

Appendix J: Methodology for Estimating Demand, Economic Benefits, and Economic Impacts

Applicants for TIGER Discretionary Grants are generally required to identify, quantify, and compare expected benefits and costs of proposed projects. The following sections of this proposal provide expected estimates of identified project benefits and costs. Detailed cost estimates have been developed by local transportation planners for the proposed project. Many of the benefit estimates and much of the underlying methodology presented in this proposal rely heavily on the recent work of Krizek et al. ¹ in the National Cooperative Highway Research Program (NCHRP) Report 552. NCHRP Report 552 was the first attempt to create a standard method for quantifying the economic impacts of investments in bicycle facilities. This work was a major step in providing necessary information to planners, engineers, policy makers, and the general public about the impacts of bicycle facilities and providing a way to compare the costs of the facility with potential benefits. The project produced a web-based bicycle facility planning tool to assist in the development of cost and benefit estimates for proposed bicycle facilities (<http://www.bicyclinginfo.org/bikecost/>). The tool uses data from recent studies of bicycle facility demand, location-specific information on population and commute shares from the U.S. Census and other government surveys, and local user input to develop cost and benefit estimates.

BICYCLE FACILITY DESIGN AND CONSTRUCTION COSTS AND IMPACTS

Detailed cost estimates for the proposed bicycling facilities have been developed by the City of Wilmington, Transportation Planning office ². An important aspect of the proposed project is that the facility developer, the City of Wilmington, owns or has right-of-way/easement over all land needed for the project. This eliminates a common source of delay in project implementation--securing necessary property and right-of-way.

The proposed facilities will add on-street and off-street bike lanes to connect currently disconnected on-street and off-street bike lanes with the City of Wilmington urban center / riverfront area, the University of North Carolina Wilmington, the regional shopping mall, two primary suburban retail areas, many residential areas including low-income areas, city parks, and Wrightsville Beach, NC. An estimated 47,778 feet (9.05 miles) of off-street bicycle paths and 42,665 feet (8.08 miles) of on-street bicycle lanes will be provided at an estimated cost of \$11.94 million, including design and construction ². Appropriate improvements in bicycle and pedestrian crossings will also be provided at an additional cost of \$3.98 million, including design and construction, for a total project cost of \$15.92 million. These new bicycle paths and lanes will connect a currently disconnected system of 11.8 miles of off-street bike trails and 7.5 miles of on-street bike lanes into one, continuous system 36.4 miles in total length.

Appropriate improvements in bicycle and pedestrian crossings will also be provided at an additional cost of \$3.98 million, including design and construction, for a total project cost of \$15.92 million ². The equivalent annual cost amortized over 30-years assuming a 3% cost of funds is \$812,227 per year.

IMPLAN ³ economic input-output modeling software and database (2006 database) is used to estimate the economic impacts of facility design and construction on the local economy.

IMPLAN is a leading software package used by university researchers, government and industry nationwide to conduct economic impact analysis⁴. We estimate that \$15.92 million in facility design and construction expenditures will generate an additional \$13.2 million in business activity (i.e., sales) in the local economy through economic multiplier effects. An estimated 159 jobs earning \$6.6 million in wages and salaries will be directly supported by the design and construction work itself, with an additional 118 jobs paying \$4.5 million in wages and salaries supported by economic multiplier effects. These are the one-time (not annually recurring) effects

BICYCLE FACILITY OPERATION AND MAINTENANCE COSTS AND IMPACTS

Routine trail operation and maintenance can be defined as maintenance that is needed to keep the trail operating in a safe and usable condition, not involving major trail development for reconstruction. Below is a list of routine maintenance activities (American Trails 2009).

