THE POTENTIAL ECONOMIC, ENVIRONMENTAL, HEALTH, AND QUALITY OF LIFE BENEFITS OF A FULLY CONNECTED WATERFRONT GREENWAY IN PHILADELPHIA

Final Report Submitted To:
Citizens for Pennsylvania's Future (PennFuture)
1500 Walnut Street Suite 502
Philadelphia PA 19102

Final Report Submitted By:
Econsult Corporation
3600 Market Street 6th Floor
Philadelphia PA 19104

FINAL REPORT – September 21, 2010

TABLE OF CONTENTS

1.0 INTRODUCTORY CONTEXT AND METHODOLOGICAL APPROACH

Cities, first established along rivers for reasons of trade and industry, now also seek to use their riverfronts as outdoor amenities, and are coordinating millions of dollars of public and private sector investment to encourage boating in rivers as well as running, bicycling, and other recreational pursuits alongside them. Across the nation, the desire for waterfront greenways is fueled in part by heightened environmental awareness, higher gas prices, and increased congestion. Greenways are increasingly included in regional strategies to attract tourists, residents, and firms, and the mobility and recreational options afforded by them are more and more perceived as positively contributing to physical and emotional health and to more sustainable lifestyles. As noted in the Bicycle Coalition of Greater Philadelphia's 2008 report, "Double Dutch":

> *20th century transportation policy in the United States presumed that streets were made to carry motor vehicles. But, in a 21st century that is facing higher gas prices, a dire need to dramatically cut greenhouse gas emissions, and a national obesity epidemic, there is a strong imperative for the US to encourage Americans to drive less and use "active transportation" – bicycles, walking or public transit – to move themselves around, especially for short distances.*[1]

Local interest in these opportunities is high, as evidenced by a 2006 poll in which 77 percent of business owners and residents expressed a desire for increased public funding to restore the City of Philadelphia's rivers and maintain open space along these waterways.[2] Nevertheless, as public finances are presently challenged and private development has slowed considerably, it is appropriate to more thoroughly consider the benefits associated with waterfront greenways, so that those benefits can be thoughtfully weighted against the costs that would have to be borne to make them possible.

This report by Econsult Corporation, commissioned by Citizens for Pennsylvania's Future (PennFuture) on behalf of the Coalition for Philadelphia's Riverfronts (CPR), with generous funding from the William Penn Foundation, explores **the potential economic, environmental, health, and quality of life benefits of a fully connected waterfront greenway in Philadelphia**. Through literature review, economic impact study, and econometric analysis, benefits were articulated, supported, and, where possible, quantified,[3] in the following categories (see Figure 1.1):

---

[1] "Double Dutch: Bicycling Jumps in Philadelphia," Bicycle Coalition of Greater Philadelphia (2008).

[2] "Next Great City Environmental Poll," Terry Madonna Opinion Research (2006).

[3] Benefits were quantified where possible, although these estimates should be considered as rough, given the inherent imprecision associated with the quantification of relatively qualitative characteristics, as well as the relatively early stage the City is in, in terms of actual waterfront greenway infrastructure investment. Where possible, conservative assumptions were employed and hard-to-quantify categories merely described and not reduced to a number, so those

Figure 1.1 – The Potential Economic, Environmental, Health, and Quality of Life Benefits of a Fully Connected Waterfront Greenway in Philadelphia

Category	*Description*	*Main Beneficiaries*
Direct Use Benefits (Section 2)	Greenway users derive physical and emotional benefit from a variety of direct uses, as quantified through their "willingness to pay."	Greenway users
Enhanced Commuting Options (Section 3)	The existence of greenways can lead to more and better commuting options, thus reducing automobile usage (with attendant environmental and other benefits for the region) and providing safer passage for pedestrians and bicyclists.	Commuters The City and region as a whole
Health Care Cost Reductions (Section 4)	Greenways can provide opportunity for active recreation, resulting in positive health outcomes and reduced health care costs for users.	Greenway users, and the City and region as a whole
Tourism Expenditures Generated (Section 5)	Greenways can increase the amount of tourism and recreational expenditures taking place within the City, with attendant economic and fiscal benefits for the City.	The City's economy
Property Value Appreciation (Section 6)	Greenways can increase nearby property values because of peoples' willingness to be located near a significant outdoor amenity, thus increasing wealth for households and potentially generating local property tax revenues for the City and School District.	Property owners The City and the School District
Ecological Services Rendered (Section 7)	Greenways add pervious surface and tree cover, which provide beneficial ecological services for the City and region.	The City and region as a whole

Source: Econsult Corporation (2010)

estimates that did emerge should be considered a lower bound. Additional primary research may provide additional precision to these estimates, and some specific explorations are discussed throughout this report.

This report presents a simplified and illustrative example of the benefit of greenways by comparing the difference between having a fully connected waterfront greenway along all 50 miles of riverfont within the City, and having no waterfront greenway space at all.[4] In each of the ensuing sections, benefits are advanced in theoretical terms, and then confirmed by evidence from recent research and other supporting information; and finally, as possible, a rough estimate of the scale of impact is attempted and described, usually by using any available relevant local or national averages as proxies for the anticipated impact of a fully connected waterfront greenway in Philadelphia. A concluding section connects these categories of benefits together, providing some sense as to whether and where they overlap, and offering a sense of the scale and composition of the aggregate impact of a fully connected waterfront greenway in Philadelphia.

This report considers only a generic waterfront greenway and does not advocate for any particular approach or route, while actual benefit may depend greatly on a variety of factors associated with the greenway's actual qualities – it may very well be that there are larger variations in impact from different levels in the design, connections, and dimensions of the greenway, than from whether the greenway exists or not (see Figure 1.2). Ultimately, whether and where investments are made to add to the City's current inventory of greenway space will depend on a confluence of factors – economic, fiscal, political, environmental, health, and quality of life. The objective of this report is to contribute content to these ongoing discussions, as policymakers and citizens alike weigh the pros and cons of a fully connected waterfront greenway in the City.

Source: Drexel University

[4] Thus, it is neither an evaluation of the existing waterfront greenway space within the City (i.e. the difference between no waterfront greenways and the present inventory of waterfront greenways), nor one of what additional benefit would accrue if new waterfront greenway space were added (i.e. the difference between the present inventory of waterfront greenways and a fully connected waterfront greenway). Rather, it estimates the difference between having a fully connected waterfront greenway and having no greenway at all (i.e. the sum of the present benefit of existing greenway space and the potential benefit of future greenway space).

Estimates also represent magnitudes of impact associated with full implementation. In reality, a fully connected waterfront greenway would be implemented in stages over time, and thus impacts would ramp up to full implementation levels over time.

Figure 1.2 – Presuming a Baseline Standard of Quality, Design and Accessibility

Good design can mean all the difference: in instances in which people were unaware of a greenway's existence or were unsure of its safety and quality, there was very little if any net new use, resulting in very little if any net new benefit. For example, a recent study found no statistical change in physical activity by nearby residents of a newly installed trailway in North Carolina, due in large part because most residents were not aware of this amenity.[5] Closer to home, lack of awareness of recreational opportunities has hindered more extensive use of the existing Tidal Delaware Water Trail.[6]

Furthermore, even if outreach is good and wayfinding mechanisms are dutifully implemented, design challenges can still hinder usage. For example, the existence of Interstate 95 creates significant difficulties in connecting neighborhoods and residents who are geographically proximate to the waterfront but who may encounter physical and psychological barriers to getting there.

On a related note, extrapolating potential usage of a new greenway in Philadelphia from the results of other recent greenway additions in other parts of the country – whether commuters switch from cars to bicycles, or residents choose to exercise more now that an outdoor recreational amenity is more readily available to them – is fraught with difficulty. Many papers documenting the before-and-after effect on greenway use of new infrastructure investments are careful to point out that while the methods used to count usage are replicable, the results may not be, given the many possible differences, including but not limited to weather, design, access, and outreach.[7]

At this juncture, there is no consensus as to where a fully connected waterfront greenway should run, what design quality it will aspire to, how wide it will be, how wooded it will be, and how specific accessibility challenges will be overcome. What is assumed in the remainder of this report is that a fully connected waterfront greenway can and will be built, it will be of baseline quality and design, and it will offer reasonably convenient access points for nearby residents, other Philadelphians, and out-of-town visitors.

Source: Econsult Corporation (2010)

[5] "Evaluating Change in Physical Activity with the Building of a Multi-Use Trail," American Journal of Preventive Medicine (2005).

[6] "Tidal Delaware River Recreational Boating: Research Results," Pennsylvania Environmental Council (May 2010).

[7] See, for example, "Neighborhood Correlates of Urban Trail Use," Journal of Physical Activity and Health (2006).

2.0 HEALTH AND QUALITY OF LIFE IMPACT – INCREASED CONSUMER UTILITY DERIVED FROM DIRECT USE

At its most basic level, a waterfront greenway is a recreational amenity that enables enjoyable direct uses such as jogging, rollerblading, and canoeing. Little or no money exchanges hands when a person uses a greenway in these ways, but there is still significant gain to that person, which economists call "consumer utility" and which can be quantified in the form of "willingness to pay." What people are essentially "paying" for when they name a price for a recreational activity is the physical and emotional gain they derive from partaking in the activity. Thus, more intensive uses tend to have higher "willingness to pay" values, reflecting the higher physical and emotional gain that is enjoyed by engaging in them, as well as the relative scarcity of availability of facilities in which to enjoy them.

The aggregate "willingness to pay" that would be captured within the City of Philadelphia by users of a fully connected waterfront greenway would therefore be an estimate of the physical and emotional benefit derived by users as a result of the existence of such an outdoor amenity. Said another way, the value would represent **the amount of benefit accrued to users due to their access and enjoyment of the greenway**. As intangible as this benefit is, it is useful to attempt to make a monetary estimate of it, so that that value can be accounted for in policy and priority decisions.[8]

"Mother Nature, it seems, is a cheap date. In an uncertain economy, outdoor exercise is posting big gains, even as the number of people who take part in indoor activities and team sports stays flat." – "Exercise Goes Back to Nature," Independence Blue Cross Update (August 2010).

In order to arrive at an aggregate "willingness to pay" amount associated with a fully connected waterfront greenway, one would need to have a way of estimating both the amount and distribution of various activities that would take place on a connected greenway, as well as an average "willingness to pay" rate for each type of activity. The most precise, direct, and locally relevant way to know this number is to conduct primary research within the City, to determine from specific survey questions the anticipated behavioral changes and activity preferences of residents throughout the City, as far as the

[8] In fact, increasingly so in difficult economic times, individuals and households are shifting their leisure outlets from those that cost money (restaurants, entertainment venues) to those that do not cost money (parks, open spaces). So greenway use can generate very real financial gains to individuals and households if they use freely available greenways instead of spending money elsewhere.

number and type of net new uses of a fully connected waterfront greenway and the value ascribed to such uses.

Apart from such primary research, an accepted approach to "willingness to pay" or benefit valuation is to use estimates, based on surveys conducted by the US Army Corps of Engineers, of the "Unit Day Value" of a variety of recreational activities.[9] As for estimating net new usage, one can use existing data to determine current usage types and levels, and apply levels of change in usage from other, similar greenway additions, to arrive at a rough estimate of the recreational activity anticipated to take place on a new waterfront greenway.[10]

Source: Schuylkill River Development Corporation

The most recent State Comprehensive Outdoor Recreation Plan (SCORP) in the Commonwealth of Pennsylvania, conducted in 2009,[11] included a survey that provides some guidance as to the current recreational habits of local residents. One of the four quadrants for which survey responses were available was the City as a whole, so those results were used as a proxy for recreational behavior throughout the City. From SCORP survey results for the City, one can estimate a base proportion of the City population that participates in a variety of recreational activities, and how many times per year on average they engage in such activities.

Then, residents within the City were divided into one of four categories: 1) near a major park but not near a river, 2) near a river but not near a major park, 3) near a major park and a river, 4) not near

[9] Unit Day Values used in this report are taken from a 2009 Philadelphia Parks Alliance report, which reported on the direct use value of parks within the City: "How Much Value Does the City of Philadelphia Receive from its Parks and Recreation System," Philadelphia Parks Alliance (June 2008). See also: "Updated Outdoor Recreation Use Values on National Forests and Other Public Lands," US Department of Agriculture (2005).

[10] See Appendix A for additional detail on these calculations.

[11] The National Park Service requires that states prepare SCORPs every five years. "Outdoor Recreation in Pennsylvania Resident Survey," Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009).

a major park or a river (see Figure 2.1).[12] Currently, 324,000 residents within the City live within a half-mile of a significant outdoor amenity in the form of a major park.[13] If a fully connected waterfront greenway were to be built, **an additional 98,000 residents would now be within a half-mile of a significant outdoor amenity**, thus representing a tripling of the number of people who would be near such an amenity, from 50,000 to 148,000.[14]

Figure 2.1 – Distribution of Residents within the City Based on Distance to Major Parks and Rivers (Near = within ½ mile)

		Near River	Not Near River	Total
Near	Park	50,000	274,000	324,000
Not Near	Park	98,000	1,005,000	1,103,000
	Total	148,000	1,279,000	1,427,000

Source: US Census Bureau (2009), Econsult Corporation (2010)

The addition of open space as part of the Atlanta BeltLine project was found to increase by 50 percent the likelihood of outdoor recreation among residents of neighborhoods within a half-mile of the open space parts of the Atlanta BeltLine.[15] The analogous population in Philadelphia would be those who live near a river but not near a major park (i.e. the addition of a greenway makes them newly near a significant outdoor amenity). Therefore, though it is unknown how much use a fully connected waterfront greenway in Philadelphia would

[12] These population estimates were based on 2009 US Census Bureau data to the Census Block Group level. Half-mile buffers were drawn around the Delaware and Schuylkill Rivers, as well as Fairmount Park, Pennypack Park, Cobbs Creek Park, Roosevelt Park, and Tacony Park. If a Census Block Group was fully contained within a buffer, the entire population for that Census Block Group was included; if it was partially contained within a buffer, it was assumed that the distribution of population within that Census Block Group was uniform, such that a percentage of that Census Block Group's population was included commensurate with the percentage of that Census Block Group's land area that was contained within the buffer.

[13] A half-mile is a distance used in a recent study by Georgia Institute of Technology on the health impacts of the Atlanta BeltLine, and was based on an Atlanta-area study funded by the Robert Wood Johnson Foundation that found that people walk approximately a half-mile to access parks. Therefore, for purposes of assuming regular active use, a half-mile is used to connote "nearness." "Atlanta BeltLine Health Impact Assessment," Georgia Institute of Technology (June 2007); "Neighborhood Parks and Active Living," Emory University (June 2008).

[14] See Appendix B for a "heat map" of the City produced by Walk Source, which suggests that a number of neighborhoods adjacent to a river are presently relatively distanced from commercial and recreational amenities.

[15] "Atlanta BeltLine Health Impact Assessment," Georgia Institute of Technology (June 2007).

generate, the net new increase observed in Atlanta is most applicable to this proportion of the population. To be conservative, it was assumed for this proportion of the population that the new waterfront greenway would capture recreational activity equivalent to a lower estimate of current recreational levels: 40 percent rather than 50 percent. It was further assumed, to be conservative, that the equivalent percentages for the other three categories would be 20 percent for residents near a major park and a river, 5 percent for residents near a major park but not a river, and 5 percent for residents not near a major park or a river (see Figure 2.2).[16]

Figure 2.2 – Assumed Recreational Activity Enjoyed on a Fully Connected Greenway, as a Percentage of Current Recreational Levels, Based on Distance to Major Parks and Rivers (Near = within ½ mile)[17]

		Near River	Not Near River
Near	Park	20%	5%
Not Near	Park	40%	5%

Source: Georgia Institute of Technology (2007), Econsult Corporation (2010)

The types of activities that could take place on or near a waterfront greenway were considered, and the SCORP survey results served as a baseline amount of recreational activity within the City for these various activity types, from which recreational activity levels for the greenway

[16] Ultimately, though these percentages are based on other, similar studies, such as the Atlanta BeltLine Health Impact Assessment, there is no way to know what net new actual use will be as a proportion of current activity levels, absent extensive primary research. Additional, primary research may yield better assumptions, and will likely lead to higher estimates. Therefore, for the purposes of this report, assumptions are purposely conservative, and results rounded accordingly.

[17] Some of these uses on the greenway will be net new uses (i.e. over and above what users are currently engaging in), and some will consist of current uses, some on existing waterfront greenway space and some on other recreational space, that are being switched over to the new waterfront greenway.

These differing percentages account for the relative behavioral changes that are anticipated to occur upon implementation of a fully connected waterfront greenway. For example, a family living within walking distance of the new amenity may enjoy it significantly more, as part of their regular routine of leisure activities, than a family for whom using the new amenity requires a distinct trip, while an individual may be more apt to use the new greenway to get in a half-hour of brisk walking if she lives near a section of the greenway than if she has to travel out of her way to use it. The highest percentages are assigned to residents and households who are not currently near a park but who are near a river, under the assumption that the addition of a fully connected waterfront greenway will have the highest impact, in terms of direct use, on this population than on any other population.

could be estimated, resulting in about 15 million total uses per year (see Figure 2.3).[18] The vast majority of these uses are walking or dog-walking (78 percent of the uses, or about one use per month for every resident of the City) and jogging or bicycling (17 percent of the uses, or about one use every four-and-a-half months for every resident of the City).[19]

Figure 2.3 – Total Recreational Uses by Activity Estimated to Take Place Each Year on a Fully Connected Waterfront Greenway (in Millions of Uses)

% Attributable to Greenway	*5.0%*	*40.0%*	*20.0%*	*5.0%*	
	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River	Total Recreational Uses
Walking or dog-walking	1.4	4.1	1.0	5.2	11.7
Jogging, running, or bicycling	0.3	0.9	0.2	1.1	2.6
All other uses	0.1	0.3	0.1	0.3	0.8
Total	1.8	5.2	1.3	6.7	15.1

Source: Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Finally, these activity counts are multiplied by Unit Day Values taken from the 2009 Philadelphia Parks Alliance report, yielding **an annual recreational value taking place on a fully connected waterfront greenway of about $28 million** (see Figure 2.4). This aggregate number is taken to

[18] As a point of reference, one existing portion of waterfront greenway, Schuylkill Banks, is currently responsible for at least 340,000 uses on an annual basis. See Appendix C for additional detail on how current usage on Schuylkill Banks was calculated.

[19] All other uses account for the remaining 5 percent or about one use every year for every resident of the City. The per-resident averages account for the likely distribution of uses among all residents of the City, many of whom may not use the waterfront greenway at all and some of whom may use it far more often than the average. The Bicycle Coalition of Greater Philadelphia estimates significant bicycle use on existing greenways in Philadelphia, relative to walking or jogging, so it is possible that bicycling estimates here are too low "Schuylkill Banks Trail Usage and Perception Assessment," Melior Group (October 2005). See Appendix D for additional detail on these calculations.

represent the quality of life benefit received each year by direct users from the direct use of the greenway.[20]

Figure 2.4 – Total Recreational Value by Activity Estimated to Take Place Each Year on a Fully Connected Waterfront Greenway (in $Millions)

% Attributable to Greenway		*5.0%*	*40.0%*	*20.0%*	*5.0%*	
	Unit Day Value	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River	Total Recreational Value
Walking	$1.47	$1.5	$4.2	$1.1	$5.4	$12.2
Jogging or running	$3.25	$0.5	$1.5	$0.4	$1.9	$4.2
Dog walking	$1.32	$0.5	$1.6	$0.4	$2.0	$4.5
Bicycling	$3.16	$0.5	$1.4	$0.4	$1.8	$4.0
Other uses	varies	$0.4	$1.0	$0.3	$1.3	$3.0
Total		$3.4	$9.7	$2.5	$12.4	$28.0

Source: Philadelphia Parks Alliance (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Bear in mind that this aggregate value includes only residents of Philadelphia; a large number of tourists are likely to also enjoy outdoor activities on a fully connected waterfront greenway, thus deriving recreational value (over and above the direct monetary expenditures they make within the City, which is discussed in Section 5). To be conservative, no dollar amount is estimated for this category of direct use benefit, although it is likely to be a very large number.

