE II: BIKE SHARE TRIP ESTIMATES FOR CORE & EXPANDED MARKET AREAS

Transportation based method to estimate bike sharing demand in Philadelphia

A sketch-planning method was developed in order to estimate the trip-level demand for bike sharing in Philadelphia based on the demand for existing modes and diversion rates extrapolated from public bicycle systems in other cities. The method involved three steps:

- Calculation of diversion rates based on peer-city experience;
- Calculation of demand for existing transportation modes in Philadelphia; and
- Application of the diversion rates to existing Philadelphia trips to determine the demand for bike sharing.

Estimation of Peer City Diversion Rates

Traditional travel demand models have typically been used to determine the demand for travel by auto and, to a lesser extent, the demand for transit. Models have been modified in recent years to also estimate the demand for non-motorized modes (biking and walking) as transportation planning and engineering has moved to a more comprehensive multi-modal approach. Bike sharing and car sharing, however, are relatively new modes. As such, travel demand models have not yet been modified to estimate the demand for these modes. Insufficient research has been conducted to determine the fundamental factors that drive the demand for bike share trips or the factors that determine whether a trip or chain of trips will be made by bike share or another mode. We could not, therefore, directly modify the DVRPC Regional Travel Demand Model in order to estimate the demand for this new mode. The trip-level demand for bike share must be estimated using other means.

In order to estimate the demand for a bike share system, the experience of cities that have already implemented bike share systems was first used to estimate diversion rates. A diversion rate means that, for example, x% of existing transit trips were diverted to bike share when such a system was introduced. Unfortunately, there are currently no large-scale bike share systems in North America from which to obtain useful data. Washington, DC has a small pilot system, but it is not large enough to provide meaningful data. Montreal has a larger system, but this program was too new at the time of study to provide the required data. We were able to obtain data from three European cities on the effects of introducing a comprehensive, large-scale bike share system. The three cities are Lyon, France; Paris, France; and Barcelona, Spain. Data on the three cities are summarized in Table 2.

Table 2 – Initial peer city comparison

City	Population [2005/06] (000)	Population density (000/sq. km)	Daily bike share trips (000)
Lyon	472	26.0	20
Paris	2,168	64.6	100
Barcelona	1,620	39.4	50
Philadelphia	1,483	11.0	-

Source: Internet data sources; *Translink Public Bike System Feasibility Study*, 2008

Surveys in each of the three cities asked bike share users which mode they would have used if they had not used bike share. The results are summarized in Table 3, and are reasonably consistent between cities. The majority of trips were diverted from transit with the average roughly 54%. About a quarter of bike share trips were diverted from walking, with an average of 27%. However, the survey methods were not uniform between cities. Only Lyon asked about bicycle use (3.7% said they would have used a non-shared bicycle) or the possibility of an induced trip (2.2% said they would not have otherwise taken the trip). Only Paris asked about taxi use (5% indicated they would have used a taxi).

Table 3: Summary of responses to question "Without a shared bicycle, how would you have completed your trip?"

Mode	Lyon (%)	Paris (%)	Barcelona (%)	Average*(%)
Bus or subway	50.6	65	51	54.3
Car or motorcycle	6.7	8	10	8.1
Taxi	n/a	5	n/a	4.9
Bicycle	3.7	n/a	n/a	3.6
Walk	36.7	20	26	27.0
New trip	2.2	n/a	n/a	2.2

* - normalized to sum to 100%, n/a – not asked

Source: Lyon – *"Vélo'v: Un Service de Mobilité de Personnes à Transferer?", Benoît BEROUD, Université Lyon 2- Mémoire de Master Recherche, March 10, 2007.* Paris – 2008 survey commissioned by Mairie de Paris and administered by TNS-Sofres. Barcelona – ElPeriodico.com October 2007 survey of Bicing Users by Ajuntament de Barcelona.

The survey results in Table 3 together with the total number of daily bike share trips in each city (Table 2) allowed us to calculate the number of bike share trips by the mode that patrons would have used if bike share was not available. These results are summarized in Table 4. Because this data directly follows from the survey data, there are only entries where questions were asked for each mode in each city. For example, "n/a" for Paris for New trips does not imply that there were no new trips generated as a result of the introduction of the bike share system; only that this question was not asked to Parisian bike share system users.

Table 4: Trips diverted to bike sharing by mode and city

Mode	Lyon	Paris	Barcelona
Bus or subway	10,120	65,000	25,500
Car or motorcycle	1,340	8,000	5,000
Taxi	n/a	5,000	n/a
Bicycle	740	n/a	n/a
Walk	7,340	20,000	13,000
New trip	440	n/a	n/a

Source: DVRPC calculations 2009

To calculate the diversion rates for each city and mode, the figures in Table 4 needed to be divided by the total number of trips for each mode within the coverage area of the bike share system in each city. For example, in order to determine the diversion rate of transit to bike share in Lyon, the number of diverted transit trips (10,120) must be divided by the total number of transit trips in Lyon within the service area of the bike share system. Obtaining good data for each city was problematic.