<http://www.americantrails.org/resources/ManageMaintain/index.html>

- Yearly facility evaluation to determine the need for minor repairs
- Removing encroaching vegetation
- Mowing
- Map/signage updates
- Trash removal/litter clean-up
- Flood or rain damage repair: silt clean up, culvert clean out, etc.
- Patching, minor re-grading, or concrete panel replacement
- Planting, pruning, and general landscaping

Research was conducted to determine annual per mile maintenance costs for off-street bike trails. (It is assumed that on-street bike trails will be maintained as part of routine highway maintenance and will not increase highway maintenance costs significantly.) Some estimates are specific to a trail surface type and others are not. Maintenance and operation costs are very similar whether a surface is crushed gravel or asphalt. Below is a list of maintenance costs from various sources:

- \$1,500 per mile provided in the Iowa Trails 2000 plan by the Iowa Department of Transportation (includes a mixture of different trail surfaces)
- \$2,525 per mile summarized by the Milwaukee County Park System (all asphalt paths)
- \$1,200 per mile (as an absolute minimal cost) in the Rail Trail Maintenance & Operation Manual provided by the Rails-to-Trails Conservancy.
- \$2,077 per mile for government run trails provided in the Rail Trail Maintenance & Operation Manual provided by the Rails-to-Trails Conservancy.
- \$2,042.06 per mile of unpaved trail in the Trail Cost Model - Draft by the Wisconsin Department of Natural Resources.

For the purposes of the proposed project, we will assume off-street bike trail operation and maintenance costs of \$2,000/mile/year. For the 9.05 miles of off-street bicycle trails to be constructed under this proposal, estimated operation and maintenance costs are therefore \$18,100 per year. (The costs of maintaining the additional 11.8 miles of preexisting off-street bicycle

trails would be an additional \$23,600 per year; however, these costs will be incurred whether or not the proposed project is approved.) These relatively small expenditures would be expected to add few if any additional jobs to the regional economy and would support little additional labor income. The necessary work would likely be completed by existing highway and/or parks and recreation personnel.

NUMBER OF NON-UNIVERSITY BICYCLISTS

Estimating the demand for different types of cycling facilities forms the basis to estimate user travel time and cost savings as well as reduced traffic congestion, energy consumption, and air pollution. We use the model of bicycling facility demand recently developed by Krizek et al.¹ and Poindexter et al. (2007)⁵ for the National Cooperative Highway Research Program.

Krizek et al.¹ found that people are more likely to ride a bicycle if they live within 2,400 meters (1.5 mile) of a bicycle trail or bike lane facility. The likelihood of bicycling increases further at shorter distances of 1,600 (1 mile) and 800 (0.5 mile) meters. We follow Krizek et al.'s¹ methodology but make the conservative assumption that only those residents living within 1,600 meters (1 mile) of the facility will use it. That is, we estimate existing and new bicycle commuting demand for a 1,600 meter buffer region around the proposed 36.50-mile bike trail system, including both existing segments and proposed new construction. City of Wilmington Geographic Information System (GIS) analysis² finds that the number of residents living within the 800 meter buffer region is 48,822. Given a total bike trail length of 36.50 miles, the population density in the 800 meter buffer region is 1,338 persons per square mile. We assume that the population density is the same in the 800-1,600 meter buffer region. (This estimate is likely conservative, as the U.S. Census Bureau's estimate of Wilmington, NC, residential population density in 2006 was 2,340 persons per square mile.)

To identify the number of existing, pre-project, daily bicycle commuters, we follow Krizek et al.¹ in multiplying the estimated number of residents in each buffer region, R_i , where $i = 800$ and 1600 , by 0.80 the proportion of adults in the resident population, based on regional U.S. Census data. We then multiply by 0.50 , the proportion of adults who are working commuters (all travel modes), again based on U.S. Census data. Next, we multiply by the share of working commuters who commute using bicycles, C ; this proportion is 0.0058 for the Wilmington, NC, region, based on the 2007 American Community Survey of the U.S. Census Bureau (USCB-ACS 2007)⁶. This proportion does not include the commuting activity of university students going to school.

$$\text{Existing adult, non-student bicycle commuters} = \sum_i C \cdot 0.50 \cdot 0.80 \cdot R_i$$

where $C = 0.0058$ for the Wilmington, NC region (2007 USCB).