A not insignificant component of this category of benefits is the distribution of that benefit within the City. Much of the existing greenway space is immediately available to higher-income neighborhoods; **a fully connected waterfront greenway within the City would extend that**

[20] Because the vast majority of anticipated uses have lower Unit Day Values, the average Unit Day Value per use is less than two dollars. Should the fully connected waterfront greenway attract higher-value uses, or should peoples' willingness to pay increase over time, the total recreational value associated with uses of the greenway would be even higher.

amenity to a number of lower-income neighborhoods, thus making recreational opportunities more widely available to residents of those neighborhoods, improving their quality of life.

Thus, perhaps just as if not more significant than the scale of the health and quality of life benefits that accrue to Philadelphians as a result of the existence of a fully connected waterfront greenway is the distribution of those benefits: **many of those who are currently relatively distanced from the positive amenity that a greenway can provide as a place for enjoyable outdoor activity would now have more immediate access to such a resource**. As noted above, it is estimated that a fully connected waterfront greenway in the City would increase the number of residents who live within a half-mile of open space from 324,000 (those who live near a major park) to 422,000 (those who live near a major park and/or a river), an increase of 98,000, encompassing 44,000 households (see Figure 2.5). Notably, this population includes a relatively high proportion of people aged 65 and older, for whom easy access to exercise can have significant direct use and health care benefits, and a relatively high proportion of households without cars, which would therefore enjoy considerable mobility gains as a result of proximity to a greenway.

Figure 2.5 – Selected Demographic Information Regarding the Estimated 98,000 Residents Who Do Not Live Near a Major Park and Who Do Live Near a River, and Whose Outdoor Recreational Options Would Be Greatly Enhanced by a Fully Connected Waterfront Greenway

	Newly Near Outdoor Recreational Amenity (i.e. Not Currently within ½ Mile of a Major Park, But within ½ Mile of a River)		Philadelphia as a Whole	
Population	97,836		1,547,297	
Population Age 65+ (% of Population)	12,740	13%	186,883	12%
Households	43,955		661,575	
Households w/o Cars (% of Households)	23,000	52%	191,729	29%
Average Household Income	$43,238		$50,673	
Average Per Capita Income	$19,762		$20,876	

Source: US Census Bureau (2009), Econsult Corporation (2010)

These notions of equity and access were an important component of a report conducted by the Georgia Institute of Technology's Center for Quality Growth and Regional Development on the Atlanta BeltLine, which proposes to replace an old rail corridor with a connected loop of parks, trails, transit, and residential and commercial development, and in doing so may have significant impact for neighborhoods once cut off by rail lines that would now have access to outdoor amenities, transportation nodes, and employment and entertainment options.[21] Similarly, depending on where and how a fully connected waterfront greenway is built in Philadelphia, neighborhoods once saddled with the remnants of heavy industry may now be connected to open space and to other recreational resources, making a significant outdoor amenity newly available to 98,000 residents and 44,000 households.

[21] "Atlanta BeltLine Health Impact Assessment," Georgia Institute of Technology (June 2007).

3.0 HEALTH AND QUALITY OF LIFE IMPACT – INCREASED COMMUTING OPTIONS, REDUCED AUTOMOBILE USAGE

The existence of a fully connected waterfront greenway within the City of Philadelphia could have a number of positive effects in terms of commuting options. First, some current drivers may switch to active forms of commuting on greenways, which would reduce congestion and pollution for others. Second, those who switch may enjoy a more pleasant commute and improved mental health outcomes. Third, people who currently walk or bike would be able to do so in the safer environment of a dedicated, car-free route.

There is an increasing body of literature associated with the benefits of active commuting, due to the growing epidemic of obesity in this country, as well as to heightened environmental awareness, higher gas prices, and increased congestion. This literature suggests that some or all of the aforementioned benefits may be accrued should the City implement a fully connected waterfront greenway.

First, **a greenway does encourage switching from driving to active forms of commuting, particularly if it is fully connected**. Wendel-Vos (2007) stated that areas with greater connectivity had higher frequencies of walking and bicycling,[22] while Vuori (1994) found that significant proportions of commuters were willing to switch to active commuting if provided safe passages for doing so.[23] Nelson and Allen conducted a cross-sectional analysis of 18 US cities and found a positive association between the presence of bikeway facilities and the share of commuters commuting by bicycle.[24]

Second, **greenways provide bicyclists in particular with safer alternatives than roads and highways, which are designed for and dominated by cars**.[25] Vuori (1994) considered greenways to be an important way to encourage increased active commuting; said another way, perception of safety is a key prerequisite for most people who are otherwise willing to

[22] "Potential Environmental Determinants of Physical Activity in Adults: a Systematic Review," Obesity Reports (2007).

[23] "Physically Active Commuting to Work – Testing Its Potential for Exercise Promotion," Medicine and Science in Sports and Exercise (1994).

[24] "If You Build Them, Commuters Will Use Them: Association between Bicycle Facilities and Bicycle Commuting." Transportation Research Record (1997).

[25] The impacts of a fully connected waterfront greenway on commuter safety are multi-faceted. On the one hand, bicyclists are vastly safer on car-free roads such as greenways. On the other hand, not all of a bicycle commuter's trip will take place on a greenway, so more bicycle commuters may mean more opportunity for accidents during the non-greenway portions of their commutes. Consider also that fewer cars means fewer car accidents, but also that more bicycle commuters on greenways may lead to an increase in accidents on greenways, between bicycle commuters or between bicyclists and pedestrians.

change their commuting habits.[26] Gotschi (2008) documented the dangers to bicyclists of sharing roads with cars that are much bigger, faster, and numerous,[27] while Retting (2003) explored a number of solutions to separate pedestrians from vehicular traffic that were successful in increasing pedestrian safety.[28] Additionally, to the extent that a fully connected waterfront greenway increases overall bicycle use within the City, there is a "safety in numbers effect": when bicycle usage doubles, the crash risk for each individual declines by one-third, according to Jacobsen (2003).[29]

Third, **switching from auto commuting to active commuting has significant health implications**. While active commuting has significant physical and emotional health benefits, which is explored in further detail in Section 4,[30] auto commuting is frequently considered one of the more stressful and unpleasant aspects of an individual's regular routine.[31]

Finally, **less auto-dependence yields positive environmental outcomes**, with benefits to the City and region as a whole and not just for those who begin to commute via the greenway. Friedman (2001) found that an alternative transportation plan that was implemented in Atlanta during the 1996 Olympics led to fewer acute asthma events, lower peak ozone concentrations, and higher air quality,[32] while Mason (2000) stated that mixed-use residential neighborhoods had significantly lower carbon emissions than more traditional, auto-oriented ones.[33]

How much actual health and quality of life impact associated with changes in commuting would derive from the existence of a fully connected waterfront greenway is difficult to know precisely, because of the qualitative nature of both elements of impact: how many people would switch from driving to bicycling, and what gains they would derive from the switch. As to what individual and aggregate gains are derived from these changes in commuting habits, much of this is covered in Section 2 (the enjoyment value of walking and bicycling) and Section 4 (the gains in health and the reductions in health care costs associated with more active forms of commuting).

[26] "Physically Active Commuting to Work – Testing Its Potential for Exercise Promotion," Medicine and Science in Sports and Exercise (1994).

[27] "Active Transportation for America," Rails-to-Trails Conservancy (2008).

[28] "A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes." American Journal Public Health (2003).

[29] "Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling," Injury Prevention (September 2003).

[30] Ohta (2007) found that active commuting was particularly positive for men in terms of mental well-being. "Effect of the Physical Activities in Leisure Time and Commuting to Work on Mental Health," Journal of Occupational Health (2007).

[31] Stutzer (2008) found that people with long commutes reported significantly lower subjective well-being, and that commuting generates the lowest level of positive affect and a relatively high level of negative affect. "Stress that Doesn't Pay: The Commuting Paradox," Scandinavian Journal of Economics (2008).

[32] "Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Asthma," Journal of the American Medical Association (2001).

[33] "Transport and Health: En Route to a Healthier Australia?" The Medical Journal of Australia (2000).

As to how many people would change their commuting habits, this question is further complicated by the fact that a number of key influencing variables are unknown at this time, particularly the quality of the greenway itself and of its connections to other routes. Nevertheless, one can approximate the impact by considering that, riding the wave of increased bicycle usage due to higher gas prices and increased congestion, the opening of dedicated bicycle lanes on Spruce and Pine Streets in Center City led to a doubling of bicycle traffic on those streets, according to the Bicycle Coalition of Greater Philadelphia.[34] In fact, according to the 2009 American Community Survey of the US Census Bureau, bicycle commuting in Philadelphia doubled from 2005 to 2008, and the City's percentage of commuters who bike is, at 1.6 percent, the highest among big cities and three times the national average.[35]

Source: Bicycle Coalition of Greater Philadelphia

[34] "Keeping Philly's Wheels Turning," PlanPhilly (June 7, 2010); "Bicycle Coalition: What Our Stats Really Mean," Philadelphia Daily News (April 28, 2010).

[35] "Philadelphia is No. 1 among Big Cities for Bicycle Commuting," Bicycle Coalition of Greater Philadelphia (October 1, 2009).

This is consistent with "Double Dutch," the Bicycle Coalition's own report in 2008, which found that bicycle use at counted locations doubled from 2005 to 2008.[36] The report also estimates that there are 11,000 bicycle commuters,[37] and that bicycle trips represent 6 percent of trips in Center City[38] and 2 percent of trips citywide.[39]

It is estimated that there are 183,000 households in the City that live within a mile of a river.[40] If it is assumed that they currently commute by bicycle at the same rate as the City as a whole (i.e. 1.6 percent),[41] and that the addition of a fully connected waterfront greenway would increase that rate by 50 percent (vs. the 100 percent increase that was seen on Spruce and Pine Streets after the addition of dedicated bicycle lanes),[42] and that the average trip length is 3 miles (the citywide average is 3.47 miles),[43] then that translates into about **1,500 new bicycle commuters and about 1 million miles no longer traveled by car**, to say nothing of non-commuting trips that are converted from car to bicycle (see Figure 3.1).[44] This is a helpful

[36] Counted locations included Schuylkill River bridge crossings, Broad and Chestnut, and 38th and Spruce. Usage at these intersections doubled from 1990 to 2005, and doubled again from 2005 to 2008, aided in part by an extended SEPTA strike in 2005 and the completion of the first portion of the Schuylkill River Trail between the Philadelphia Art Museum and Locust Street in 2004. "Double Dutch: Bicycling Jumps in Philadelphia," Bicycle Coalition of Greater Philadelphia (2008).

[37] 11,000 commuters = 14.7 million commuter trips in the Philadelphia five-county region; x 0.9% bicycle mode share, as cited in "Transportation for the 21st Century: Household Travel Survey," Delaware Valley Regional Planning Commission (2001); x 29% bicycle trips that are for work purposes; x 57 percent of the region's bicycle commuters living in the City; ÷ 2 legs per trip.

[38] Six percent = 23,300 trips made by bicycles in Center City and surrounding neighborhoods out of 400,000 total trips, as cited in "2005 Motorized and Non-Motorized Travel Survey," Delaware Valley Regional Planning Commission (April 2008).

[39] "Transportation for the 21st Century: Household Travel Survey," Delaware Valley Regional Planning Commission (2001).

[40] In the previous section, nearness to the waterfront greenway was defined as being within a half-mile, as defined by a distance to which people are willing to walk regularly. Since this section deals with potential bicyclists, nearness was defined as being within a mile, to account for a bicyclist's willingness to go further than a pedestrian to connect to the greenway.

[41] It is likely that households that are further from Center City would commute by bicycle at a lower rate, while households that are closer to Center City would commute by bicycle at a higher rate.

[42] This seems a fair assumption: given the relatively low proportion of such households that own cars, a new greenway is likely to induce some to commute by bicycle.

[43] A 3-mile commute means that the average round-trip commute is assumed to be 6 miles per day. This is then conservatively multiplied by 125 days per year, to account for non-workdays, bad weather days, and other days in which car or other travel is required. "Bicycling in the Delaware Valley in 2005," Delaware Valley Regional Planning Commission (2007).

[44] It is estimated that there are a total 75,000 bicycle trips per day within the City, of which commuting trips represent less than a third, since 11,000 commuters x 2 legs per trip = 22,000 commuting trips and therefore 53,000 non-commuting trips. 75,000 daily trips = 133,000 daily trips within the region, as cited in "Bicycling in the Delaware Valley in 2005," Delaware Valley Regional Planning Commission (2007); x 57 percent of the region's bicycle commuters living in the City.

While it is likely that the existence of a fully connected waterfront greenway within the City would increase the number of non-commuting trips as well as the number of commuting trips, it is assumed that most of those new non-commuting

contribution to the City's Greenworks Philadelphia goal of lowering vehicle miles traveled by 10 percent by 2015.

Figure 3.1 – Estimated Aggregate Miles Not Driven Each Year As a Result of Car Commuters Switching to Bicycling Because of the Existence of a Fully Connected Waterfront Greenway

183,000 households that live within a mile of a river

x 1.6 percent presently commutes by bicycle

x 50 percent increase in bicycle commuting as a result of a greenway

x 3 mile average one-way trip length

x 2 trips per day

x 125 days commuting by bicycle per year

= 1.1 million miles per by bicycle that used to be by car

Source: Bicycle Coalition of Greater Philadelphia (2008), Delaware Valley Regional Planning Commission (2008), Econsult Corporation (2010)

It may be that such assumptions – that a waterfront greenway would increase bicycling commuting by 0.8 percentage points (i.e. from 1.6 percent to 2.4 percent) among the households that live within one mile of a river - prove to be too conservative, and that the number of people who switch from car commuting to bicycle commuting is far higher. As a point of reference, a 1992 greenway plan in the City of Portland, Oregon increased the proportion of commuters who bike from 1.2 percent in 1990 to 7 percent in 2007 (and 12 percent in the downtown area), resulting in Portland being named the most bike friendly city in the US (and 2nd in the world) in 2008.[45] Meanwhile, bicycle commuting nearly doubled in St. Louis from 2000 to 2008 due in part to the creation of a Great Rivers Greenway District.[46]

trips are not substituting for car trips but are purely leisure-oriented. Therefore, to be conservative, the only net reductions in car trips that are assumed are associated with commuters switching from driving to bicycling.

Furthermore, estimating new bicycle commuters as the difference between current bicycle commuting rates and expected future bicycle commuting rates as a result of the existence of a fully connected waterfront greenway means that not being included are current bicycle commuting trips that take place on existing greenway space, such as the Schuylkill River Trail. Since this engagement is intended to measure the impact of a fully connected waterfront greenway over no greenway at all, rather than over the existing inventory of greenway space, excluding current bicycle commuting trips on existing greenway space conservatively lowers the estimate.

[45] "North America's Most Bike-Friendly Cities," Forbes Traveler (June 19, 2008).

Consider also that Nelson and Allen (1997) estimated from a regression model of the bicycling patterns of 20 cities that for each additional mile of bikeway per 100,000 residents, bicycle commuting increased by 0.075 percent.[47] This relationship suggests that adding greenways along Philadelphia's 50 miles of waterfront would garner a 3.8 percentage point increase in bicycle commuting, well above the assumed 0.8 percentage point increase. Finally, as was noted before, a higher proportion of households near a river are without cars, when compared to the City as a whole; this may mean there is even more willingness to switch over to bicycle commuting should a viable option, such as a fully connected waterfront greenway, become available to do so.[48]

Nevertheless, even our conservative assumption of miles not driven creates **environmental and productivity gains to individuals and to the City as a whole, in the form of reduced congestion and pollution**. Based on a methodology created by Econsult in 2010 to estimate the environmental implications of PhillyCarShare's impact on the Philadelphia region in terms of fewer miles driven,[49] it is estimated that 1,500 people switching away from car commuting and driving an aggregate 1 million fewer miles would yield a number of positive environmental outcomes each year:[50]

1. Direct decreases in car travel from new bicycle commuters is estimated to result in CO2 emissions reduced of 440 tons; externality cost reductions associated with all emission reductions of $37,000; 49,000 gallons of gasoline not consumed and $114,000 not spent on gasoline; and 2,600 barrels of oil not refined (see Figure 3.2).

2. Direct decreases in car travel also create marginal decreases in congestion for all drivers, resulting in 22,000 fewer hours in travel delay; 14,000 gallons of fuel not consumed; and at least $62,000 in congestion costs avoided within the Philadelphia region (see Figure 3.3).[51]

[46] "St. Louis Named Bronze-Level Bicycle Friendly Community," Missouri Bicycle and Pedestrian Federation (October 19, 2009).

[47] "If You Build Them, Commuters Will Use Them: Association between Bicycle Facilities and Bicycle Commuting." Transportation Research Record (1997).

[48] Here, in particular, is where primary research, in the form of direct surveying of working households within a mile of a river, will prove useful in better gauging actual behavioral changes resulting from the existence of a fully connected waterfront greenway.

[49] The Economic and Environmental Impact of PhillyCarShare in the Philadelphia Region," Econsult Corporation (February 15, 2010).

[50] See Appendix D for additional detail on the methodology employed to arrive at these estimates, and on estimated results.

[51] I.e. the costs associated with congestion, such as lost productivity from travel delays. The congestion estimates are likely to be far too low, since reductions in miles traveled do not have a linear effect on congestion: during off-peak times, reducing miles traveled may have little or no effect on congestion, while reducing miles traveled during peak times may have a significant effect on congestion. Since the vast majority of net new bicycle commuting trips would be

Figure 3.2 – Estimated Environmental Impacts Each Year As a Result of Fewer Miles Driven within the City Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Total Miles Not Driven	1,098,000
CO2 Emissions Reduced (tons)	442
Cost of all Emissions Reduced	$37,000
Gasoline Not Consumed (gallons)	49,000
$ Not Spent on Gasoline	$114,000
Oil Not Consumed (barrels)	2,600

Source: Econsult Corporation (2010), Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008)

Figure 3.3 – Estimated Environmental Impacts Each Year As a Result of Less Congestion within the Region Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Travel Delay Averted (hours)	22,000
Excess Fuel Not Consumed (gallons)	14,000
Congestion Costs Avoided	$62,000

Source: Econsult Corporation (2010), Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008)

Notably, the benefits of having enhanced commuting options are widely distributed. Individuals who are near enough to the greenway to use it on a regular basis for commuting purposes gain from having this new commuting option available to them, a not insignificant benefit for the high percentage of such residents who do not own cars. Active commuting confers upon them health-related benefits, as well, accruing benefits not only to those

taking place during peak times, it is likely that removing a certain amount of miles driven during those times would have a disproportionately large impact on congestion.

Notably, it was determined that the City of Atlanta's congestion dropped 36 percent from 2007 to 2008 as a result of the commencement of the implementation of the Atlanta BeltLine, in conjunction with an increased emphasis on the use of public transportation through the addition of park-and-ride facilities. "National Traffic Scorecard 2009 Annual Report," INRIX (2010).

individuals but to employers and to the health insurance groups of which they are a member. By no longer driving, these new bicycle commuters also take cars off the road, reducing congestion for the remaining drivers and reducing pollution within the region as a whole, with attendant economic, environmental, and quality of life benefits for all.