Two main sources were used to estimate the total number of trips by mode in the bike share service area for each city. The first source was the Millennium Cities Database (MCD) from the International Association of Public Transport (UITP). The MCD contains transport and development indicators for 52 cities for the year 2001, including Paris, Lyon, and Barcelona. Importantly, this data preceded bike share implementation for each of these three cities. The data included trip making rates and modal shares for auto, transit, walking, and biking. No data could be found on taxi trips, which were therefore not analyzed further. The second source of data was transit system ridership for each city/region. This was used because it was readily available and because transit was the predominant mode that bike share trips were diverted from. This also served as a check against the MCD, for which some of the definitions were vague.

The geographic area for both the MCD and the transit data for each city did not align with the bike share service areas. The data for both sources was for the entire metropolitan region, while the bike share systems only cover a smaller portion of each region (analogous to the primary market areas identified for Philadelphia in Phase I). This required that the regional data be factored down to be more representative of the smaller bike share service areas. The estimated number of trips by mode for each city in the bike share service areas appears in Table 5.

Several assumptions were made in arriving at these figures, and consequently they should be taken as estimates that reflect some level of uncertainty. The bike share service area trips were obtained from regional totals by simple factoring. However, this method did not fully account for the fact that bike share service areas are located in the more dense cores of each region. Accordingly, the pre-existing trip totals for the auto mode are likely to be overestimated while the other modes are likely to be underestimated. Additionally, non-motorized trips are often undercounted in travel surveys. There was unfortunately no data available to correct for these errors.

Table 5: Estimated total daily trips by mode (prior to bike share program) within the established bike share service area for each city

Mode	Lyon	Paris	Barcelona	Philadelphia (Center City)	Philadelphia (total)
Bus or subway	725,260 (16.8%)	1,409,049 (12.4%)	669,874 (12.1%)	232,000 (31.0%)	601,000 (13.1%)
Car or motorcycle	2,239,448 (51.9%)	5,653,435 (49.7%)	2,811,186 (50.7%)	333,000 (44.6%)	3,314,000 (72.0%)
Bicycle	28,025 (0.6%)	103,717 (0.9%)	17,511 (0.3%)	24,000 (3.2%)	58,000 (1.3%)
Walk	1,321,706 (30.6%)	4,205,908 (30.6%)	2,041,200 (36.8%)	159,000 (21.2%)	628,000 (13.6%)

Source: Mobility in Cities Database – IATP 2005, Internet data sources, DVRPC 2009

From Tables 4 and 5 the bike share diversion rates were calculated using the following equation:

$$Diversion\ Rate = (Diverted\ Trips) / (Total\ Trips)$$

The resulting estimated diversion rates are summarized in Table 6. All three cities have similar diversion rates for the walking mode. The diversion rate for Lyon for transit (1.4%) is much less than those for Paris (4.6%) or Barcelona (3.8%). The diversion rate for Lyon for auto (0.06%) is also much less than those for Paris (0.14%) or Barcelona (0.18%). Lyon is the only city with a diversion rate from private to shared bike (again because it was the only system where the bike share user survey included that option). Regarding the uncertainty in the figures in Table 5, there is an inverse relationship between total trips and the diversion rate according to the above equation. Therefore, if the number of walking trips for Paris, for example, are underestimated, then the true diversion rate will be somewhat lower than the rate displayed in Table 6.

Table 6: Estimated diversion rates to bike sharing by mode and city

Mode	Lyon	Paris	Barcelona
Bus or subway	1.4%	4.6%	3.8%
Car or motorcycle	0.06%	0.14%	0.18%
Bicycle	2.6%	n/a	n/a
Walk	0.56%	0.48%	0.64%

Source: DVRPC 2009

Calculation of existing travel demand in Philadelphia

The DVRPC regional travel demand model calculates trip making activity in the region as the first step in the conventional 4-step travel demand modeling process. The region is divided into 1,912 Traffic Analysis Zones (TAZs) for purposes of travel modeling. Demographic data such as population and employment are estimated for each TAZ from Census and other data sources. Trip rates are estimated primarily from the 2000 Household Travel Survey which was conducted in the Delaware Valley region. In this survey, participants were surveyed concerning their travel patterns and asked to keep a daily travel diary. This data was then processed in order to determine trip rates for motorized travel, walking, and biking. The trip rates are multiplied by zonal demographic variables in order to determine the number of trips by mode in each TAZ. The motorized trips are divided between auto and transit in the mode split stage based on the travel time and cost of each mode. More details on trip generation and mode split can be found in the document *2000 and 2005 Validation of the DVRPC Regional Simulation Models*.

For the purposes of this study, the number of trips for each mode originating and terminating in each TAZ were summed and then divided by two in order to avoid double counting. This resulted in a table of trips by TAZ for each of four modes: auto, transit (bus and rail), walk, and bike.