This methodology produces an estimate of 243 existing, pre-project, non-student, daily bicycle commuters. This represents 48 percent of the estimated 503 existing, pre-project, non-student, daily bicycle commuters in New Hanover County, NC, in 2007 (USCB-ACS 2007). [New Hanover County had an estimated 90,303 workers in 2007. The estimated 503 bike commuters represents 0.56% of the working population, a value in the middle of the range of 0.10% for

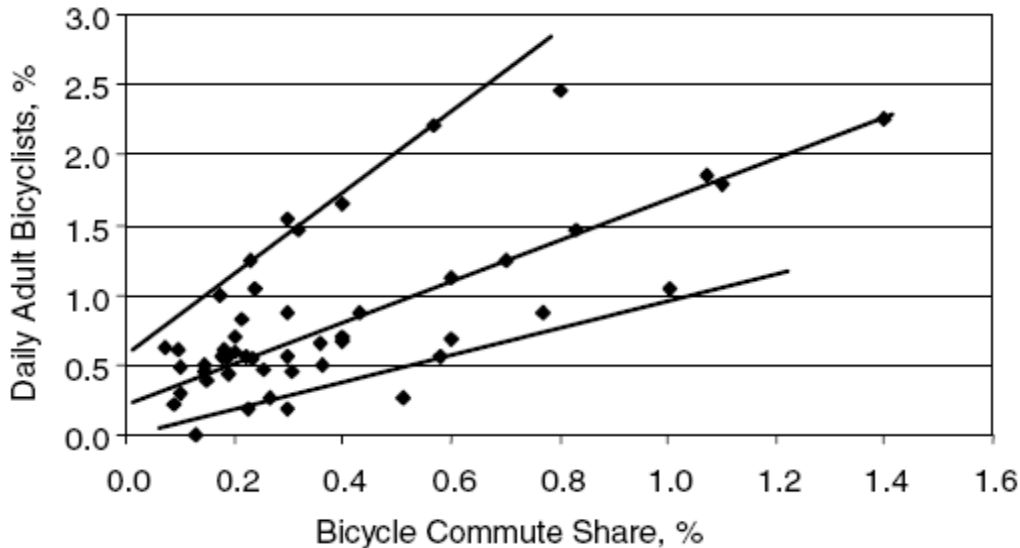
Memphis, TN, the lowest estimate, and 3.5% for Portland, OR, the highest estimate, in a tabulation of "bike to work" ratios for 50 American Cities (USCB-ACS 2005).] That is, about 243 non-student individuals are commuting daily by bicycle to work in the area that will be served by the proposed bicycle facilities, and this is about half of the existing non-student bicycle commuting activity in the county. An implication of this finding is that the proposed facilities are sited in areas that will serve a large proportion of existing biking commuters.

Of course, many bicycle trips are made for purposes other than commuting to work. Krizek et al.¹ compared U.S. Census work commute shares to National Household Transportation Survey (NHTS)⁷ data and found that the total adult bicycling rate (including both commuters and non-commuters) ranges from the Census bicycle commute share C at the low end to 0.006 (0.6 percent) plus three times C at the high end (Appendix A of the NCHRP Report 552)¹. This allows us to estimate total adult bicycling rates, T, as a function of bicycle commute share C.

$$\begin{aligned} T_{\text{high}} &= 0.006 + 3C \\ T_{\text{mid}} &= 0.004 + 1.2C \\ T_{\text{low}} &= C \end{aligned}$$

where C = 0.0058 for the Wilmington, NC region (2007 USCB)

The Relationship between Bicycle Commuters as Share of All Commuters and Total Bicyclists as a Percentage of Adult Population for U.S. Metropolitan Statistical Areas (MSA's) and States. (The three trend lines are T_{high} , T_{mid} , and T_{low} . Source: Krizek et al. 2006.)



We use T_{mid} to estimate the total number of existing, adult, non-student cyclists:

$$\text{Existing adult, non-student, bicyclists (commuters and non-commuters)} = \sum_i T_{\text{mid}} \cdot 0.50 \cdot 0.80 \cdot R_i$$

To obtain the number of existing daily child cyclists, we multiply the number of residents in each buffer R_i by 0.2 to approximate the number of children, then by 0.05 to estimate the number of children who ride a bicycle on a given day (2001 NHTS shows that approximately 5% of children ride a bicycle on a given day), and then sum over regions.

$$\text{Existing child cyclists} = \sum_i 0.05 \cdot 0.2 \cdot R_i$$

Krizek et al. ¹ developed "cycling likelihood multipliers" that give the additional, new cyclists per existing cyclist for the three buffer zones ($i = 0\text{-}800\text{m}$, $800\text{-}1600\text{m}$, and $1600\text{-}2400\text{m}$) and for three classes of bicycle facility improvements, $j = \text{On-Street Bicycle Lane with Car Parking}$, $\text{On-Street Bicycle Lane without Car Parking}$, and $\text{Off-Street Bicycle Trail}$. We use the multipliers for the $0\text{-}800\text{m}$ and $800\text{-}1600\text{m}$ buffer zones. The likelihood multipliers are based on an assumption that there are no preexisting bicycle lanes/trails available fully connecting the origin and destination points in question and that the only pre-existing bicycle option is to ride on a street with car parking and without a bicycle lane.