4.0 HEALTH, QUALITY OF LIFE, AND ECONOMIC IMPACT – REDUCED HEALTH CARE COSTS AND SICK DAYS

Unhealthiness due to inactivity is a growing problem in the US, with significant quality of life and economic consequences. The National Health Statistics Group estimates that inactivity results in 2.4 percent to 5.0 percent of national health care expenditures, or as mush as $72 billion per year.[52] According to the National Center for Health Statistics, over a third of Americans are obese.[53]

Even **manageable amounts of physical activity and minor changes in daily habits can make a difference**. Mason (2000)[54] found that 30 minutes of brisk walking per day was enough to create a number of positive health benefits, while Hu (2007)[55] and Gordon-Larsen (2009)[56] connected physical activity to reductions in specific heart-related problems for both men and women, and Wennberg (2010) found that car commuting was statistically associated with a person's risk of myocardial infarction.[57] While increased physical activity can increase the risk of injury for older adults, lack of physical activity is also a risk factor, according to Hoidrum (2001).[58]

Outdoor amenities such as waterfront greenways are particularly helpful in these regards. Godbey (2009) found outdoor recreation helped reduce stress levels, that over 75 percent of all visits to primary care physicians are for stress-related complaints and disorders, and that people with high stress levels are more at risk for obesity, heart disease, and some cancers,[59] while Bedimo-Rung (2005) found a wide range of participants who experienced stress reduction and other psychological benefits from outdoor recreation.[60] Bodin and Hartig (2003) and Hartig (1991) in particular have made the connection between natural settings and stress reduction,

[52] "Cost Effectiveness of Community-Based Physical Activity Interventions," American Journal of Preventative Medicine (2008).

[53] "NCHS Data on Obesity," National Center for Health Statistics (2009).

[54] "Transport and health: en route to a healthier Australia," Medical Journal of Australia (2000).

[55] "Occupational, Leisure Time, and Commuting Physical Activity in Relation to Cardiovascular Mortality among Finnish Subjects with Hypertension," American Journal of Hypertension (2007).

[56] "Active Commuting and Cardiovascular Disease Risk," Archives of Internal Medicine (2009).

[57] "Reduced Risk of Myocardial Infarction Related to Active Commuting: Inflammatory and Haemostatic Effects Are Potential Major Mediating Mechanisms," European Journal of Cardiovascular Prevention and Rehabilitation (2010).

[58] "Leisure-time Physical Activity Levels and Changes in Relation to Risk of Hip Fracture in Men and Women," American Journal of Epidemiology (2001).

[59] "Outdoor Recreation, Health, and Wellness: Understanding and Enhancing the Relationship," Resources for the Future (2009).

[60] "The Significance of Parks to Physical Activity and Public Health," American Journal of Preventive Medicine (2005).

finding more psychological restoration and greater reduction of mental fatigue for those exercising in parks and waterfront greenways than in urban settings.[61]

Proximity to outdoor amenities matters when it comes to encouraging recreational activity: Corti (1998) found that for people with limited access to open space, walking decreased by half.[62] Thus, increasing greenway space within the City of Philadelphia can lead to increased physical activity for Philadelphians, with significant positive health and economic implications.

"Time spent with nature has been linked to decreased anger and fear, increased mental alertness, and feelings of well-being and energy, according to the American Journal of Preventive Medicine. It's no wonder that people who exercise outdoors tend to work out more often and more vigorously than those who don't, accordingly to the Outdoor Foundation's 2009 report on participation in outdoor recreation." – "Exercise Goes Back to Nature," Independence Blue Cross Update (August 2010).

Health care cost reductions for people who engage in physical activity, defined as moderate to strenuous exercise three or more times a week for a half-hour or more, take place on a number of levels:

1. **Direct health care costs**. There is less spent immediately as a result of any short-term health care needs. Pratt (2000) estimates this annual cost per person to be $330, including preventive, diagnostic, and treatment services.[63]

2. **Indirect health care costs**. There is less spent over a lifetime as a result of reduced risk of chronic illnesses. Chenowith (2005) estimated the ratio of indirect to direct medical costs to be 6:1, when accounting for pain and suffering, reduction in quality of life, and shorter life expectancy.[64]

3. **Direct workers' compensation costs**. Several studies indicate that physically inactive people are more likely to incur workers' compensation injuries and have longer recovery

[61] "Does the Outdoor Environment Matter for Psychological Restoration Gained through Running?" Psychology of Sports and Exercise (2003); "Restorative Effects of Natural Environment Experiences," Environment & Behavior (1991).

[62] "The Relative Influence of, and Interaction between, Environmental and Individual Determinants of Recreational Physical Activity in Sedentary Workers and Home Makers," University of Western Australia (1998).

[63] "Higher Direct Medical Costs Associated with Physical Inactivity," The Physician and Sportsmedicine (2000).

[64] "Physical Inactivity Cost Calculator: How the Physical Inactivity Cost Calculator was Developed," College of Health and Human Performance (2005).

periods. Chenowith (2005) estimates direct workers' compensation cost savings from physical activity at $10 per person.[65]

4. **Indirect workers' compensation costs**. In addition to direct costs, workers' compensation claims impose an indirect administrative cost on employers. Chenowith (2005) estimates that the ratio of indirect to direct workers' compensation costs exceeds the ratio of indirect to direct health care costs.[66]

5. **Lost productivity**. Physical inactivity contributes not only to absenteeism (not present for work) but also what has become known as "presenteeism" (present for work but not fully functioning). Chenowith (2005) bases estimates of lost productivity costs on median wages, so a Philadelphia equivalent would yield costs per person of $218 for absenteeism and $1,700 for presenteeism.[67]

Together, these five categories of costs associated with physical inactivity represent the aggregate loss to individuals, to their employers, and to the overall economy as a result of the negative health-related effects of not being physically active. To the extent that a fully connected waterfront greenway facilitates physical activity, by facilitating active forms of commuting and leisure, it can be said to contribute to the reduction of these costs to the City and its residents and businesses.

To arrive at an estimate of health care cost reductions associated with exercise taking place on a fully connected waterfront greenway, SCORP survey data was used to provide an understanding of the percentage of people who exercise regularly enough to derive health benefits, and a percentage of that exercise that took place within outdoor recreational amenities such as parks and open space. A literature review conducted by Econsult for GreenSpace Alliance and the Delaware Valley Regional Planning Commission yielded an aggregation of valuation studies of costs related to health care associated with physical activity, resulting in minimum, mean, and maximum cost savings per active exerciser.

It is conservatively assumed a fully connected waterfront greenway would yield uses commensurate with five percent of the minimum estimate of this benefit across the City, deriving both from net new uses made more convenient by proximity and by accounting for current uses on existing outdoor recreation space.[68] Even this conservative assumption yields

[65] Ibid.

[66] Ibid.

[67] Ibid.

[68] Said another way, five percent of the health care cost savings benefit associated with exercise taking place on open space is estimated to be attributable to active uses of the new waterfront greenway. Five percent was chosen to represent a conservatively low proportion. Knowing this proportion at a higher level of precision would require some primary research and likely some form of longitudinal study, to measure a number of relevant drivers of health care cost savings:

overall annual health care cost savings associated with the greenway of about $20 million (see Figure 4.1).[69] This number can be taken to represent the annual health care cost savings to direct users associated with direct use of the newly available greenway.[70]

Figure 4.1 – Estimated Health Care Cost Savings Each Year As a Result of Physical Activity Taking Place on a Fully Connected Waterfront Greenway (in $M)

	Min	Mean	Max	Health Care Cost Savings from Greenway (Attributed with 5% of Minimum Benefit)
Direct Medical Care Costs	$43.1	$66.4	$89.8	$2.2
Indirect Medical Care Costs	$129.2	$199.2	$269.3	$6.5
Workers Compensation Costs	$0.8	$1.4	$1.7	$0.0
Indirect Worker Compensation Costs	$3.4	$5.6	$6.7	$0.2
Lost Productivity	$227.8	$268.1	$295.2	$11.4
Total	$404.3	$540.7	$662.6	$20.2

Source: Econsult Corporation (2010), US Census Bureau (2009), various studies

In fact, it is possible that the greenway would lead to even higher usage patterns than what this conservative estimate is based on. For some residents, net new activity levels may not change much, but particularly for the 98,000 residents and 44,000 households near a river but not near a major park, newly available outdoor recreational space may facilitate a much higher increase in physical activity: as noted previously, the addition of open space as part of the Atlanta

- How much active use would take place on the waterfront greenway (i.e. as opposed to other locations for exercise, such as non-waterfront parks and trails as well as gyms and streets);
- What would be the distribution of such uses in terms of the exercise patterns of the users (someone shifting from zero to five uses per month is likely to enjoy significantly more health benefit than someone shifting from 20 to 25 uses per month); and
- What difference does active use make in terms of health quality and health care costs (which takes into account other factors such as diet, preventive care, and the cost of health care services).

[69] See Appendix E for additional detail on these calculations.

[70] The figure is annual in that, in the literature, future gains associated with better health from active use have been discounted back to the present. That cost savings is enjoyed not only by individual users but also their employers and, in cases in which individuals are part of private or public health insurance groups, other group members.

BeltLine project was found to increase by 50 percent the likelihood of outdoor recreation among residents of neighborhoods within a half-mile of the open space parts of the Atlanta BeltLine.[71] And, that activity may accrue disproportionately higher gains, given the high incidence rate of health-related risk factors within the City and the relatively high proportion of residents near a river but not currently near a park who are aged 65 or older.[72]

Source: Greater Philadelphia Tourism Marketing Corporation

[71] "Atlanta BeltLine Health Impact Assessment," Georgia Institute of Technology (June 2007).

[72] Incidence rates for health-related risk factors are comparable to national averages for residents within the Philadelphia region: heart disease (10.4 percent vs. 12 percent), high blood pressure (30.2 percent vs. 32 percent), high cholesterol (26.9 percent vs. 16 percent), obesity (61.7 percent vs. 68 percent), and diabetes (10.4 percent vs. 10 percent). Philadelphia region data is from Public Health Management Corporation: "Heart Health among Adults (18+) in Southeastern Pennsylvania," Public Health Management Corporation (February 1, 2010). US national average data is from the Centers for Disease Control and Prevention website, as of August 2010.

5.0 ECONOMIC IMPACT – INCREASED RECREATIONAL AND TOURISM EXPENDITURES

A fully connected waterfront greenway is expected to generate significant use and expenditures from both local residents and outside tourists. Importantly for the City of Philadelphia, tourism is a key engine for local economic growth. It is a major employer within the region, and it generates business sales and tax revenues from outsiders, making it an exporter of goods and services and thus a significant avenue for growing the local economy.

If a fully connected waterfront greenway can bring tourists into the City, their spending represents net new dollars for the City and its businesses. Mundet (2010)[73] suggests just that: that greenways, especially well-connected ones, create recreational networks that serve as major draws for tourists and their purchasing power. Furthermore, local residents, when faced with a significant increase in outdoor recreational resources, may switch from other recreational pursuits or from active recreational activities outside the City, leading to net new expenditures on recreation and related retail and entertainment, as suggested by Mundet (2010)[74] and Graefe (2009).[75]

This has been the case so far with recent greenway initiatives in Atlanta, Portland, and St. Louis, where regional connectivity has led to significant usage among regional residents as well as tourists traveling from further distances. Connected greenways ringing the core of these three regions create recreational opportunities for city residents traveling to the periphery of city limits and for tourists and suburban residents traveling into the city to partake of this outdoor amenity.[76]

This net new spending represents potential economic activity for and within the City of Philadelphia, which then creates a spillover effect via indirect and induced expenditures. This composition and scale of economic impact can be expressed in the form of total expenditures supporting total employment and total earnings, and generating total local tax revenues.[77]

Given the many outstanding complementary amenities available to tourists to Philadelphia – a world-class park system, a number of different kinds of bicycle-related draws, a dense historic district that can be easily traversed without a car – it is anticipated that the addition of a fully

[73] "Greenways: A Sustainable Leisure Experience Concept for Both Communities and Tourists," Journal of Sustainable Tourism (2010).

[74] Ibid.

[75] "Outdoor Recreation in Pennsylvania Resident Survey," The Department of Natural Resources, Commonwealth of Pennsylvania (2009).

[76] St. Louis' main tourism website lists its greenway as the third of 25 "things to do" in St. Louis.

[77] See Appendix F for additional detail on our economic and fiscal impact methodologies.

connected waterfront greenway would increase tourism activity, both from existing tourists staying longer and enjoying more activities as well as from new tourists specifically induced to Philadelphia as a result of this new amenity.

Source: Greater Philadelphia Tourism Marketing Corporation

It is difficult to extrapolate results from other greenway additions in other cities to what might happen in Philadelphia, as well as to isolate the impact within the City of a waterfront greenway on overall tourism (even if the waterfront greenway was in place and historical data already existed, one would have to rely on extensive surveying to infer from tourist responses how much aggregate tourism activity could be assigned to the greenway's existence). Instead, consider what the economic and fiscal impact would be to the City if a conservatively low proportion of tourism activity was assigned to greenways. If it is assumed that a fully connected waterfront greenway would generate net new tourism activity in the amount of one percent of all tourism activities within the City, this results in **over $50 million in total expenditures within the City, supporting about 400 jobs and about $15 million in earnings, and generating about $4 million in local and state taxes**, based on recent economic and fiscal impact calculations performed by the Greater Philadelphia Tourism Marketing Corporation of local tourism activity (see Figure 5.1).

Figure 5.1 – Estimated Direct, Indirect/Induced, and Total Impact Each Year within the City of Philadelphia Associated with Tourism within the City That is Attributable to a Fully Connected Waterfront Greenway, Assuming a One Percentage Point Proportion Attributable to a Fully Connected Waterfront Greenway[78]

	Direct	Indirect/Induced	Total
Expenditures (in $M)	$33.2	$20.1	$53.3
Employment	277	105	382
Earnings (in $M)	$9.2	$6.7	$15.6

	Federal	State	Local	Total
Taxes (in $M)	$4.2	$1.8	$2.1	$8.0

Source: Greater Philadelphia Tourism Marketing Corporation (2009), Econsult Corporation (2010)

Such an assumption conservatively does not account for another, potentially significant importation of economic activity: knowledge workers, knowledge work, and knowledge firms. Increasingly, in expending resources to create outdoor amenities such as waterfront greenways, regions do so to compete not only to win tourists but also to attract and retain employees and employers. **Given the importance ascribed to recreational amenities by entrepreneurs and knowledge workers considering where to locate themselves, it is likely that the existence of a fully connected waterfront greenway would lead to significant addition of economic activity to the City**.[79] As a point of reference, it is estimated that Millennium Park, Chicago's premier outdoor amenity, is responsible for one-quarter of all new retail, commercial, and residential development that has taken place in the East Loop since the park's creation.[80] Similarly, greenway advocates in Philadelphia intend for a fully connected waterfront greenway to serve as a tool for business and employee attraction.

Greenways can also encourage environmentally sustainable commercial development: a recent New York Times article makes a connection between greenway efforts in Pittsburgh and that city's emphasis on green building.[81] Consider also the example of Battery Park, which was

[78] Based on 2008 estimates made by Tourism Economics for Greater Philadelphia Tourism and Marketing Corporation. "The Economic Impact of Tourism in Greater Philadelphia," Tourism Economics (May 2009).

[79] See, for example, "Quality of Place and the New Economy," Richard Florida (2000).

[80] "2009 Rudy Bruner Award: Silver Medal Winner - Millennium Park," Rudy Bruner Foundation (2010).

[81] "Arts and Science Remake the Steel City," New York Times (July 20, 2005).

essentially deserted and dilapidated until 1994, when the Battery Park City Parks Conservatory was founded; in 1998, the renovated harbor promenade was opened, and the park now hosts 4 million visitors per year, the most traffic per square foot of any park in New York City.[82] The redevelopment of Baltimore Inner Harbor, which was initially intended to be used primarily by Baltimoreans, is estimated to have generated $60 million in new tax revenue, supported 50,000 new jobs, and produced a previously non-existent tourism industry that now adds $4 billion to the Baltimore economy.[83]

Furthermore, while it is still too early to know what impact greenway projects have had in cities like Atlanta and St. Louis, it is interesting to consider the geographic and programmatic similarities to a potential waterfront greenway in Philadelphia and these projects, which are positioned as ringing an urban area and therefore serving as an outward draw for local residents and an inward draw for suburban residents and other visitors. Notably, a recent Prevention Magazine ranking of "top walking cities" included nine with recently implemented or conceived waterfront greenway plans (see Figure 5.2).[84]

Figure 5.2 – Cities on Prevention Magazine's 2010 Top Walking Cities Ranking That Have Recently Implemented or Conceived Waterfront Greenway Plans

2. Boston
3. New York
5. Chicago
6. Washington DC
9. Portland
10. Pittsburgh
12. Minneapolis
15. Milwaukee
16. Baltimore

Source: Prevention Magazine (2010)

[82] From the Battery Park City Parks Conservatory website, as of July 2010.

[83] "Business Climate, Inner Harbor, Maglev Top Priorities," Baltimore Business Journal (May 19, 2010), "On the Path to Revitalizing Harborplace," Baltimore Business Journal (May 14, 2010), "The Inner Harbor Story," Urban Land (April 2003), "Take Me to the River: Designing the Intimate Waterfront," Master's Thesis by Gabriel Andrew Kruse for Virginia Polytechnic Institute and State University Department of Landscape Architecture (March 22, 2006).

[84] From the Prevention Magazine website, as of July 2010.

6.0 ECONOMIC IMPACT – INCREASED PROPERTY VALUES

A fully connected waterfront greenway would represent a major recreational amenity and infrastructural investment for the City of Philadelphia. One of the purposes of making these types of outlays is to create a virtuous cycle whereby investments in desired amenities enhance the attractiveness of a location, thus increasing population and causing people to be willing to pay a premium to live near such an amenity. This can lead to economic growth and tax revenue generation, which can enable even more infrastructural investment. Increased property values thus represent another type of economic benefit of greenways that are of particular importance to the City, because they result in a gain to the City's relative status as a destination of choice. They also impart **wealth gains to individual property owners**.

Recent studies offer guidance on the nature and scale of this property value appreciation. The most analogous study for the purposes of this report is one conducted by Econsult in 2010 for the Pennsylvania Horticultural Society (PHS), which looked at the property value impact on neighboring parcels of conversions of abandoned or vacant industrial sites into green space.[85] Because much of the land that has been or would be taken up by a fully connected waterfront greenway is or was industrial and/or vacant in nature, it is likely the effect of such an infrastructure project would be most similar to what was observed in this study for PHS. In that study, it was found that there was a 0.7 percent "announcement effect," whereby properties located within a quarter-mile of the conversions appreciated by 0.7 percent more than other, similar parcels, when controlling for other potentially explanatory variables, when news of conversion was made public. This was followed by a 7.2 percent increase in property values in Year 1, and a 5.2 percent annual increase in property values thereafter.[86]

Consider the impact if that effect were applied to Philadelphia's entire riverfront.[87] The vast majority of houses located within a quarter-mile of a river's edge within the City are higher in value than the citywide median (see Figure 6.1) and are located in high-value neighborhoods

[85] "Valuing the Conversion of Urban Greenspace," Econsult Corporation (June 2010). See also Appendix G for additional studies that have attempted to estimate the property value impact of the addition of trails and/or open space.