Application of rates to estimate bike share demand: low, middle, and high scenarios

The diversion rates in Table 6 were multiplied by the number of trips in each Philadelphia TAZ in order to estimate demand for and usage of a bike share system in Philadelphia. As indicated in Table 6, there is significant variation in the diversion rates for peer systems. For this reason, bike share trips were estimated under three scenarios: low, middle, and high levels of bike share system usage. For each mode in Table 6, the low, middle, and high diversion rates were applied to each TAZ as follows:

- **Low** – lowest calculated diversion rates for each of the four modes (1.4% transit diversion rate, 0.06% auto/motorcycle diversion rate, etc.)
- **Middle** – middle calculated diversion rates for each of the four modes (3.8% transit diversion rate, 0.14% auto/motorcycle diversion rate, etc.)
- **High** – highest calculated diversion rates for each of the four modes (i.e., 4.6% transit diversion rate, 0.18% auto/motorcycle diversion rate, etc.)

There was only one entry (Lyon) for bicycle trips. Consequently, this diversion rate was applied to the middle scenario, and the low and high scenarios decreased and increased this rate, respectively, by 30%. The high scenario also increased the total number of bike trips in each TAZ (to which the diversion rate was applied) by approximately 50%. This is to account for growth in bicycle usage in Philadelphia since the 2000 Household Travel Survey as documented by a limited number of bicycle counts.
As noted previously, only survey data from Lyon included a rate of new or induced trips (2.2%). Accordingly, the total estimated number of diverted trips for the middle scenario was multiplied by 2.2% to estimate the number of induced trips based on the Lyon data. This figure was halved (1.1%) for the low scenario and doubled (4.4%) for the high scenario.

Table 7 summarizes the diversion rates applied under the three demand scenarios.

Table 7: Diversion rate details for low, middle, and high demand scenarios

Mode	Low	Middle	High
Bus or subway	1.4%	3.8%	4.6%
Car or motorcycle	0.06%	0.14%	0.18%
Bicycle	1.8%	2.6%	3.4%
Walk	0.48%	0.56%	0.64%
New trips (as a % of the combined diverted trip volume for all above modes)	1.1%	2.2%	4.4%

RESULTS SUMMARY

The outcome of Phase II yielded an estimate of bike share trips for every TAZ in the City of Philadelphia under the three demand scenarios: low, middle, and high. Notably, these demand estimates assume the provision of a Philadelphia bike share system comparable in scale and scope to those of the peer European cities from which diversion rates were derived.

The final task was to combine the results of Phases I and II and prepare estimates for bike share demand within the specific TAZs that comprised the identified core (and expanded) market areas. Table 8 summarizes the aggregate estimated demand for each scenario for the two market areas; trip numbers for the expanded market area are inclusive of core market area trips.

Table 8: Estimated daily bike share trips in Philadelphia by market area and demand scenario

Market area	Demand scenario	Estimated daily bike share trips	Estimated daily trips per capita
Core (2000 population: 98,415)	Low	5,900	0.06
	Middle	14,200	0.14
	High	18,200	0.18
Expanded (2000 population: 317,710)	Low	7,500	0.02
	Middle	18,200	0.06
	High	23,200	0.07
Lyon *Vélo'v* (Est. population: 610,000)	Actual	20,000	0.03

Source: DVRPC 2009

To place these figures into context, population numbers for both market areas from the 2000 US Census are also indicated in Table 8. For purposes of comparison, the estimated population for the bike share service area in Lyon (which includes the City of Lyon as well as neighboring Villeurbanne) is just over 610,000, with roughly 20,000 daily bike share trips. Taken together, the three estimate levels yield a wide range for potential daily demand, consistent with the broader aim of transparency and a generally conservative project approach. While some of the variation among peer cities reflected in the three demand scenarios is certainly due to geographic, climatic, and cultural differences, some can also be attributed to programmatic issues such as pricing, the distribution and number of bicycles, and supportive policies and infrastructure.

In order to approach the "high" projections, Philadelphia would have to score exceptionally well with respect to each of these issues, potentially requiring a substantial subsidy, exceptional availability of bicycles, and a very aggressive commitment to bicycle infrastructure (even at the expense of traffic capacity) within the bike share service area. In essence, the high projections would mean that Philadelphia would outperform each of the peer European cities, and therefore they should not necessarily be viewed as the target. Rather, the low and medium projections reflect a more pragmatic range of outcomes, which would nonetheless mark performance comparable to that of very successful European bike share systems.

Figure 3 summarizes the middle demand scenario trip estimates at the TAZ level, using a measure for bike share trips of riders per acre. It also bears noting that when these trip densities are mapped, the resulting distribution of usage corresponds quite closely with the core and expanded market areas defined in Phase I (Figure 1). This provides a visual “sanity check” for the results of the two phases.

Figure 3: Estimated TAZ-level bike share trip densities with core and expanded market areas overlaid