Multiplying the number of existing cyclists in each of the cycling groups (commuters, total adults, and children) in each buffer region i by the cycling likelihood multipliers, $L_{i,j}$, provides estimates of the number of new ("induced") cyclists in each group.

$$\text{New bicycle commuters} = \sum_{i,j} L_{i,j} \cdot C \cdot 0.5 \cdot 0.8 \cdot R_i$$

$$\text{New total adult cyclists} = \sum_{i,j} L_{i,j} \cdot T_{\text{miles}} \cdot 0.5 \cdot 0.8 \cdot R_i$$

$$\text{New child cyclists} = \sum_{i,j} L_{i,j} \cdot 0.05 \cdot 0.2 \cdot R_i$$

where, for example: $L_{800\text{m}, \text{Off-Street Bicycle Trail}} = 0.51$
 $L_{1600\text{m}, \text{Off-Street Bicycle Trail}} = 0.44$

**Estimated Impact of Proposed Project on
 Number of Non-Student Bicycle Commuters and Total Non-Student Bicyclists,
 (In a one-mile (1,600 m) region around the proposed facility.)**

	Existing Pre-Project	New With Project	Percentage Change	Total Post-Project
Bicycle Non-Student Commuters	243	115	+ 47%	358
Total Non-Student Cyclists	18,117	8,696	+ 48%	26,813

Assumes 19.3 miles of existing bike facilities and 17.13 additional miles of new bike facilities constructed by TIGER project. Source: Mello 2009.

NUMBER OF UNIVERSITY-AFFILIATED BICYCLISTS

As a university town, Wilmington, NC, would be expected to have higher than average levels of bicycle commuting. For example, Nelson and Allen⁸ and Dill and Carr⁹ found that cities with colleges or universities have higher rates of bicycle commuting relative to cities without such educational institutions. The University of North Carolina Wilmington is located at the hub of the proposed bicycle facility project. University students living on campus may use bicycles to commute to off-campus jobs, to run errands, and to access other off-campus destinations such as nearby Wrightsville Beach. University students, faculty and staff living off-campus may use bicycles to commute to campus, commute to off-campus jobs, and to run errands and reach other destinations. It is anticipated that a major impact of the proposed facility will be to increase the number of bicycle trips made by university-affiliated persons, relieving regional traffic congestion, reducing regional fuel use and carbon emissions, and reducing the need for costly university auto parking facilities.

In fall 2008, the University had 12,195 students (including undergraduate and graduate students, both full-time and part-time) and 1,878 faculty and staff (including both full-time and part-time), for a total of 14,073 university-affiliated persons (UNCW-OIR 2009, UNCW-HR 2009). As of fall 2009, a total of 3,428 university persons had registered their bicycles for use on campus. Of these, 77 percent (2,635 bicycles) were registered by persons living on campus, and 23 percent (793 bicycles) were registered by persons living off-campus.

In addition to persons using registered bicycles on campus, other persons use unregistered bicycles. A random sample survey of all bicycle parking and rack locations on campus found that of 535 bicycles in the sample, 53 percent were registered and 47 percent were unregistered. Given that there are 3,428 registered bicycles in total, an estimate of the total number of unregistered bicycles is 3,040 ($3,428 * 0.47 / 0.53$). Assuming that the proportion of unregistered bicycles belonging to persons living on campus is the same as the proportion of registered bicycles belonging to persons on campus, 0.77, then a simple estimate of the number of unregistered bikes belonging to persons on campus is 2,341 ($3,040 * 0.77$). Using similar methods, a simple estimate of the number of unregistered bikes belonging to persons living off campus is 699 ($3,040 * 0.23$).