[86] These figures represent impacts that control for other potentially explanatory variables associated with changes in property values. In other words, in a real estate environment that is flat over time, houses located within a quarter-mile of the conversions would appreciate by 0.7 percent during the year of the announcement of the conversion, by 7.2 percent in Year 1 after the conversion, and by 5.2 percent per year in subsequent years. Conversely, in a real estate environment in which property values grow by 3 percent per year, houses located within a quarter-mile of the conversions would appreciate by 3.7 percent during the year of the announcement of the conversion, by 10.2 percent in Year 1 after the conversion, and by 8.2 percent per year in subsequent years (i.e. 3 percent plus the effect of the conversion).

[87] In this case, a quarter-mile is used to match up with the distance used in the PHS study. The literature also seems to suggest that the property value impact attenuates significantly after a quarter-mile.

like Center City and Manayunk (see Figure 6.2).[88] In addition, the overwhelming majority of the highest valued houses among this sample of houses are located near the existing Schuylkill Banks greenway, suggesting that that newly built segment of the greenway has already led to a premium effect at nearby parcels (see Figure 6.3).

Figure 6.1 – Distribution of Estimated Value per Square Foot for Houses Located within ¼-Mile of the Potential Waterfront Greenway[89]

Maximum Value	$348/ft
Third Quartile	$312/ft
Second Quartile (i.e. Median)	$193/ft
First Quartile	$157/ft
Minimum Value	$16/ft
Average Value	$216/ft
Citywide Average Value	$130/ft

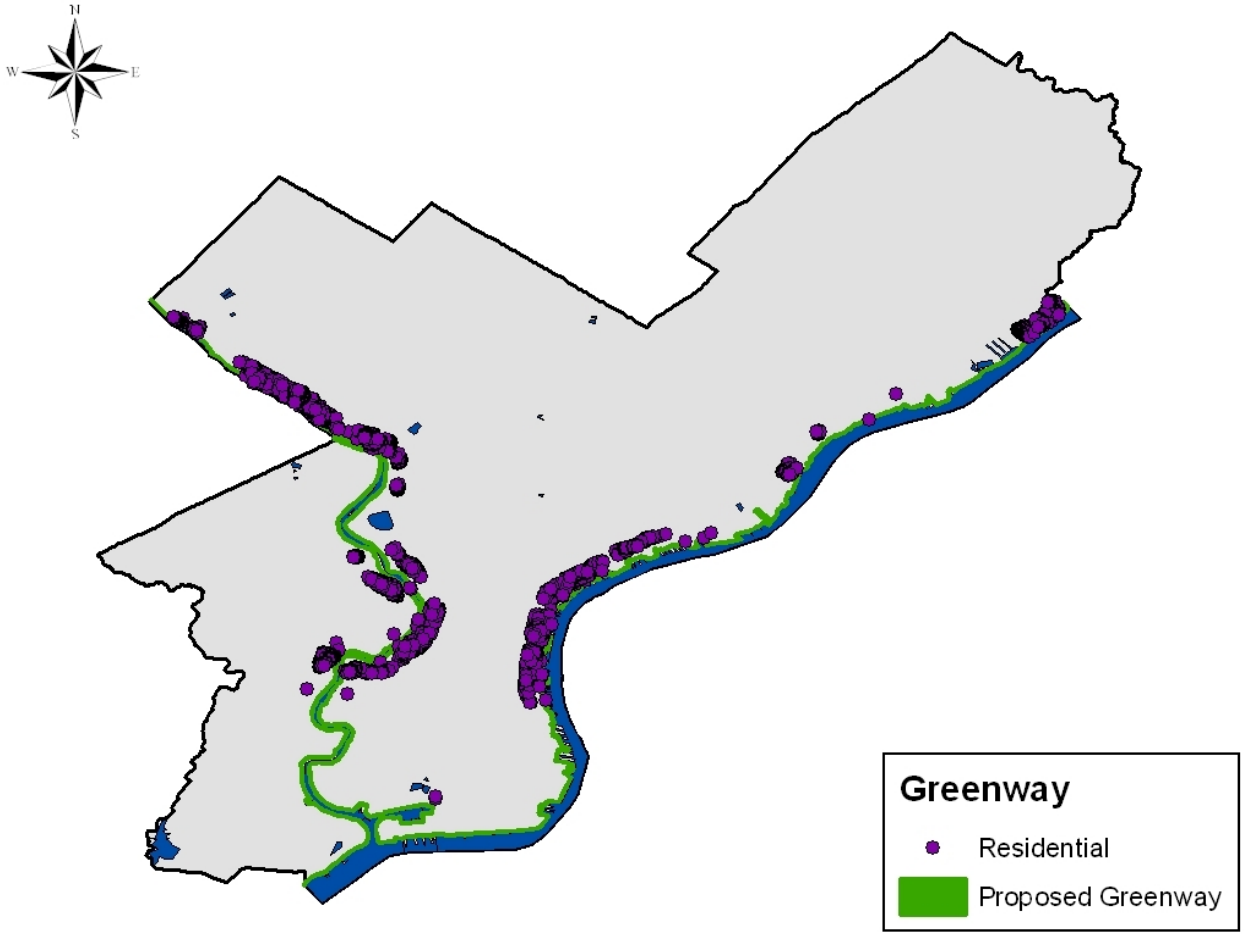
Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[88] The median value of the affected housing is $193 per square foot, with an average of $216 per square foot. This is significantly above the average house price in the City of $130 per square foot, and is a result of the affected housing stock being located in disproportionately more affluent areas of the City, particularly Center City. As noted in the above footnote, the property value impact, which represents the willingness homebuyers have to pay a premium for a particular property, attenuates significantly after a quarter-mile. This explains the fact that houses located within a quarter-mile of a river's edge are higher in value than the citywide median, but houses located within a half-mile of a river's edge have lower median household income than the citywide median.

[89] Because the majority of the affected housing has not recently transacted, it becomes necessary to compute a current estimate of value for each home, which will serve as the baseline value. Typically, a regression analysis (hedonic) would be the ideal way to estimate a value, as it explicitly takes into account the different physical and locational characteristics of each property. However, because of the well-documented problems of missing and erroneous data associated with the Board of Revision of Taxes' record-keeping, this was not feasible. Instead, the average price per square foot was computed for recent sales in each Census Tract where the affected properties are located, and this average was applied to the square footage of each individual property.

All arms-length sales in Philadelphia from the past year (i.e. from the second quarter of 2009 to the second quarter of 2010) were used for this analysis. Given the distressed nature of local and national real estate markets during this time, these values are lower than they were just a few years ago. It is unknown at this junction whether house values from this time period will be representative of house values over time, but at the very least, they do not represent the unusual highs from a few years ago.

Figure 6.2 – Existing Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway[90]

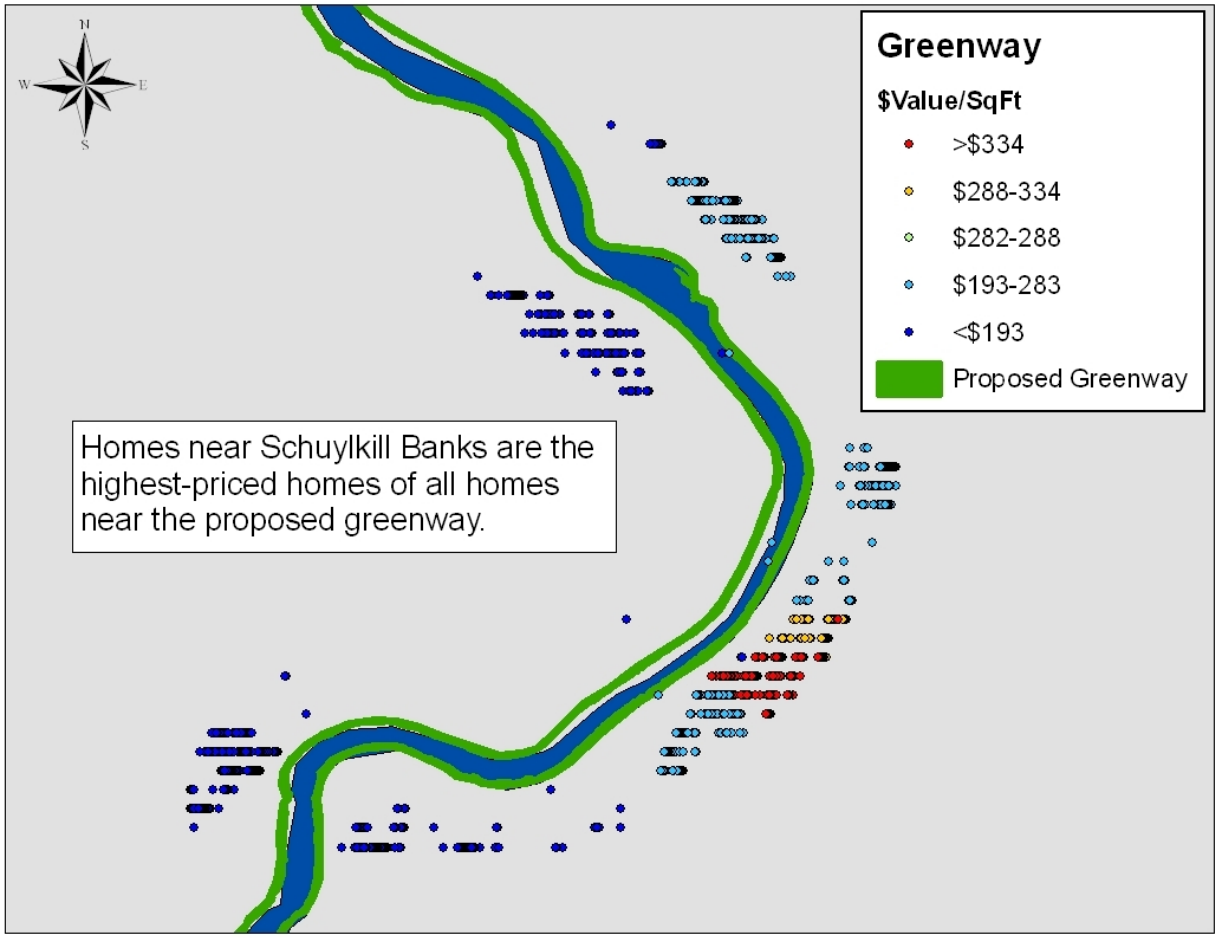


Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[90] A file on the City's stock of all real estate was obtained from the Board of Revision of Taxes. Residential properties were subsetted from the file, and geocoded to assign a unique latitude and longitude to each. The file was then spatially joined to a shapefile representing a 100-foot-wide greenway, and properties with a distance of less than a quarter-mile were retained. Of the 454,917 residential parcels in Philadelphia, 16,507 were identified as being within a quarter-mile of the proposed greenway.

It is not anticipated that, all else equal, a greenway of varying width would yield a significantly different result, either in terms of the numbers of houses impacted or the magnitude of estimated impact.

Figure 6.3 – Distribution of Estimated Value per Square Foot for Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway – Close-Up on Schuylkill Banks



Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

Applying the estimated property value impacts to all houses located within a quarter-mile of the waterfront greenway yields **an "announcement" effect of an aggregate property value increase of over $30 million, a Year 1 aggregate property value increase of over $340 million, and annual aggregate property value increases of over $260 million**. For a house that is at the median value for all houses located within a quarter-mile of the greenway, that represents appreciation of over $1,600, over $17,000, and over $13,000, respectively (see Figure 6.4).

Figure 6.4 – Estimated Property Value Impact for Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway If It Were Built All at Once

	Current Value	*$Gain upon Announcement*	*$Gain in Year 1*	*Annual $Gain After Year 1*
Aggregate Property Value	$4.7B	$33M	$341M	$264M
Median House Value	$235,655	$1,650	$17,086	$13,228
Median Value/SqFt	$193.00	$1.35	$14.00	$10.83

Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

Because the anticipated impact on nearby parcels may extend beyond a quarter-mile, to a diminishing degree until about one mile away, it may be conservative to only look at houses within a quarter-mile.[91] These estimates also do not include the gains associated with any new houses that do not currently exist but that would get built near the greenway as a result of the existence of the greenway.[92] Finally, as noted above, an average property value impact was applied to the citywide inventory of houses located within a quarter-mile of a river, but it is likely that the impact on those houses is actually higher, since they are located disproportionately in wealthier neighborhoods, which tend to be more willing to pay a premium for proximity to outdoor amenities.[93]

Of course, it is not likely that the entire waterfront greenway would be built all at once. In describing the property value impact of a fully connected waterfront greenway in Philadelphia, it may be useful to consider what that impact looks like over a period of time. Assuming either a 15-year or 30-year build-out period,[94] and conservatively assuming that the property value

[91] The property value impact attenuates fairly sharply after a quarter-mile, so while it is conservative to exclude any impact outside of a quarter-mile, there is, relatively speaking, not much additional property value impact there.

[92] I.e. some of the new demand associated with a new outdoor amenity on the river's edge will be accounted for in higher prices homebuyers are willing to pay for existing houses, and some will be accounted for in new houses developers are willing to build because homebuyers are willing to pay for them.

[93] As a point of reference, Econsult estimated in 2005 that a proposed full greenway plan, including linear park, trail, and greening along access streets, along the North Delaware River from Bridesburg through Wissinoming and Tacony to Holmesburg would by itself lead to an aggregate $348 million in one-time property value appreciation.

[94] It must be noted that these calculations assume that no waterfront greenway currently exists, and that it is built up in even amounts over a 15-year or 30-year period. In reality, some waterfront greenway already currently exists, so some of the estimated property value appreciation has already taken place. What this estimate represents, then, is not the additional property value appreciation that might take place once the waterfront greenway is fully built out, from the starting point of the current inventory of waterfront greenway, but rather what the total property value appreciation

impact attenuates over time,[95] it is estimated that **the implementation of a fully connected waterfront greenway in Philadelphia would lead to an increase in property values of over $800 million over a 30-year period** (see Figure 6.5 and Figure 6.6).[96]

It is uncertain what these estimated property value increases mean for the City and School District in terms of property tax revenues, given that at the present, properties are not often or accurately assessed. Should reassessments take place more frequently, and should they reflect actual market values, the property tax revenue impact would be significant: assuming the City's current stated ratio of assessed value to market value of 32 percent and its current property tax rate of 8.264 percent to the City and School District, **the estimated property value appreciation associated with the introduction of a fully connected waterfront greenway would eventually yield over $20 million more each year in property tax revenues**, or about $315 million to $485 million in new property tax revenues over a 30-year period (see Figure 6.7 and Figure 6.8).[97]

would be, which includes both that which has already resulted from previously built waterfront greenway as well as that which is anticipated to result from waterfront greenway to be built in the future.

For simplicity's sake, it is assumed that what is evenly distributed over 15 or 30 years is not greenway length, but rather the property value of nearby houses (i.e. instead of adding a greenway to 1/15th or 1/30th of the 50 miles of coastline each year, greenways are added next to 1/15th or 1/30th of the aggregate property value of all of the houses near a river. Thus, given that there is $4.7 billion in aggregate property value within a quarter-mile of a river, a 15-year build-out scenario would add greenway space near $313 million worth of houses each year, while a 30-year build-out scenario would add greenway space near $157 million worth of houses each year.

In reality, it is likely that greenways would be added first in areas in which there are more houses and/or more high-value houses. As a result, the property value and property tax revenue gains would not accrue equally over time, but rather higher amounts would accrue in earlier years, thus accelerating and compounding the gains.

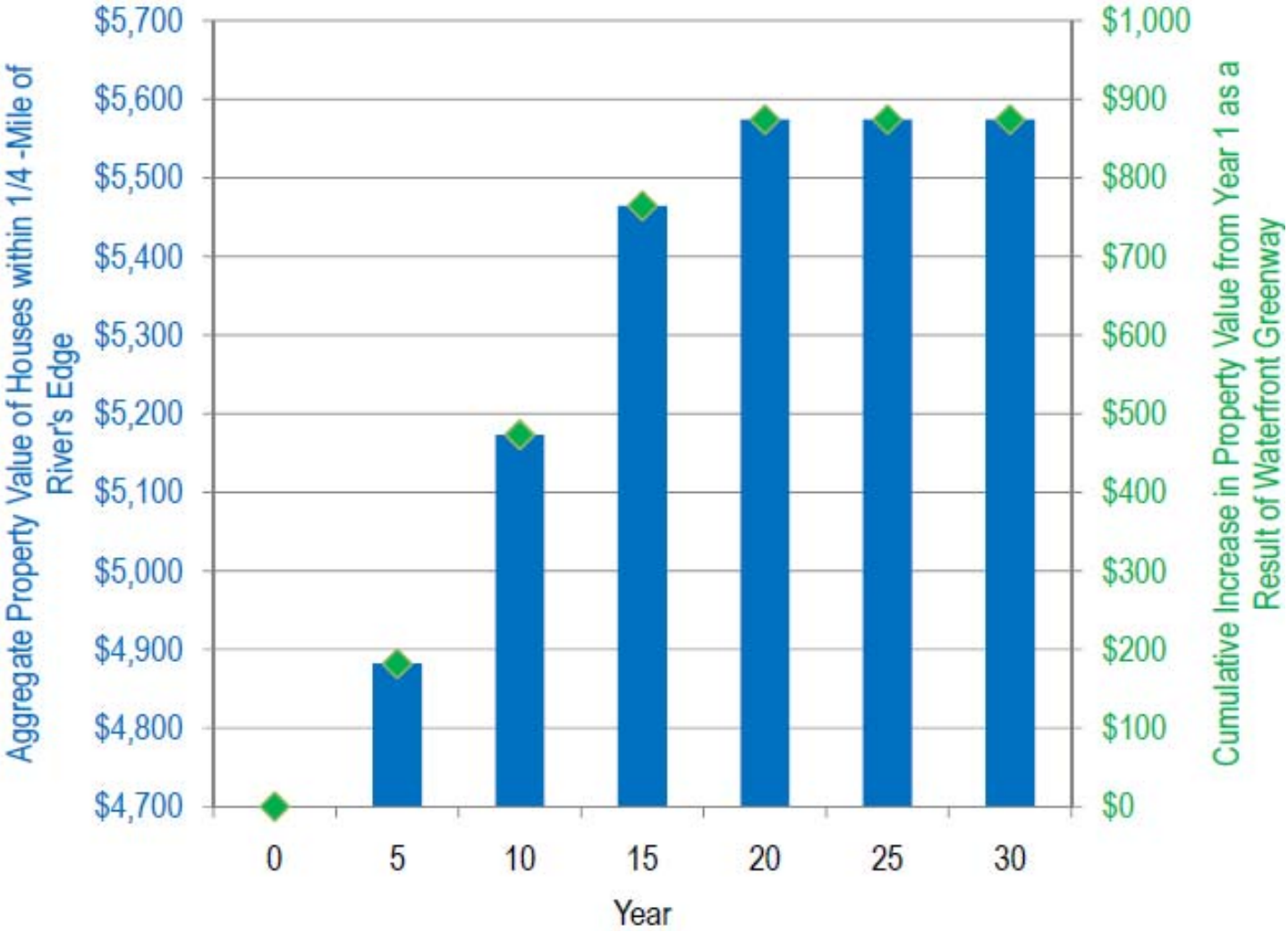
[95] In the analogous study, conducted by Econsult for PHS, it was estimated that each "greening" had a 0.7 percent announcement effect, a 7.2 percent Year 1 effect, and a 5.2 percent annual effect every year thereafter. For this report, it is conservatively estimated that each segment of waterfront greenway built has an announcement effect of 0.7 percent, a Year 1 effect of 7.2 percent, a Year 2 effect of 5.2 percent, a Year 3 effect of 3.2 percent, a Year 4 effect of 1.2 percent, and no effect in Years 5 and on.