Numbers of Existing, Pre-Project, University Bicyclists, Fall 2009

	Registered	Unregistered	Totals	Percent of University Population
Living On-Campus (use bikes to run errands)	2635	2341	4976	0.354
Living Off-Campus (use bikes to commute and run errands)	793	699	1492	0.106
Total	3428	3040	6468	0.460

To estimate the impacts of the proposed project on bicycling by university-affiliated persons, we assume that the proposed project results in a percentage increase in university cyclists of 45 percent, slightly less than the estimated 47-48 percent increase in non-university cyclists resulting from the application of Krizek et al.'s ¹ methodology. We believe that a 45 percent increase is a conservative assumption, as university students are less likely to own cars and more likely to ride bicycles than the surrounding city population and are likely to respond at least as strongly to improved bicycle facilities as the non-university population. With a 45 percent increase in university bicycling, the percentage of university-affiliated persons living on-campus using bicycles increases from 35 to 51 percent, and the percentage of university-affiliated persons living off-campus using bicycles increases from 11 to 15 percent. Overall, the percentage of university-affiliated persons using bicycles increases from 46 to 67 percent.

Estimated Numbers of New, Post-Project, University Bicyclists

	Existing Totals	New Cyclists	Post-Project Totals	Percent of University Population
Living On-Campus (use bikes to run errands)	4976	2239	7215	0.513
Living Off-Campus (use bikes to commute and run errands)	1492	671	2163	0.154
Total	6468	2911	9379	0.666

Assumes 45 percent increase in University-affiliated bicyclists with construction of project.

For the purposes of this proposal, we assume that those university-affiliated bikers living off-campus use their bikes to commute to campus and to run errands, whereas those bikers living on-campus use their bikes to run errands only.

BICYCLE COMMUTER BENEFITS FROM IMPROVED BICYCLING FACILITIES

Krizek et al. (2006, Appendix D) ¹ found that bicycle commuters are willing to spend 20.38 extra minutes per trip (M) to travel on an off-street bicycle trail when the alternative is riding on a street with parked cars, 18.02 minutes for an on-street bicycle lane without parked cars, and 15.83 minutes for a lane with parked cars, each relative to riding on the street with no lane and parked cars. Assuming an hourly value of time (V) of \$12, the benefit per one-way trip (M·V/60) is \$4.08, \$3.60, and \$3.17, respectively. Following Krizek et al.'s ¹ methodology, we multiply the per-trip benefit for the appropriate facility by the number of daily existing and new commuters, including off-campus university-affiliated cyclists, then multiply by 2 to include trips both to and from work. As off-street trail may not be available for the entire commute for many commuters, we conservatively use the on-street value of \$3.60 for (M·V/60). This results in a daily commuting benefit. Multiplying the daily benefit by 47 weeks per year and 5 days per week results in an estimate of annual benefits to bicycle commuters.

$$\text{Annual benefits to bicycle commuters} = (M \cdot V/60) \cdot (\text{existing commuters} + \text{new commuters} + \text{off-campus university-affiliated cyclists}) \cdot 2 \cdot 47 \cdot 5$$

Using this methodology, the estimated annual benefits of the TIGER project to bicycle commuters are \$4.27 million per year.

Wilmington, NC, has an average of 117 rainfall days per year, more than some cities with high bicycle commuting rates, such as Sacramento, CA, with only 58 rainfall days per year, but less than other cities with high bicycle commuting rates, such as Portland, OR, with 153 rainfall days per year (<http://www.erh.noaa.gov/er/gyx/climo/prcpdays.html>). Although Nankervis¹⁰ and Dill and Carr⁹ found that short and long-run weather conditions have a statistically significant impact on bicycle commuting, the effect was very weak relative to other factors. Indeed, Dill and Carr found in their study of bicycle commuting in 35 U.S. cities, three of the top six cities in terms of bicycle commuting have over 100 rainfall days per year.

JOB ACCESS BENEFITS

The proposed project will increase job access for city residents without autos living in economically distressed areas. The project will connect distressed areas of zip code 28401, where the proportion of households without an auto ranges from 13.5% to 47.8% with commercial areas of zip codes 28403 and 28405. Data on available jobs by zip code for August 2009 provided by the North Carolina Employment Security Commission (NCESC 2009)¹¹ show that access to jobs in zip codes 28403 and 28405 would more than double the number of available jobs that could be accessed by residents of zip code 28401. With the proposed project, residents of zip code 28401 could access these additional available jobs by bicycle, without incurring the additional costs associated with car ownership.