Whether or not the property value impact continues in perpetuity or attenuates in time is unknown as of now. It is possible that heightened sensitivities to environmental concerns and/or obesity issues increases demand for space for outdoor recreation and active commuting, such that the premium people are willing to pay for proximity to a greenway not only does not attenuate but increases over time.

[96] See also Appendix H for additional detail on estimated property value impact over time.

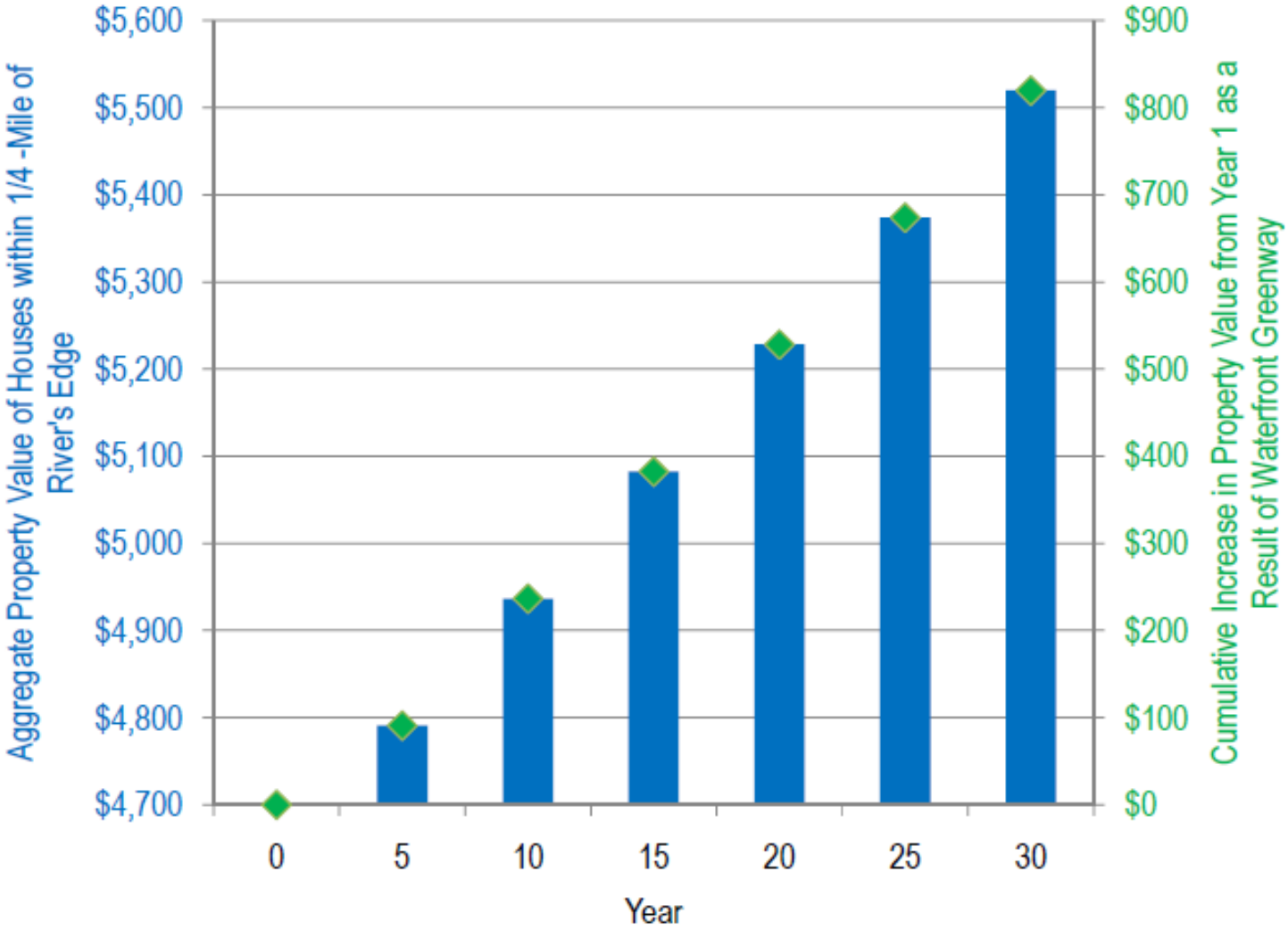
[97] See also Appendix H for additional detail on estimated property tax revenue impact over time.

Figure 6.5 – Estimated Aggregate Property Value Impact for Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway, Assuming a 15-Year Build-Out Period (in $M) (Left Axis = Blue Bars = Aggregate Property Value, Right Axis = Green Diamonds = Cumulative Property Value Increase)



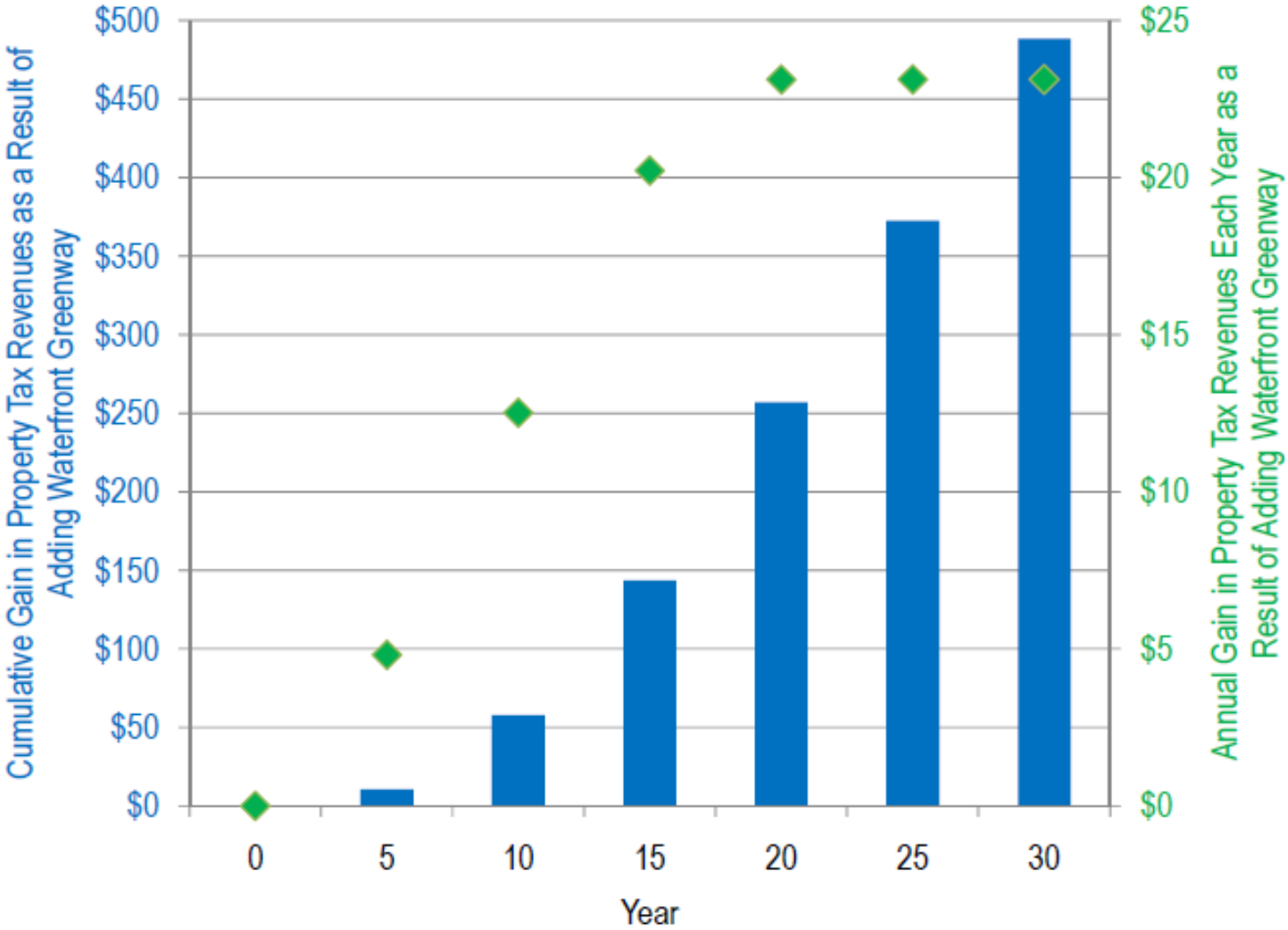
Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

Figure 6.6 – Estimated Aggregate Property Value Impact for Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway, Assuming a 30-Year Build-Out Period (in $M) (Left Axis = Blue Bars = Aggregate Property Value, Right Axis = Green Diamonds = Cumulative Property Value Increase)



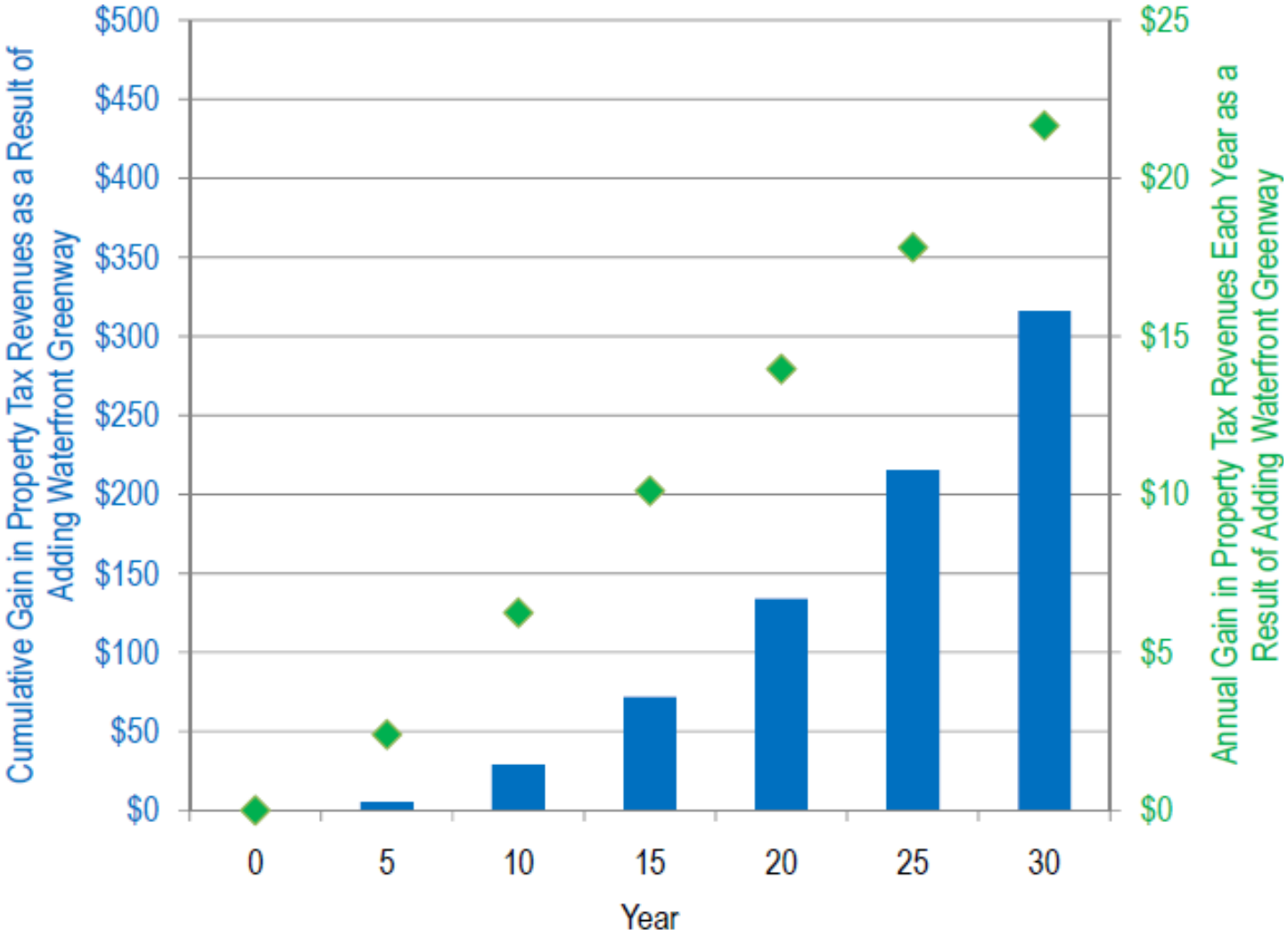
Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

Figure 6.7 – Estimated Cumulative Property Tax Revenue Gain from Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway, Assuming a 15-Year Build-Out Period (in $M) (Left Axis = Blue Bars = Cumulative Property Tax Revenue Gain, Right Axis = Green Diamonds = Annual Property Tax Revenue Gain)



Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

Figure 6.8 – Estimated Cumulative Property Tax Revenue Gain from Houses Located within ¼-Mile of the Proposed Fully Connected Waterfront Greenway, Assuming a 30-Year Build-Out Period (in $M) (Left Axis = Blue Bars = Cumulative Property Tax Revenue Gain, Right Axis = Green Diamonds = Annual Property Tax Revenue Gain)



Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

7.0 ENVIRONMENTAL IMPACTS – ECOLOGICAL SERVICES RENDERED

Types of Ecological Services Rendered

The addition of a fully connected waterfront greenway within the City of Philadelphia would produce **environmental benefits and cost savings associated with the ecological services rendered by the greenway itself.** As such, the environmental benefits discussed in this section are generated regardless of actual usage levels, because they accrue from the existence of the pervious surface and tree cover that are added to the City and that render certain ecological services that would otherwise not be performed apart from their existence.

Previous research and modeling tools can be drawn from to estimate environmental benefits in two categories: ecosystem services and air quality improvements. Ecosystem services are defined as the benefits people obtain from ecosystems, including storm water management, waste assimilation, flood mitigation, and wildlife habit (Costanza 2006).[98] In each of the categories, the addition of a fully connected greenway contributes environmental benefits that may result in cost savings, increased biodiversity, health benefits, or other positives on which people are willing to place a value. A review of the relevant literature provided guidance on minimum, median, and maximum values for each ecological service rendered on a per-acre basis, which were then applied to the total acreage associated with a fully connected waterfront greenway.

Some of the main ecosystem service benefits of a fully connected waterfront greenway include:

1. Stormwater Management and Water Quality
2. Flood Mitigation
3. Wildlife Habitat
4. Additional Ecosystem Services
5. Air Quality
6. Carbon Storage and Carbon Sequestration

[98] "The Value of New Jersey's Ecosystem Services and Natural Capital." New Jersey Department of Environmental Protection, Division of Science, Research, and Technology. Report Number: SR04-075 (2006).

Stormwater Management and Water Quality

Greenways provide two types of hydrologic services. The first is **stormwater runoff reduction**. In many areas along the riverfront, the construction of the greenway would replace previously impervious surfaces (parking lots, roads, and other developed uses) with a vegetated strip of land. The vegetated areas of a greenway would assist with reducing stormwater runoff from the surrounding areas and help the Philadelphia Water Department (PWD) meet the goals detailed in their *Green Cities, Clean Waters* report.[99] This natural system would ultimately result in storm water management savings by avoiding costly infrastructure improvement projects such as deep tunnel storage or combined sewer separation (Costanza 2006).[100]

Source: Schuylkill River Development Corporation

The second hydrologic service provided by the greenway is **waste assimilation**. Vegetated areas along streams and rivers also provide a natural protective buffer between anthropogenic activities and water supplies, helping to filter out pathogens, excess nutrients, metals and sediments. These water quality improvements can lead to valuable pollution mitigation and reductions in nutrient-removal treatment costs (Costanza 2006).[101]

[99] As part of the Green City, Clean Waters program, the City will invest over $1.6 billion to improve the quality of City's rivers amd streams. A fully connected greenway will provide citizens with improved access to the restored waterbodies, thereby allowing them to take full advantage of the City's investment. "Green City, Clean Waters," Philadelphia Water Department (September 11, 2009).

[100] "The Value of New Jersey's Ecosystem Services and Natural Capital." New Jersey Department of Environmental Protection, Division of Science, Research, and Technology. Report Number: SR04-075 (2006).

[101] Ibid.

Flood Mitigation

Land use decisions directly influence the function of floodplains and levels of flood hazards, a fact that must be taken into account when making land use decisions. **A greenway along the river can serve as a buffer between the body of water and human development, protecting property from flooding.** By adding vegetation, soil, and large amounts of pervious surface cover, runoff to streams and rivers from rainfall and snowmelt decreases. As a result, the peak discharge, volume, and frequency of floods decrease in nearby streams. Without this natural service, residents and governments would be forced to pay to protect structures from damage due to river flooding (Costanza 2006).[102]

One way to value flood protection services rendered is to consider the value of the parcels that would face a decreased risk of flooding due to the conversion of previously developed space into a fully connected waterfront greenway. Parcel-level GIS data and 100-year and 500-year floodplain maps from the Federal Emergency Management Agency can be utilized to determine the number of parcels that would be at decreased risk of flooding if nearby land was converted into open space. Then tax assessment data can be used to identify the current values of those parcels within the 100-year and 500-year floodplains, from which the aggregate value of parcels that are at decreased risk of flooding due to the increase of open space within the watershed can be calculated.

However, given the relatively large width of the Schuylkill and Delaware Rivers, and the relatively small width of the proposed waterfront greenway, it is not certain that the greenway would provide meaningful flood mitigation. Thus, the general approach employed in this section, of assuming that a certain acreage of pervious surface performs a certain magnitude of ecological service, may be inappropriate, given the relevant characteristics. Therefore, to be conservative, no value was assigned to the greenway for flood mitigation services rendered.

Wildlife Habitat

In addition to providing hydrologic services, **green spaces serve as a habitat for a diversity of wildlife**. Contiguous patches of land cover with sufficient area to hold naturally functioning ecosystems support a diversity of plant and animal life. The region's forest land has been significantly reduced and fragmented as a result of development, shrinking the habitat available for birds and other wildlife. While intact forests and wetlands function as a critical population source for plant and animal species that humans value for both aesthetic and functional reasons, a fully connected waterfront greenway would also generate significant wildlife habitat benefits (Costanza 2006).[103] These benefits result from the fact that a fully connected

[102] Ibid.

[103] Ibid.

greenway would connect large patches of habitat throughout the city, thereby giving animals a way to safely move to these different patches.

Additional Ecosystem Services

In additional to the ecosystem services discussed above, the development of a fully connected waterfront greenway would provide **a number of other ecosystems services**, including soil formation, biological control,[104] and pollination. While the value of these services may be small in terms of dollar values, they are a vital component in the provision of many of the other ecosystem services.

Air Quality

Poor air quality is a common problem in many urban and suburban areas and can lead to a variety of human health problems, including asthma and other respiratory aliments. Philadelphia ranked in the worst 10 percent of US cities in terms of person-days in excess of national air quality standards in 2002, and in terms of air release of toxins in 2003. In the city of Philadelphia, 13.4 percent of children have asthma, higher than the national average of 9.4 percent. Each year, over half of the children with asthma in the city of Philadelphia visit the emergency room with an asthma-related problem.[105]

Additionally, air pollution can damage buildings and plants, disrupt many ecosystem services and cause reduced visibility and smog. **Trees offer the ability to remove significant amounts of air pollution and consequently improve environmental quality and human health.** In particular trees have been found to remove significant amounts of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), and particulate matter. Trees remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. Trees also remove pollution by intercepting airborne particles (Nowak 2006).[106]

[104] Biological control refers to the dynamic regulation of species populations, including the control of invasive species and unwanted species, such as pest predators, weeds, and disease vectors (i.e. mosquitoes).