BENEFITS FROM DECREASED AUTOMOBILE USE

We follow Krizek et al.¹ in assuming that commuter biking replaces auto trips but recreational biking does not replace auto travel. Bicycle trips may also replace errand-purpose trips made by auto. We augment Krizek et al.'s¹ analysis using data from the U.S. Bureau of Transportation Statistics Omnibus Survey for 2002¹² to estimate the number of errand-purpose auto trips replaced by bicycle trips. The benefits of decreased auto travel include reduced road congestion, reduced air pollution, and user cost savings. User cost savings are avoided auto operating expenses (avoided fuel and maintenance costs) net of bike operating expenses (tire and chain replacement, etc.).

The congestion-reduction benefits of replacing auto travel with bicycle travel are a function of location and the time of day. There will be no congestion-reduction benefits in places or at times when there is no road congestion. For simplicity, we assume that all commuting trips occur during congested periods. We calculate congestion benefits for the estimated 115 new non-university-affiliated bicycle commuters and the estimated 671 new university-affiliated bicyclists living off-campus, for a total of 786 new commuters.

Pollution-reduction benefits will be higher in more densely populated areas and lower elsewhere. Based on Barnes'¹³, congestion savings will be 0-5 cents per mile, and pollution savings from 1-5 cents per mile, depending on conditions, where the high end of this range applies in central city areas, the middle range in suburban areas, and the low end in small town and rural areas.

User cost savings will be higher during peak periods when stop-and-go traffic increases the cost of driving. User cost savings were determined to be 3 cents per mile during congested peak periods and 0 otherwise.

Summing over the benefit categories, the benefits from decreased automobile use per new bicycle commuter are 13 cents per mile in urban areas, 8 cents per mile in suburban areas, and 1 cent per mile in small towns and rural areas; we use the 13 cents per mile urban area value ¹. The average round-trip bike commute mileage for non-university commuters is derived from the average one-way bicycle commute trip duration of 14.80 minutes for the Wilmington area ¹⁴. Assuming an average bicycle commute travel speed of 5 miles per hour, the average one-way commute distance is 2.96 miles (14.80/5), or 6 miles round-trip for non-university commuters. Based on the locations of off-campus living areas for university students, we assume that the average round-trip commute distance for university-affiliated persons is 2 miles. We further assume that bicycle commuters commute 5 days a week 47 weeks a year.

Annual benefit from decreased auto use = new commuters · round-trip distance · 0.13 · 47 · 5
for work commute trips

The estimated annual benefits of decreased auto use due to all new bicycle commuters for the proposed project are \$62,078 per year.

Travel for the purpose of non-work errands makes a significant contribution to the traffic congestion and pollution problems. The U.S. Department of Transportation reports that on the average workday, non-work travel constitutes 56 percent of trips during the morning peak travel period and 69 percent of trips during the evening peak period ¹⁵. Bicycles can substitute for autos for some non-work travel. The U.S. Bureau of Transportation Statistics Omnibus Survey for 2002 collected data on the purpose/destination of adult bicycle trips ¹². Recreation accounted for 53.9 percent of adult bicycle trips, exercise was the purpose of 31.2 percent of trips, 4.9 percent of trips were commuter trips to work/school, and 7.5 percent were for errands. Based on this information, we assume that the number of errand-destination bicycle trips is equal to the number of work and school commuter round-trips multiplied by 1.53 (7.5/4.9). We assume an average bicycle errand round-trip length of 2 miles, and benefits per mile similar to those of commuting.

Annual benefit from decreased auto use = 1.53 · (new commuters · round-trip distance
for errand trips · 0.13 · 47 · 5)

The estimated annual benefits of decreased auto use due to new bicycle errands for the proposed project are \$94,979 per year.

In summary, the estimated annual benefits of decreased auto use due to new bicycle commuting and errands for the proposed project total \$157,057 per year.