[105] "Heart Health among Adults (18+) in Southeastern Pennsylvania," Public Health Management Corporation (February 1, 2010). See also: "Childhood Asthma in the United States: Urban Issues," Pediatric Pulmonology (December 2001); "Patterns of Asthma Mortality in Philadelphia from 1969 to 1991," New England Journal of Medicine (December 8, 1994); "2006 Asthma Rankings," Asthma and Allergy Foundation of America.

[106] "Air Pollution Removal by Urban Trees and Shrubs in the United States," Urban Forestry and Greening (2006).

Carbon Storage and Carbon Sequestration

Trees help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in new biomass each year. Carbon storage is another way that trees can influence climate change. As trees grow, they store more carbon by holding it in their accumulated tissue. As trees die and decay, they release much of the stored carbon back to the atmosphere (Nowak 2007).[107] **Carbon storage** is an estimate of the total amount of carbon that is currently stored in the above and below ground biomass of the forest, while **carbon sequestration** is a measure of how much new carbon dioxide is taken up by the forest each year through new growth. This estimate takes into account the yearly release of stored carbon through the death and decay of trees – it measures the net new sequestration of carbon.

Model Specifications and Limitations

This analysis assumed that the current land cover in the trail area is replaced with a 15-foot wide trail made out of impervious materials. To consider either a greenway of a width of either 50 or 100 feet means to model the addition of either 35 or 85 feet of pervious surface,[108] times 50 miles of coastland. This yields either about 200 or about 500 acres of total vegetated surface, and since much of the City's coastland is not currently considered green space, a fully connected waterfront greenway would represent a significant contribution to the City's Greenworks Philadelphia goal of adding 500 acres of green space by 2015.

For the purposes of modeling ecological services rendered, it was assumed that this pervious surface had land cover and ecosystem function and ecosystem service values similar to that of what is typically classified as pasture (i.e. areas covered with grass and other shrub-like vegetation with trees interspersed throughout). For the purposes of modeling hydrologic functions (i.e. stormwater runoff reduction and water quality improvements), it was assumed that these pervious surfaces would function similar to riparian areas. As a result, the analysis used the following values from Costanza et al (2006):[109]

1. Water Supply – Riparian Buffer land cover values
2. Soil Formation – Pasture land cover values
3. Waste Treatment – Pasture land cover values

[107] "Assessing Urban Forest Effects and Values," US Forest Service (2007).

[108] i.e. allowing water to pass through and contrasted with impervious surfaces such as concrete.

[109] "The Value of New Jersey's Ecosystem Services and Natural Capital." New Jersey Department of Environmental Protection, Division of Science, Research, and Technology. Report Number: SR04-075 (2006).

4. Pollination – Pasture land cover values
5. Biological Control – Pasture land cover values
6. Wildlife Habitat – Pasture land cover values

An important characteristic in this modeling exercise is the proportion of greenway that is in the form of tree canopy cover. Based on photo-interpretation of the current Schuylkill Banks greenway, which suggests that tree canopy cover there is about 16 percent, it was assumed that a fully connected waterfront greenway would have that proportion of tree canopy cover.[110] We then used the i-Tree Vue model, developed by the US Forests service, to estimate the air pollution removal and carbon sequestration and storage benefits. The i-Tree software provided estimates of the amounts of carbon storage, carbon sequestration, and CO, NO_2, O_3, SO_2, and PM_{10} pollution removal associated with each acre of tree canopy cover.[111] Pollution removal values were estimated using national median externality values. The values are based on the median monetized dollar per-ton externality values obtained from Nowak et al (2006)[112] and Murray et al (1994).[113] These values in dollars per metric ton are: NO_2=$6,752, PM_{10}=$4,508, SO_2=$1,653, and CO $959. Following accepted practice, the externality values for O_3 were set to equal the value for NO_2.[114] Externality values can be considered the estimated costs of pollution to society that is not accounted for in the market price of the goods or services that produced the pollution.

At this level of analysis, it was not possible to account more precisely for the spatial distribution of the newly added pervious surface and tree canopy cover, other than to apply per-acre value estimates to the aggregate number of acres represented by a fully connected waterfront greenway. However, it must be acknowledged that this new addition is in the form of a very long but very narrow strip of green space. This may affect the greenway's ability to render ecological services at the same rate as is suggested in national studies, most of which are considering larger and less abnormally shaped parcels of open space. On the other hand, the fact that the greenway would intersect with a very urban portion of the Philadelphia region may mean that using national averages for ecological services rendered is too conservative,

[110] i.e. hundreds of satellite images were sampled, yielding a proportion of nice canopy cover of 16 percent. Greenworks Philadelphia has advanced a goal of 30 percent coverage in all neighborhoods by 2025, so if the fully connected waterfront greenway achieves tree canopy cover higher than 16 percent, environmental benefits would exceed the estimates here.

[111] "I-Tree Vue User's Manual, Version 3.0," US Forest Service (2010). As with the rest of this report, this approach measures the function of the greenway in full form. In this case, the important consideration is that the trees that have been planted are mature.

[112] "Air Pollution Removal by Urban Trees and Shrubs in the United States," Urban Forestry and Greening (2006).

[113] "New York State Energy Plan, Vol. II: Issue Reports," New York State Energy Office (1994).

[114] "Air Pollution Removal by Urban Trees and Shrubs in the United States," Urban Forestry and Greening (2006).

because of the relative rarity of green space within the City when compared to less developed parts of the region.[115, 116]

Estimates of Ecological Services Rendered

Based on this modeling approach, it was determined that a fully connected waterfront greenway would provide about $88,000 to $205,000 in aggregate environmental benefits, depending on whether the greenway is 50 or 100 feet in width (see Figure 7.1). The vast majority of this estimated amount is in the form of ecosystem services rendered: stormwater runoff reduction, water assimilation, soil formation, pollination, biological control, wildlife habitat, and gas and climate regulation.[117]

[115] One concession that is made to account for this is that only 10 percent of the per-acre value wildlife habitat is included, since most of the value of open space in terms of wildlife habitat services comes from peoples' willingness to pay to preserve the habitat of the so-called charismatic mega-fauna that people place a high value on (such as bears, deer, bald eagles etc), as well as the species that do not meet this criteria. This value comes from the aesthetic value of seeing the animals, for their existence value, as well as the services that those animals sometimes supply. The habitat value of a parcel is typically determined by the size of the parcel, with larger contiguous parcels typically able to support more diverse and larger populations and thereby have greater wildlife habitat values. While the proposed greenway will be large when taken in aggregate, it will be relatively narrow and as such will likely not function the same way, in terms of wildlife habitat, as a contiguous block of the same size. Hence, an adjustment was made for its per-acre value.

[116] An additional concession was made to account for this is that only 10 percent of the per-acre value for the hydrologic and water quality benefits are included, since most of the value of open space in terms of these ecosystem services comes from intercepting runoff before it enters the stream. Most of the City of Philadelphia is currently served by a combined sewer system and we are unsure how much stormwater runoff goes into the combined sewer versus directly into a river or stream. In areas served by a combined sewer this benefit will be substantially smaller than in areas where the stormwater runoff flows directly into the stream. Therefore, an adjustment was made in the per-acre value.

[117] See Appendix I for additional detail on environmental benefit estimates.

Figure 7.1 – Estimate of Ecological Services Rendered by a Fully Connected Waterfront Greenway

Description	*100-Ft Greenway*	*50-Ft Greenway*
Total Greenway Area (acres)	606	303
Percent that is Trail (i.e. impervious)	15%	30%
Total Pervious Surface Area (acres)	515	212
Percent that is Tree Canopy Cover	16%	16%
Total Tree Canopy Cover (acres)	82	34
Ecosystem Service Values ($)[118]	$105K	$44K
Air Pollution Removal ($K)	$28K	$15K
Carbon Storage and Sequestration ($K)	$71K	$29K
Aggregate Environmental Benefits ($K)	$205K	$88K

Source: Econsult Corporation (2010), Costanza et al (2006)

[118] Includes values for stormwater management, water quality, soil formation, pollination, biological control and wildlife habitat.

8.0 AGGREGATE BENEFITS AND CONCLUDING REMARKS

This report has determined that a fully connected waterfront greenway along both sides of both rivers within the City of Philadelphia would accrue significant economic, environmental, health, and quality of life benefits to the City and its residents:

- The greenway would lead to additional recreational uses, accruing direct use benefits to users, and generating health-related benefits in the form of short-term and long-term health care cost savings and reductions in absenteeism and "presenteeism" (i.e. lower worker productivity).

- The greenway would lead to additional commuting trips, also generating health-related benefits to users as well as accruing broader benefits to others in the region from reduced congestion and pollution from reductions in vehicle miles traveled.

- The greenway would draw additional tourism activity to the City, with attendant economic and fiscal impact associated with out-of-towners making expenditures within the City.

- The greenway's existence would confer wealth benefits to adjacent property owners whose holdings would now be worth more in the marketplace because of their proximity to a major recreational amenity.

- The addition of pervious surface and tree cover brings some environmental impact to the City by rendering certain ecological services, such as storm water and waste water management, flood protection, flora and fauna diversification, and improved air quality and carbon sequestration.

- The greenway is consistent with the principles set forth in the City's "Greenworks Philadelphia" document and in Philadelphia Water Department's "Green Cities, Clean Waters" report, helping achieve stated goals and capitalize on anticipated infrastructure investments.

This report represents a preliminary exploration of these benefits – of what gains are intended, what existing literature suggests might actually occur, and how much those advantages might be worth to the City and its residents. Further study should account for the proposed design of the greenway, since actual usage and environmental impacts will likely depend greatly on such matters as access, aesthetics, and composition, and impact assumptions can be adjusted accordingly. Primary research is likely in order, as well, since estimates and assumptions applied from other examples may differ in their applicability in the City because of personal preferences, demographics, topology, climate, or other factors.

Source: Greater Philadelphia Tourism Marketing Corporation

In pursuing additional understanding of the benefits of a fully connected waterfront greenway within the City for the purposes of making investment decisions, It is useful to consider the extent to which the benefits articulated in this report can be summed together to arrive at an aggregate benefit. The estimated nature of impact levels in this report does not allow for a more precise measurement of double-counted benefits, but rough proportions can be used to account for such double-counts.

Conceptually, four of the categories of benefits stand alone, with little if any overlap:

1. *Environmental benefits from the greenway's existence.* There is some sense in which environmental benefits are partially accounted for in this report's property value estimates, if for example the provision of storm water management services is part of what people are willing to pay a premium for when considering properties adjacent to the greenway. However, the vast majority of these environmental benefits are very diffuse in nature, accruing more broadly than to a more localized set of property owners, and do not depend on the greenway's actual use. Hence, it is not anticipated that any double-counting is occurring there.

2. *Environmental benefits from the greenway's use as a commuting option.* These environmental benefits accrue from the substitution of car trips for bicycle trips, not from the ecological services rendered by the greenway itself.

3. *Economic impacts associated with increases in tourism activity drawn by the greenway.* Benefits associated with direct use have tended to focus on City residents using the greenway for recreational or commuting purposes. Economic impacts associated with tourism increases are therefore separate from those estimates.

4. *Property value increases resulting from proximity to the greenway.* Proximity to the greenway is what people are willing to pay a premium for, which is different from the value derived from actual use. Thus, it is not likely that these estimates are also accounted for in any other benefits calculations.

On the other hand, it is likely that there is significant overlap between the estimated values associated with direct use and with health care costs. Direct use benefits for the greenway represent what people gain when they use the greenway, and are made numeric through national surveys that translate that gain into dollars via "willingness to pay" estimates. Part of what people are gaining from direct use is pure enjoyment and recreation, but part is also the health-related benefits of exercise and nature.

Keeping these potential overlaps in mind, and keeping in mind that different benefits accrue to different groups and are measured in different ways, it is nevertheless useful to consider all of these benefits together in one place, as they represent in aggregate the many annual benefits of a fully connected waterfront greenway that accrue to its users and to the City as a whole. Even at this initial and preliminary level of analysis, it seems clear that the greenway's environmental benefits are relatively small, and that the greenway as a recreational amenity, economic draw, and property value enhancer is significant (see Figure 8.1 and Figure 8.2).[119]

Ultimately, the costs associated with making a fully connected waterfront greenway will have to be weighed against these categories and magnitudes of benefits. What this report demonstrates is that there is a wide range of benefits, that the scale of those benefits is in many cases quite significant, and that the benefits likely accrue not only to individual users but to City government and to the City and region as a whole.

[119] Bear in mind that in making all of these estimates, conservative assumptions were employed, so it is possible the true number is much higher. Further study, including extensive primary research, may yield results that are more specific to the City and that result in a bigger impact estimate. Consider also that this aggregate benefit result is a combination of a number of different kinds of benefits. Some are more tangible or more focused than others. A greenway may directly reduce the City's expenditures associated with various ecological services, which can free the City to lower taxes or redeploy spending. A greenway may also serve as an accessible outdoor amenity option for residents, increasing their enjoyment of the City but adding nothing directly to the City's finances or to the local economy.

Figure 8.1 – Disaggregated Detail of Estimated Benefits Resulting from a Fully Connected Waterfront Greenway within the City[120]

Benefit	*Estimated Gain to Individuals*	*Estimated Gain to the City Government*	*Estimated Gain to the City and Region as a Whole*
"Willingness to pay" value of direct use by City residents	$28 million in the value of direct use each year by actual greenway users 44,000 households and 98,000 residents now within a ½ mile of an outdoor recreational amenity		
Environmental benefits resulting from fewer vehicle miles traveled because of more bicycle commuters[121]	$114,000 not spent on gasoline each year	1 million fewer miles driven each year, contributing towards the Greenworks Philadelphia goal of reducing vehicle miles traveled (VMT) by 10% by 2015	$37,000 in emission costs reduced each year $62,000 in congestion costs avoided each year
Avoided health care and absenteeism/"presenteeism" costs because of health gains from greenway use by City residents	$20 million in avoided health care costs each year to City residents, to their employers, and to their health insurance groups resulting from exercise conducted on greenway		

[120] These figures represent final estimates associated with a fully connected waterfront greenway. To the extent that such a greenway would not be built all at once, these figures would be arrived at over time as more and more of the greenway exists.

[121] "All-in" externality costs associated not only with former car commuters switching to bicycle commuting but also with reduced congestion to remaining car commuters.

Benefit	*Estimated Gain to Individuals*	*Estimated Gain to the City Government*	*Estimated Gain to the City and Region as a Whole*
Total economic output generated within the City resulting from increased tourism drawn by the greenway, and from ensuing indirect and induced output supported by that increase[122]		$4 million in state and local tax revenues each year resulting from economic output attracted to the City from tourists drawn to the greenway	$53 million in total economic output attracted to the City each year from tourists drawn to the greenway[123]
Wealth enhancement to property owners as the greenway creates a price premium for proximate locations	$800+ million in overall property value increase (assuming 15-year or 30-year build-out)	$20 million in new property tax revenues to the City and School District each year from increase in property values[124]	
Externality and market replacement costs avoided from ecological services provided by the greenway		200-500 acres of open space added to the City, contributing to the Greenworks Philadelphia goal of adding 500 acres of open space by 2015	$88,000 to $205,000 in ecological services rendered and other, related environmental benefits

Source: Econsult Corporation (2010)

[122] Direct tourism impacts, plus any indirect and induced impacts associated with that composition and scale of economic activity within the City.

[123] Additionally, there may be an increase in other business operations as employers and employees are drawn to Philadelphia as a location because of the quality of life provided by the fully connected waterfront greenway.

[124] Assuming up-to-date assessment and Actual Value approach.

Figure 8.2 – Aggregated Summary of Estimated Benefits Resulting from a Fully Connected Waterfront Greenway within the City[125]

Estimated Gain to Individuals	*Estimated Gain to the City Government*	*Estimated Gain to the City and Region as a Whole*
$30-$40 million in aggregate direct use benefit and reduced health care costs to direct users each year Particular gains for the 44,000 households and 98,000 residents not previously near an outdoor amenity who will now be within ½-mile of the greenway[126] $800+ million in aggregate in household wealth gains to property owners	$4-$24 million each year in new tax revenues from increased tourism activities and higher property values Contributions towards Greenworks Philadelphia goals in terms of reduction in vehicle miles traveled and addition of open space, and towards capitalizing on anticipated Green City, Clean Waters infrastructure investments	$50+ million each year in new economic activity from increased tourism and other business operations Some reduction in congestion and pollution from reduced vehicle miles traveled because of increased bicycle commuters Some gains from ecological services rendered, air quality improved, and carbon stored and sequestered

Source: Econsult Corporation (2010)

[125] These figures represent a general aggregation of the different benefits presented and estimated in this report, are rounded according to the relative level of precision associated with each calculation, and attempt to roughly account for any double-counting.

[126] With, as noted previously, particular gains for the relatively high proportion of residents aged 65 and older, for whom exercising on the greenway would confer particularly high health care cost savings, and for the relatively high proportion of households without cars, which would now enjoy significant gains in mobility as a result of the greenway.

APPENDIX A – ESTIMATES OF RECREATIONAL ACTIVITY LEVELS TAKING PLACE ON A FULLY CONNECTED WATERFRONT GREENWAY

One reasonable way to proxy the amount and value of recreational activity that will take place on a fully connected waterfront greenway is to estimate a base amount of recreational activity that currently takes place and then to assume a certain amount of recreational activity that will take place on a greenway that is a proportion of the current amount. The base amount of recreational activity currently taking place within the City of Philadelphia was estimated by using SCORP survey data to extrapolate to a citywide level the responses from City residents as to whether and how often they participate in various outdoor recreational activities (see Figure A.1). Conservative proportions for amounts that would then take place on a greenway (in some cases net new uses, and in other cases switches of existing uses to the greenway from existing locations) were assumed to determine activity levels for the greenway for each user (see Figure A.2) and then for the City as a whole (see Figure A.3). Finally, these activity levels were multiplied by Unit Day Values taken from the 2009 Philadelphia Parks Alliance report to arrive at an estimated recreational value of activities taking place on a fully connected waterfront greenway in the City (see Figure A.4).

Figure A.1 – Current Base Level of Recreational Users within the City, by Activity[127]

	Total Population	274,000	98,000	50,000	1,005,000	1,427,000
Activity	% Survey Participants Who Participate	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River	Total Recreational Users
Walking	49%	134,924	48,258	24,621	494,886	702,689
Jogging / running	14%	37,364	13,364	6,818	137,045	194,591
Dog walking	14%	37,364	13,364	6,818	137,045	194,591
Bicycling	20%	53,970	19,303	9,848	197,955	281,076
Skateboarding / rollerblading	4%	10,379	3,712	1,894	38,068	54,053
Picnicking	4%	10,379	3,712	1,894	38,068	54,053
Fishing	14%	39,439	14,106	7,197	144,659	205,402
Sailing	4%	10,379	3,712	1,894	38,068	54,053
Boating	2%	4,152	1,485	758	15,227	21,621
Canoeing	3%	8,303	2,970	1,515	30,455	43,242
Kayaking	1%	2,076	742	379	7,614	10,811
Tubing	2%	4,152	1,485	758	15,227	21,621
Total		352,879	126,212	64,394	1,294,318	1,837,803

Source: Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

[127] I.e. the number of people within the City who participate in each of the listed activities.