BENEFITS OF REDUCED PARKING REQUIREMENTS AT UNC-WILMINGTON

The proposed project will increase bicycle commuting to the University of North Carolina Wilmington, which will substitute for auto commuting, reducing the University's need to construct expensive auto parking facilities. We estimate that the proposed project will increase bicycle commuting to and from the university by university-affiliated persons living off campus by 671 persons (4.8% of all university students, faculty and staff). We assume that all of these persons would have otherwise used an auto to commute to the university but that 10 percent of these persons would have carpooled, so the net reduction in auto parking capacity is an amount necessary to accommodate 604 autos. Commuter students are assigned parking permits on a 2:1 basis; in other words, for a 100 space commuter lot, we assign 200 commuter vehicles (UNCW Parking Services, personal communication, August 2009)¹⁶. Therefore, a reduction in commuting autos of 604 is equivalent to a 302 unit reduction in parking space requirements. Based on recent on-campus parking lot construction and expansion projects, the incremental cost of providing an additional parking space (including design, construction, and required storm water facilities) ranges from \$4,500 to \$7,000 per space, with an average of \$5,500 per space (UNCW Office of Facilities, personal communication, August 2009)¹⁷. Hence, a 302 unit reduction in parking space requirements produces an estimated a one-time reduction in university parking facility costs of \$1.66 million (302*\$5,500). In addition, if fewer auto parking facilities are necessary, the university can use the land for classroom and dormitory buildings, reducing the university's need to acquire additional land, reducing the university's costs; these additional savings are not considered here.

BICYCLIST SAFETY BENEFITS

The overwhelming majority of bicycle accidents resulting in fatalities are caused by collisions with motor vehicles^{18, 19} Although there has been extensive research into the relationship between the urban environment and bicycle crashes^{18, 20, 21}, little existing research addresses questions regarding the effect of modifying the urban environment on the safety of bicycle travel. Poindexter et al.⁵ examine the effect of the adding an off-street bicycle facility on bicycle safety in the Twin Cities region of Minnesota. This study shows that in the years following the opening of the Phase-1 of the Midtown Greenway there was a decrease in the number of bicycle crashes in the area immediately adjacent to the Greenway. Questions remain about the safety of off-street bicycle facilities that force bicyclists to cross streets. However, the Midtown Greenway study demonstrates that if similar off-street bicycle facilities are built, facilities with few at-grade crossings, there will likely be a reduction in bicycle crashes in the area adjacent the facility. The decrease in the number of crashes was significant in both the 0-500 meter and 501-1,000 meter buffers around the facilities, with a reduction in the mean number of crashes of 55% in the 0-500 meter buffer and 12% in the 501-1000 meter buffer.

Decrease in the number of bicycle crashes at various distances from bicycle path of Phase 1 Midtown Greenway, Twin Cities, Minnesota. Source: Poindexter et al. 2007⁵.

Buffer	Number of crashes a year 1998-2000		T-critical	Mean number of crashes a year from 2001-02	Significant
	Mean	St. Dev.			
0.0 - 0.5 Km buffer	26.67	5.69	17.08	12	Significant
0.5 - 1.0 Km buffer	17	1	15.31	15	Significant
1.0 - 1.5 Km buffer	15.67	8.5	1.33	8.5	Not Significant
1.5 - 2.0 Km buffer	13	4.36	5.65	8.5	Not Significant
2.0 - 2.5 Km buffer	6	2.65	1.54	6	Not Significant

From 2003 to 2007, New Hanover County, North Carolina, had an average of 0.2 fatal injuries, 35 non-fatal injuries, and 4 property-damage-only (PDO) crashes between autos and bicyclists per year (NCDOT 2008a)²². Each fatal injury involves an estimated monetary cost of \$1.35 million, each non-fatal injury, \$19,000, and each PDO crash, \$4,200 (NCDOT 2008b)²³. Based on the results of Poindexter et al.⁵ we assume a 25% reduction in injuries and crashes and associated monetary costs that existing bicyclists would suffer in the absence of the proposed project.

$$\text{Benefits of reduction in auto-bicycle crashes} = 0.25 \cdot (0.2 \cdot \$1,350,000 + 35 \cdot \$19,000 + 4 \cdot \$4,200) = \$237,950 / \text{year}$$

HEALTH COSTS AVOIDED

Krizek et al.¹ developed an estimate of the reduction in annual per-capita health costs resulting from physical activity associated with biking of \$128 by taking the median value of ten studies (see table below).