Figure A.2 – Total Recreational Uses per User by Activity Estimated to Take Place Each Year on a Fully Connected Waterfront Greenway

Percent Attributable to the Greenway		*5.0%*	*40.0%*	*20.0%*	*5.0%*
Activity	Citywide Average[128]	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River
Walking	149	7	60	30	7
Jogging / running	84	4	34	17	4
Dog walking	223	11	89	45	11
Bicycling	56	3	23	11	3
Skateboarding / rollerblading	18	1	7	4	1
Picnicking	32	2	13	6	2
Fishing	25	1	10	5	1
Sailing	21	1	8	4	1
Boating	26	1	10	5	1
Canoeing	4	0	2	1	0
Kayaking	10	1	4	2	1
Tubing	1	0	0	0	0
Total	649	32	260	130	32

Source: Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

[128] I.e. among those people within the City who participate in each of the listed activities, their average number of uses per year. Therefore, for example, among those people within the City who jog or run, the average number of times per year that they jogged or ran was 84, and, based on the assumed percentages of uses attributable to the greenway, those near a river only would use the greenway 40 percent x 84 current uses = 34 uses on the greenway. Because people partake in some activities more frequently than others, there may be some activities that are expected to have relatively high usage even if the percentage of people who participate in them is relatively low, and vice versa.

Figure A.3 – Total Recreational Uses by Activity Estimated to Take Place Each Year on a Fully Connected Waterfront Greenway[129]

% Attributable to Greenway	*5.0%*	*40.0%*	*20.0%*	*5.0%*	
	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River	Total Recreational Uses
Walking	1,006,639	2,880,309	734,773	3,692,233	8,313,953
Jogging / running	157,550	450,800	115,000	577,875	1,301,225
Dog walking	415,670	1,189,364	303,409	1,524,631	3,433,074
Bicycling	152,049	435,061	110,985	557,699	1,255,794
Skateboarding / rollerblading	9,341	26,727	6,818	34,261	77,148
Picnicking	16,502	47,218	12,045	60,528	136,294
Fishing	49,403	141,358	36,061	181,205	408,026
Sailing	10,690	30,588	7,803	39,210	88,291
Boating	5,397	15,442	3,939	19,795	44,574
Canoeing	1,661	4,752	1,212	6,091	13,715
Kayaking	1,038	2,970	758	3,807	8,572
Tubing	208	594	152	761	1,714
Total	1,826,148	5,225,182	1,332,955	6,698,097	15,082,381

Source: Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

[129] I.e. number of current users (from Figure A.1) x number of greenway uses (from Figure A.2). Therefore, for example, the 19,303 current bicyclists living near a river only are each expected to use the new greenway 23 times per year for bicycling, for a total of 435,061 bicycle uses on the new greenway. In the aggregate, this totals about 15 million greenway uses per year, which will be a combination of net new uses and transfers from existing uses, as well as a combination of residents who currently engage in a use now doing so more often because of the greenway and residents who do not currently engage in a use now doing so for the first time because of the greenway.

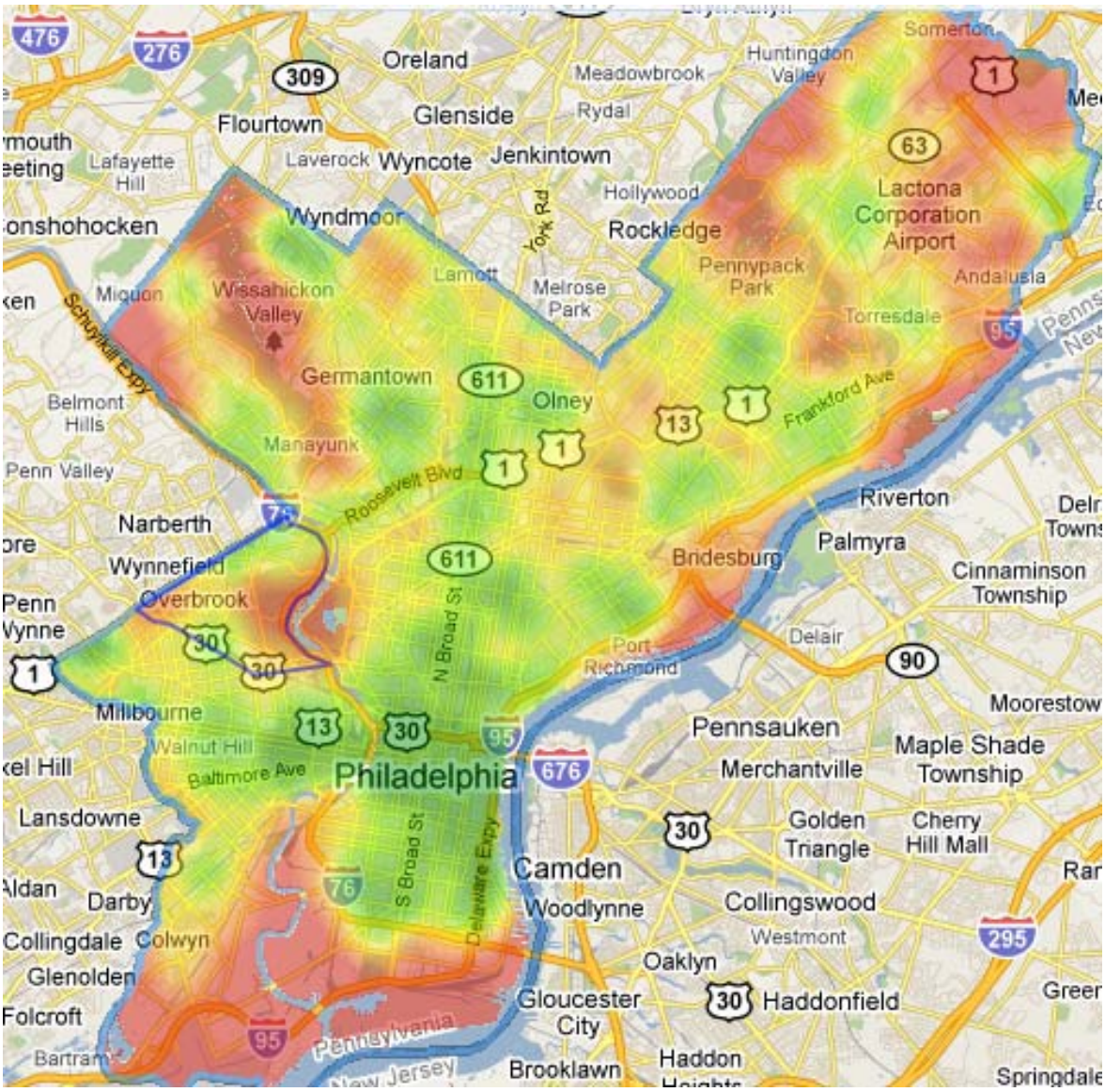
Figure A.4 – Total Recreational Value by Activity Estimated to Take Place Each Year on a Fully Connected Waterfront Greenway[130]

% Attributable to Greenway		*5.0%*	*40.0%*	*20.0%*	*5.0%*	
	Unit Day Value	Near a Park Only	Near a River Only	Near a Park and a River	Not Near a Park or a River	Total
Walking	$1.47	$1,479,759	$4,234,054	$1,080,116	$5,427,582	$12,221,512
Jogging / running	$3.25	$512,038	$1,465,100	$373,750	$1,878,094	$4,228,981
Dog walking	$1.32	$548,685	$1,569,960	$400,500	$2,012,513	$4,531,658
Bicycling	$3.16	$480,476	$1,374,792	$350,712	$1,762,328	$3,968,308
Skateboarding / rollerblading	$2.96	$27,649	$79,113	$20,182	$101,414	$228,357
Picnicking	$2.52	$41,586	$118,990	$30,355	$152,532	$343,462
Fishing	$4.31	$212,927	$609,251	$155,421	$780,992	$1,758,591
Sailing	$4.33	$46,288	$132,446	$33,787	$169,780	$382,301
Boating	$4.33	$23,369	$66,866	$17,058	$85,714	$193,006
Canoeing	$4.33	$7,190	$20,574	$5,248	$26,374	$59,387
Kayaking	$4.33	$4,494	$12,859	$3,280	$16,484	$37,117
Tubing	$4.33	$899	$2,572	$656	$3,297	$7,423
Total		$3,385,359	$9,686,575	$2,471,065	$12,417,102	$27,960,102

Source: Philadelphia Parks Alliance (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

[130] I.e. total recreational uses (from Figure X.X) x Unit Day Value, as reported by Philadelphia Parks Alliance.

APPENDIX B – "HEAT MAP" OF PHILADELPHIA'S WALKABILITY BY NEIGHBORHOOD[131]



Source: Walk Score (2010)

[131] Walk Score creates walkability indexes for over 2,500 neighborhoods in 40 cities around the US, based on proximity to various natural and commercial amenities, such as transit, retail, and parks. They also generate "heat maps" which are color-coded by the Walk Score of a particular location within a city, with green representing 100 (extremely walkable) and red representing 0 (extremely not walkable). Walk Score's methodology can be found at http://www.walkscore.com/methodology.shtml. Note that there are a number of sections within the City of Philadelphia that are adjacent to a river that are currently not very walkable.

APPENDIX C – ESTIMATED CURRENT USAGE ON SCHUYLKILL BANKS

Estimated current usage on Schuylkill Banks was based on counter data provided by Schuylkill River Development Corporation. These automatic counters are stationed at some but not all entry points, meaning that collected usage data is likely much lower than actual usage. Also, the 11 months for which data was made available included two winters and no summers, which means an annualized usage estimate based on such a data set will be much lower than actual usage, since summer activity is much higher than winter activity. For these two reasons, the estimated annual usage of 340,000 should be considered a very low estimate (see Figure C.1).

Figure C.1 – Estimated Historic Usage on Schuylkill Banks

Date Range	*# Months*	*# Users*
12/15/08-2/14/09	2	35,263
2/15/09-4/15/09	2	56,641
4/16/09-6/15/09	2	80,406
9/11/09-12/7/09	2.5	92,913
12/10/09-3/4/10	2.5	46,601
Total	11	311,823
Annualized	12	340,171

Source: Schuylkill River Development Corporation (2010), Econsult Corporation (2010)

APPENDIX D – ENVIRONMENTAL IMPACT METHODOLOGY FOR ESTIMATING ENVIRONMENT IMPACT FROM INCREASED BICYCLE COMMUTING

As people switch from driving to bicycling as a result of the existence of a fully connected waterfront greenway, reducing the number miles driven within the City of Philadelphia by 1 million miles has significant environmental implications.[132] Assuming average fuel efficiencies and the 2009 average cost of gasoline that **represents 2,600 barrels of oil not purchased, 49,000 gallons of gasoline not consumed, and $114,000 in gasoline costs not incurred** (see Figure D.1). It also means that there were about **440 tons of carbon dioxide (CO2) not emitted**, among other pollutants (see Figure D.2). It is estimated that the amount of pollutants not emitted because of fewer miles driven as a result of increased bicycle commuting translates into about **$37,000 per year in "externality costs" avoided by the City** (see Figure D.3.).[133]

Figure D.1 – Estimated Gas and Oil Not Consumed Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Annual Vehicles Miles Not Driven	1,098,000
Average Fuel Efficiency (miles per gallon)	22.5
Gallons of Gas Not Used	48,800
Average 2009 Price of Gasoline	$2.33
Total Amount Not Spent on Gasoline	$113,704
Gallons of Gas Produced per Barrel of Oil Refined	18.56
Total Barrels of Oil Not Consumed	2,629

Source: Econsult Corporation (2010), Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008)

[132] In fact, the impact may be greater. Congestion costs do not have a linear relationship to vehicle miles driven: during off-peak times, adding one additional car may have no discernible impact on congestion, while during peak times, adding one additional car may have a disproportionately high impact on congestion. Since commuting trips are during peak times, taking cars off the road during those times will be particularly impactful in terms of congestion. But, to be conservative, we will assume a straight one-to-one relationship between vehicle miles not driven and congestion reduced.

[133] "Externality cost" estimates attempt to translate pollutants emitted into social and economic costs incurred, in the form of such negative impacts as reduction in air and water quality. "Modeling the Effects of Urban Vegetation on Air Pollution," Air Pollution Modeling and Its Application XII (1998).

Figure D.2 – Estimated Annual Pollutants Not Emitted As a Result of Fewer Miles Driven within the City Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Operational Emissions	Grams per VMT	Total Pollution Avoided (tons)
CO2	365.000	442
SO2	0.020	0.02
CO	9.500	11.50
NOX	0.800	0.97
VOC	0.280	0.34
PM10	0.110	0.13

Non-Operational Emissions	Grams per VMT	Total Pollution (tons)
Startup - CO	2.400	2.90
Startup - NOX	0.150	0.18
Startup - VOC	0.220	0.27
Brake Wear - PM10	0.010	0.01
Tire Wear - PM10	0.010	0.01
Evaporative Losses - VOC	0.810	0.98

Source: Econsult Corporation (2010), Bureau of Transportation Statistics (2009), Energy Information Agency (2010), University of California at Berkeley (2008)

Figure D.3 – Estimated "Externality" Cost of Annual Pollutants Not Emitted As a Result of Fewer Miles Driven within the City Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Pollutant	Total Pollution Reduction (tons)	Costs per Ton ($)	Total Benefits
CO2	442	$21	$9,277
SO2	0.02	$2,370	$57
CO	11.50	$1,280	$14,718
NOX	0.97	$9,685	$9,378
VOC	0.34	$9,040	$3,064
PM10	0.13	$6,460	$860
Total		Total	$37,354

Source: Econsult Corporation (2010), Air Pollution Modeling and Its Application XII (1998)

Importantly, actual CO2 emissions are actually reduced by more than just that which is associated with those who change their commuting patterns, for taking that many miles of car usage off the road has an incremental effect on the travel time of those drivers who are on the road, by reducing congestion. It may seem a small and perhaps imperceptible difference, but it has significant environmental consequences, given the vast amounts of travel delay, excess fuel consumed, and overall time and money costs associated with congestion. That 1 million miles not driven each year because of the existence of a fully connected waterfront greenway means **about 22,000 fewer hours of travel delay, 14,000 gallons of gas not consumed, and $62,000 in congestion costs not borne** (see Figure D.4).

Figure D.4 – Estimated Annual Congestion Costs Avoided by Other Drivers As a Result of Fewer Miles Driven within the City Due to Increased Bicycle Commuting on a Fully Connected Waterfront Greenway

Description	2009 Region-wide Totals	Decrease Because of Greenway
Miles Driven in the Region (2005)	5,663,157,500	1,098,000
Travel Delay (hours)	112,074,000	21,700
Excess Fuel Consumed (gallons)	71,262,000	13,800
Congestion Costs ($)	$320,000,000	$62,000

Source: Econsult Corporation (2010), Delaware Valley Regional Planning Commission (2009), Texas Transportation Institute (2009), University of California at Berkeley (2008)

APPENDIX E – ESTIMATES OF HEALTH CARE COST IMPACTS FROM ACTIVE USES ON A FULLY CONNECTED WATERFRONT GREENWAY

Figure E.1 – Estimated Number of Working Age People in Philadelphia Who Exercise Moderately or Strenuously

Category	Number	Source
Population	1,448,911	US Census Bureau (2009)
Working Age Population	1,033,074	US Census Bureau (2009)
% Who Exercise Regularly	33%	SCORP Survey (2009)
# Who Exercise Regularly	340,914	

Source: US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.2 – Direct Health Care Cost Reductions Estimates Associated with a Fully Connected Waterfront Greenway in Philadelphia

		Low	Expected	High	Source
Savings per Exerciser		$308.1	$475.1	$642.1	Pratt et al (2000)
Total # Exercisers	340,914				Census/SCORP (2009)
Total Savings ($M)		$105.0	$162.0	$218.9	
% Attributable to Open Space	41%				SCORP (2009), Econsult (2010)
Attributable to Open Space ($M)		$43.1	$66.4	$89.8	
% Attributable to Greenway	5%				Econsult (2010)
Attributable to Greenway ($M)		$2.2	$3.3	$4.5	

Source: Pratt et al (2000), US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.3 – Indirect Health Care Cost Reductions Associated with a Fully Connected Waterfront Greenway in Philadelphia

		Low	Expected	High	Source
Savings per Exerciser		$924.3	$1,425.3	$1,926.3	Chenoweth (2005)
Total # Exercisers	340,914				Census/SCORP (2009)
Total Savings ($M)		$315.1	$485.9	$656.7	
% Attributable to Open Space	41%				SCORP (2009), Econsult (2010)
Attributable to Open Space ($M)		$129.2	$199.2	$269.3	
% Attributable to Greenway	5%				Econsult (2010)
Attributable to Greenway ($M)		$6.5	$10.0	$13.5	

Source: Chenoweth (2005), US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.4 – Direct Worker Compensation Cost Reductions Associated with a Fully Connected Waterfront Greenway in Philadelphia

		Low	Expected	High	Source
Savings per Exerciser		$6.0	$10.0	$12.0	Chenoweth and Bortz (2005)
Total # Exercisers	340,914				Census/SCORP (2009)
Total Savings ($M)		$2.0	$3.4	$4.1	
% Attributable to Open Space	41%				SCORP (2009), Econsult (2010)
Attributable to Open Space ($M)		$0.8	$1.4	$1.7	
% Attributable to Greenway	5%				Econsult (2010)
Attributable to Greenway ($M)		$0.0	$0.1	$0.1	

Source: Chenoweth and Bortz (2005), US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.5– Indirect Worker Compensation Cost Reductions Associated with a Fully Connected Waterfront Greenway in Philadelphia

		Low	Expected	High	Source
Savings per Exerciser		$24.0	$40.0	$48.0	Chenoweth (2005)
Total # Exercisers	340,914				Census/SCORP (2009)
Total Savings ($M)		$8.2	$13.6	$16.4	
% Attributable to Open Space	41%				SCORP (2009), Econsult (2010)
Attributable to Open Space ($M)		$3.4	$5.6	$6.7	
% Attributable to Greenway	5%				Econsult (2010)
Attributable to Greenway ($M)		$0.2	$0.3	$0.3	

Source: Chenoweth (2005), US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.6 – Lost Productivity Cost Reductions Associated with a Fully Connected Waterfront Greenway in Philadelphia

		Low	Expected	High	Source
Savings per Exerciser		$1,630.0	$1,918.0	$2,112.0	Chenoweth and Bortz (2005)
Total # Exercisers	340,914				Census/SCORP (2009)
Total Savings ($M)		$555.7	$653.9	$720.0	
% Attributable to Open Space	41%				SCORP (2009), Econsult (2010)
Attributable to Open Space ($M)		$227.8	$268.1	$295.2	
% Attributable to Greenway	5%				Econsult (2010)
Attributable to Greenway ($M)		$11.4	$13.4	$14.8	

Source: Chenoweth and Bortz (2005), US Census Bureau (2009), Commonwealth of Pennsylvania Department of Conservation and Natural Resources (2009), Econsult Corporation (2010)

Figure E.7 – Total, All Health Care Cost Reduction Categories Associated with a Fully Connected Waterfront Greenway in Philadelphia

	Low	Expected	High
Savings per Exerciser	$2,892.4	$3,868.4	$4,740.4
Total Savings ($M)	$986.1	$1,318.8	$1,616.1
Attributable to Open Space ($M)	$404.3	$540.7	$662.6
Attributable to Greenway ($M)	$20.2	$27.0	$33.1

Source: Econsult Corporation (2010)

APPENDIX F – ECONOMIC AND FISCAL IMPACT MODEL METHODOLOGY

F.1 Economic Impact Model

The methodology and input-output model used in this economic impact analysis are considered standard for estimating such expenditure impacts, and the results are typically recognized as reasonable and plausible effects, based on the assumptions (including data) used to generate the impacts. In general, one can say that any economic activity can be described in terms of the total output generated from every dollar of direct expenditures. If an industry in a given region sells $1 million of its goods, there is a direct infusion of $1 million into the region. These are referred to as *direct expenditures*.

However, the economic impact on the region does not stop with that initial direct expenditure. Regional suppliers to that industry have also been called upon to increase their production to meet the needs of the industry to produce the $1 million in goods sold. Further, suppliers of these same suppliers must also increase production to meet their increased needs as well. These are referred to as *indirect expenditures*. In addition, these direct and indirect expenditures require workers, and these workers must be paid for their labor. These wages and salaries will, in turn, be spent in part on goods and services produced locally, engendering another round of impacts. These are referred to as *induced expenditures*.

Direct expenditures are fed into a model constructed by Econsult Corporation and based on data provided by the US Department of Commerce's Bureau of Economic Analysis through its Regional Input-Output Modeling System (RIMS II). The model then produces a calculation of the total expenditure effect on the regional economy. This total effect includes the initial direct expenditure effect, as well as the ripple effects described, the indirect and induced expenditure effects.

Part of the total expenditure effect is actually the increase in total wages and salaries (usually referred to as earnings), which the model can separate from the expenditure estimates. Direct payroll estimates are fed into the "household' industry of the input-output model. Impacts of this industry are estimated using the personal consumption expenditure breakdown of the national input-output table and are adjusted to account for regional consumption spending and leakages from personal taxes and savings. The direct, indirect, and induced earnings represent a component of the total economic impact attributable to wages and salaries. Finally, the model calculates the total expenditures affecting the various industries and translates this estimate into an estimate of the total labor (or jobs) required to produce this output.[134]

[134] In the input-output model, the estimate of increased employment will always be in terms of the employment required for a given level of production, usually referred to as *person-years* of employment. As such, these estimates cannot be interpreted as specifying *permanent jobs.*

In short, the input-output model estimates the total economic activity in a region that can be attributed to the direct demand for the goods or services of various industries. This type of approach is used to estimate the total economic activity attributable to the expenditures associated with various types of spending in the region.

F.2 Fiscal Impact Model

The RIMS II model provides estimates of the economic impact of a new project or program on the regional economy. It does not, however, estimate the fiscal impact of the increased economic activity on state and local governments. Econsult has constructed a model that takes the output from the RIMS II model and generates detailed estimates of the increases in state and local tax collections that arise from the new project. Those revenues are in fact a part of the total economic impact of a new project that is often ignored in conventional economic impact analyses.

The RIMS II model provides estimates of direct, indirect, and induced expenditures, earnings, and employment within the defined region. The Econsult fiscal impact model combines the RIMS II output with U. S. Census Bureau County Business Patterns data to produce estimates of the distribution of additional employment and earnings by county. In addition, the 2000 Census "Journey to Work" data on commuting flows are utilized to estimate income earned by residents of each county within the region, regardless of where they work. The fiscal model can then estimate the increase in earned income taxes by county and for the state as a whole resulting from the new project. For complex cases, like Philadelphia, the model can differentiate between residents and nonresidents and apply the proper wage tax rate. Pennsylvania state business and sales taxes, as well as business taxes in Philadelphia, are estimated based on the most recent data on average sales tax base per employee by major industry, as contained in publications from the Pennsylvania Department of Revenue.

Figure F.1 – Glossary of Terms for Input-Output Models

Multiplier Effect – the notion that initial outlays have a ripple effect on a local economy, to the extent that direct expenditures lead to indirect and induced expenditures.

Economic Impacts – total expenditures, employment, and earnings generated.

Fiscal Impacts – local and/or state tax revenues generated.

Direct Expenditures – initial outlays usually associated with the project or activity being modeled; examples: one-time upfront construction and related expenditures associated with a new or renovated facility, annual expenditures associated with ongoing facility maintenance and/or operating activity.

Direct Employment – the full time equivalent jobs associated with the direct expenditures.

Direct Earnings – the salaries and wages earned by employees and contractors as part of the direct expenditures.

Indirect Expenditures – indirect and induced outlays resulting from the direct expenditures; examples: vendors increasing production to meet new demand associated with the direct expenditures, workers spending direct earnings on various purchases within the local economy.

Indirect Employment – the full time equivalent jobs associated with the indirect expenditures.

Indirect Earnings – the salaries and wages earned by employees and contractors as part of the indirect expenditures.

Total Expenditures – the sum total of direct expenditures and indirect expenditures.

Total Employment – the sum total of direct employment and indirect employment.

Total Earnings – the sum total of direct earnings and indirect earnings.

Source: Econsult Corporation (2009)

APPENDIX G – OTHER RECENT STUDIES ON THE PROPERTY VALUE IMPACT ON NEARBY PARCELS OF GREEN SPACE AND GREENWAY ADDITIONS

Amenity Being Analyzed	*Estimated Effect*	*Source*
Abandoned or vacant industrial sites that were converted to green space in Philadelphia	Prior to conversion, homes within ¼ mile of an abandoned/vacant site were valued at 19.7 percent less than comparable homes that were not within a ¼ mile of an abandoned/vacant site. As a result of the announcement of conversion but prior to conversion, house prices near future converted sites had an appreciation rate that was 0.70 percent per year higher than the citywide average. Immediately following conversion to green space, homes within a ¼ mile increased in value by 7.2 percent on average, relative to comparable homes that were not proximate to such sites. In the years following conversion, homes within a ¼ mile of the site experienced an additional annual appreciation rate of 5.2 percent per year, relative to comparable homes that are not near such sites.	"Valuing the Conversion of Urban Green Space," Econsult Corporation (June 2010). (For Pennsylvania Horticultural Society.)
Protected open space larger than 5 acres in Philadelphia	Homes within ¼ mile of sites have a 7 percent premium in value, declining to 0 percent within 1 mile	"Quantifying the Economic Value of Protected Open Space in Southeastern Pennsylvania," Economy League of Greater Philadelphia Econsult Corporation / Keystone Conservation Trust (August 2010). (For GreenSpace Alliance and the Delaware Valley Regional Planning Commission.)

Amenity Being Analyzed	*Estimated Effect*	*Source*
Various trailways across the US	Apex, NC: The Shepard's Vineyard housing development added $5,000 to the price of 40 homes adjacent to the regional greenway – and those homes were still the first to sell. Salem, OR: land adjacent to a greenbelt was found to be worth about $1,200 an acre more than land only 1000 feet away. Seattle, WA: Homes bordering the 12-mile Burke-Gilman trail sold for 6 percent more than other houses of comparable size. Brown County, WI: Lots adjacent to the Mountain Bay Trail sold faster for an average of 9 percent more than similar property not located next to the trail. Dayton, OH: Five percent of the selling price of homes near the Cox Arboretum and park was attributable to the proximity of that open space.	"The Economic Benefits of Parks and Open Space," The Trust for Public Land (2005), "Economic Benefits of Trails and Greenways," The Rails-to-Trails Conservancy (2005).
Pennypack Park in Philadelphia	In the vicinity of Philadelphia's 1,300-acre Pennypack Park, property values correlate significantly with proximity to the park. In 1974, the park accounted for 33 percent of the value of land 40 feet away from the park, nine percent when located 1,000 feet away, and 4.2 percent at a distance of 2,500 feet.	"The Effect of a Large Urban Park on Real Estate Value," American Institute of Planning Journal (July 1974).

APPENDIX H – ADDITIONAL DETAIL ON ESTIMATED PROPERTY VALUE AND PROPERTY TAX REVENUE IMPACT FOR HOUSES LOCATED WITHIN ¼-MILE OF THE FULLY CONNECTED WATERFRONT GREENWAY

Figure H.1– Estimated Property Value Impact for Houses Located within ¼-Mile of the Waterfront Greenway, Assuming a 15-Year Build-Out Period (in $M) (Detail)[135]

		Announced in Year																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total PV
Year	0	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,700
Year	1	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,702
Year	2	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,727
Year	3	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,770
Year	4	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,823
Year	5	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,882
Year	6	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,940
Year	7	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,998
Year	8	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,057
Year	9	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,115
Year	10	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,173
Year	11	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,232
Year	12	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,290
Year	13	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,348
Year	14	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$313	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,406
Year	15	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$316	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,465
Year	16	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$338	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,521
Year	17	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$356	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,554
Year	18	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$367	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,570
Year	19	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	20	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	21	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	22	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	23	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	24	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	25	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	26	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	27	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	28	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	29	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574
Year	30	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$372	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,574

Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[135] The houses currently located within a quarter-mile of a river are estimated to have an aggregate property value of $4.7 billion. Assuming a 15-year build-out period, greenways near 1/15th of the aggregate value of houses near a river is added each year: announced in one year, and then built the next year. The columns denote the aggregate value of houses near each year's amount of greenways being added over time, and the rows denote the aggregate value of all houses near a river each year.

Figure H.2 – Estimated Property Value Impact for Houses Located within ¼-Mile of the Potential Waterfront Greenway, Assuming a 30-Year Build-Out Period (in $M) (Detail)[136]

		Announced in Year																															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total PV
Year	0	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,700
Year	1	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,701
Year	2	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,714
Year	3	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,735
Year	4	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,762
Year	5	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,791
Year	6	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,820
Year	7	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,849
Year	8	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,878
Year	9	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,907
Year	10	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,937
Year	11	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,966
Year	12	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$4,995
Year	13	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,024
Year	14	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,053
Year	15	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,082
Year	16	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,112
Year	17	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,141
Year	18	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,170
Year	19	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,199
Year	20	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,228
Year	21	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$157	$5,257
Year	22	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$157	$5,286
Year	23	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$157	$5,316
Year	24	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$157	$5,345
Year	25	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$157	$5,374
Year	26	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$157	$5,403
Year	27	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$157	$5,432
Year	28	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$157	$5,461
Year	29	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$157	$5,490
Year	30	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$186	$184	$178	$169	$158	$5,520

Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[136] The houses currently located within a quarter-mile of a river are estimated to have an aggregate property value of $4.7 billion. Assuming a 30-year build-out period, greenways near 1/30th of the aggregate value of houses near a river is added each year: announced in one year, and then built the next year. The columns denote the aggregate value of houses near each year's amount of greenways being added over time, and the rows denote the aggregate value of all houses near a river each year.

Figure H.3 – Estimated Property Value and Property Tax Revenue Impact for Houses Located within ¼-Mile of the Waterfront Greenway, Assuming a 15-Year Build-Out Period (in $M) (Summary)[137]

Year	*Total PV*	*PV Δ Yr1*	*Annual PTR Δ Yr1*	*Cumul PTR Δ Yr 1*
0	$4,700	$0	$0	$0
1	$4,702	$2	$0	$0
2	$4,727	$27	$1	$1
3	$4,770	$70	$2	$3
4	$4,823	$123	$3	$6
5	$4,882	$182	$5	$11
6	$4,940	$240	$6	$17
7	$4,998	$298	$8	$25
8	$5,057	$357	$9	$34
9	$5,115	$415	$11	$45
10	$5,173	$473	$13	$58
11	$5,232	$532	$14	$72
12	$5,290	$590	$16	$88
13	$5,348	$648	$17	$105
14	$5,406	$706	$19	$123
15	$5,465	$765	$20	$144
16	$5,521	$821	$22	$165
17	$5,554	$854	$23	$188
18	$5,570	$870	$23	$211
19	$5,574	$874	$23	$234
20	$5,574	$874	$23	$257
21	$5,574	$874	$23	$280
22	$5,574	$874	$23	$303
23	$5,574	$874	$23	$326
24	$5,574	$874	$23	$350
25	$5,574	$874	$23	$373
26	$5,574	$874	$23	$396
27	$5,574	$874	$23	$419
28	$5,574	$874	$23	$442
29	$5,574	$874	$23	$465
30	$5,574	$874	$23	$488

Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[137] "Total PV" = aggregate property value of houses within a quarter-mile of a river, at the end of each year. "PV Δ Yr1" = gain in aggregate property value of houses within a quarter-mile of a river, as compared to Year 1. "Annual PTR Δ Yr1" = difference that year in aggregate property tax revenues for houses within a quarter-mile of a river, as compared to Year 1. "Cumul PTR Δ Yr 1" = cumulative difference in aggregate property tax revenues for houses within a quarter-mile of a river, starting from Year 1.

Figure H.4 – Estimated Property Value and Property Tax Revenue Impact for Houses Located within ¼-Mile of the Waterfront Greenway, Assuming a 30-Year Build-Out Period (in $M) (Summary)[138]

Year	*Total PV*	*PV Δ Yr1*	*Annual PTR Δ Yr1*	*Cumul PTR Δ Yr 1*
0	$4,700	$0	$0	$0
1	$4,701	$1	$0	$0
2	$4,714	$14	$0	$0
3	$4,735	$35	$1	$1
4	$4,762	$62	$2	$3
5	$4,791	$91	$2	$5
6	$4,820	$120	$3	$9
7	$4,849	$149	$4	$12
8	$4,878	$178	$5	$17
9	$4,907	$207	$5	$23
10	$4,937	$237	$6	$29
11	$4,966	$266	$7	$36
12	$4,995	$295	$8	$44
13	$5,024	$324	$9	$52
14	$5,053	$353	$9	$62
15	$5,082	$382	$10	$72
16	$5,112	$412	$11	$83
17	$5,141	$441	$12	$94
18	$5,170	$470	$12	$107
19	$5,199	$499	$13	$120
20	$5,228	$528	$14	$134
21	$5,257	$557	$15	$149
22	$5,286	$586	$16	$164
23	$5,316	$616	$16	$180
24	$5,345	$645	$17	$197
25	$5,374	$674	$18	$215
26	$5,403	$703	$19	$234
27	$5,432	$732	$19	$253
28	$5,461	$761	$20	$273
29	$5,490	$790	$21	$294
30	$5,520	$820	$22	$316

Source: Board of Revision of Taxes (2010), Econsult Corporation (2010)

[138] "Total PV" = aggregate property value of houses within a quarter-mile of a river, at the end of each year. "PV Δ Yr1" = gain in aggregate property value of houses within a quarter-mile of a river, as compared to Year 1. "Annual PTR Δ Yr1" = difference that year in aggregate property tax revenues for houses within a quarter-mile of a river, as compared to Year 1. "Cumul PTR Δ Yr 1" = cumulative difference in aggregate property tax revenues for houses within a quarter-mile of a river, starting from Year 1.

APPENDIX I – ADDITIONAL DETAIL ON ESTIMATES OF ECOLOGICAL SERVICES RENDERED BY A FULLY CONNECTED WATERFRONT GREENWAY

Figure I.1 – Characteristics of the Waterfront Greenway

Description	*100-Ft Greenway*	*50-Ft Greenway*
Total Greenway Area (acres)	606	303
Percent that is Trail (i.e. impervious)	15%	30%
Total Pervious Surface Area (acres)	515	212
Percent that is Tree Canopy Cover	16%	16%
Total Tree Canopy Cover (acres)	82	34

Source: Econsult Corporation (2010),

Figure I.2 – Per-Acre Ecosystem Service Values

	Literature Values			*Values used in the Analysis*		
Ecosystem Service Values ($)	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
Disturbance Prevention	$ 144	$ 7	$ 235	$ 14	$ 1	$ 24
Water Supply	$ 1,035	$ 5	$ 4,791	$ 104	$ 0	$ 479
Soil Formation	$ 4	$ 1	$ 7	$ 4	$ 1	$ 7
Waste Treatment	$ 51	$ 51	$ 51	$ 5	$ 5	$ 5
Pollination	$ 15	$ 15	$ 15	$ 15	$ 15	$ 15
Biological Control	$ 14	$ 14	$ 14	$ 14	$ 14	$ 14
Wildlife Habitat	$ 490	$ 490	$ 1,453	$ 49	$ 49	$ 145
Total	$ 1,754	$ 584	$ 6,567	$ 205	$ 86	$ 689

Source: Econsult Corporation (2010), Costanza et al (2006)

Figure I.3 – Ecosystem Service Benefits Generated by the Waterfront Greenway

Ecosystem Service Values ($)	*100-Ft Mean*	*100-Ft Min*	*100-Ft Max*	*50-Ft Mean*	*50-Ft Min*	*50-Ft Max*
Disturbance Prevention	$7,414	$362	$12,115	$3,053	$149	$4,988
Water Supply	$53,341	$241	$246,817	$21,964	$99	$86,864
Soil Formation	$1,808	$603	$3,616	$745	$248	$1,489
Waste Treatment	$2,652	$2,652	$2,652	$1,092	$1,092	$1,092
Pollination	$7,835	$7,835	$7,835	$3,226	$3,226	$3,226
Biological Control	$7,233	$7,233	$7,233	$2,978	$2,978	$2,978
Wildlife Habitat	$25,254	$25,254	$74,859	$10,399	$10,399	$30,824
Total	$105,538	$44,180	$355,127	$43,457	$18,192	$131,462

Source: Econsult Corporation (2010), Costanza et al (2006)

Figure I.4 – Air Pollution Removal and Carbon Storage and Sequestration by the Waterfront Greenway (tons)

Air Pollution Removal (tons)	*100-Ft Expected*	*100-Ft Low*	*100-Ft High*	*50-Ft Expected*	*50-Ft Low*	*50-Ft High*
Carbon Sequestration	105	100	110	43	41	110
Carbon Storage	3,324	3,302	3,346	1,369	1,360	1,378
O3	1.27	0.34	1.64	0.52	0.14	0.68
PM10	1.33	0.52	2.07	0.55	0.21	0.85
NO2	0.64	0.32	0.84	0.64	0.13	0.35
SO2	0.28	0.15	0.47	0.12	0.06	0.19
CO	0.07	0.07	0.07	0.03	0.03	0.03

Source: Econsult Corporation (2010), Nowak et al (2006)

Figure I.5 – Air Pollution Removal by the Waterfront Greenway ($$)

Air Pollution Removal ($)	*100-Ft Expected*	*100-Ft Low*	*100-Ft High*	*50-Ft Expected*	*50-Ft Low*	*50-Ft High*
O3	$12,560	$3,327	$16,226	$5,172	$1,370	$16,226
PM10	$8,793	$3,445	$13,689	$3,621	$1,418	$5,637
NO2	$6,314	$3,123	$8,351	$6,314	$1,286	$3,439
SO2	$681	$366	$1,130	$281	$151	$465
CO	$96	$96	$96	$40	$40	$40
Total	$28,445	$10,357	$39,492	$15,427	$4,265	$25,807

Source: Econsult Corporation (2010), Nowak et al (2006), Murray et al (1994)

Figure I.6 – Carbon Storage and Sequestration by the Waterfront Greenway ($$)

Carbon Storage and Sequestration ($)	*100-Ft Expected*	*100-Ft Low*	*100-Ft High*	*50-Ft Expected*	*50-Ft Low*	*50-Ft High*
Carbon Sequestration	$2,178	$2,075	$2,282	$897	$854	$2,282
Carbon Storage	$68,753	$68,299	$69,207	$28,310	$28,123	$28,497
Total	$70,931	$70,374	$71,488	$29,207	$28,978	$30,778

Source: Econsult Corporation (2010), Nowak et al (2006)

Figure I.7 – Aggregate Environmental Benefits Generated by the Waterfront Greenway

All Environmental Benefits	*100-Ft Expected*	*100-Ft Low*	*100-Ft High*	*50-Ft Expected*	*50-Ft Low*	*50-Ft High*
Ecosystem Service Values	$105,538	$44,180	$355,127	$43,457	$18,192	$131,462
Air Pollution Removal	$28,445	$10,357	$39,492	$15,427	$4,265	$25,807
Carbon Storage and Sequestration	$70,931	$70,374	$71,488	$29,207	$28,978	$30,778
Aggregate Environmental Benefits	$204,914	$124,911	$466,108	$88,091	$51,434	$188,047

Source: Econsult Corporation (2010), Costanza et al (2006), Nowak et al (2006), Murray et al (1994)