Study/Agency	Per Capita Cost Savings (\$)
Washington State Department of Health	19
Garrett et al.	57
South Carolina Department of Health	78
Georgia Department of Human Resources	79
Colditz (1999)	92
Minnesota Department of Health	>100
Goetz et al.	172
Pronk et al.	176
Pratt	330
Michigan Fitness Foundation	1,175

Estimated Annual per Capita Health Cost Savings of Physical Activity (2004 \$'s)
Source: Krizek et al. 2006¹.

Following the methodology recommended by Krizek et al. ¹, we multiply \$128 by the total number of new bicyclists to derive an estimate of annual health benefits.

$$\text{Annual health benefits} = \text{total new cyclists} \cdot \$128$$

The estimated increase in non-university cyclists is 8,696, and the estimated increase in university-affiliated cyclists is 2,911, for an estimated increase in total cyclists of 11,607. With this estimated increase in total cyclists, the estimated health benefits of the TIGER project are \$1.49 million per year.

RECREATION BENEFITS

A wide review of studies of outdoor recreational activities (non-bicycling) generated typical benefit values of about \$40 per day in 2004 dollars ^{1,24}. If a typical day of recreation is about 4 hours, this would be about \$10/hour. Note that this is an estimate of the *net* benefits, above and beyond the value of the alternative activity foregone (e.g., wages from working, benefit from bowling or watching TV, etc.) in order to engage in outdoor recreation. This estimate is also in line with results from a more recent study of urban trails in Indianapolis by Przybylski and Lindsey ²⁵, which used the travel cost method to find typical implied values per trip of about \$7 – \$20. From both the National Household Transportation Survey ⁷ and the Twin Cities Travel Behavior Inventory survey ²⁶, the average adult cycling day includes about 40 minutes of cycling. Including some preparation and cleanup time, Krizek et al. ¹ assume that the “typical” day involves about an hour of total bicycling activity and place the recreation value of a bicycle day at \$10 (*D*). Krizek et al. ¹ then assume 365 days of bicycle activity per year and multiply by the number of new cyclists minus the number of new commuters. We make a more conservative assumption regarding the number of days of activity per year; we assume that the typical recreational cyclist engages in recreational cycling activity 3 days per week on average for 52 weeks per year, or 156 days per year.

$$\text{Annual recreation benefit} = (\text{New bicyclists} - \text{New commuters}) * D \cdot 156$$

We make the additional conservative assumption that university-affiliated cyclists receive zero recreational benefits. The estimated annual recreation benefits of the proposed project to the estimated 8,581 new, non-commuting, non-university-affiliated recreational cyclists are \$13.4 million per year.

RESIDENTIAL PROPERTY VALUE BENEFITS

If livability is an element that people look for in a community and are willing to pay extra to have, and bicycle facilities are a factor in the livability of a community, then the value gained by living near the facility should factor into the price they are willing to pay to be part of the community, the price of their home. Although some residents of the area around the facilities look at the facility as an asset, others may look at such facilities as a detriment to their property values, as the facilities may increase opportunities for property vandalism, etc.

Lindsey ²⁷ performed a hedonic analysis of 9,348 home sales, identifying properties falling inside or outside a half-mile buffer around fourteen greenways in Marion County, Indiana. This research found that some greenways have a positive, significant effect on property values while others have no significant effect. A survey in Vancouver found that the majority of realtors perceive little effect of bicycle trails on home values, either positive or negative (City of Vancouver ²⁸). However, two-thirds of respondents also indicated that they would use bicycle trail proximity as a selling point.

Krizek ¹ used a hedonic property value model to investigate the impact of new bicycle facilities on residential property values. The study found that off-street facilities that are alongside busy streets are negatively associated with home sale prices in both the city and suburbs. However, off-street facilities away from busy streets had a positive relationship with home sale prices in the city and a negative relationship in the suburbs. On-street facilities had no discernable effect on property values in the city but had a negative relationship with property values in the suburbs. These results are mixed and appear to indicate that both the type of biking facility and the location seem to affect home sale prices.

Poindexter et al. ⁵ used a matched-pairs longitudinal approach to look at the change in the property values in the same neighborhoods over time in the Twin Cities area of Minnesota. The longitudinal approach allows for control of factors that are unique to the individual geographic areas that the bicycle facilities are located in, by comparing the same area to itself overtime with a control area that has similar traits. This research also found that building a bicycle facility has no significant effect on the property value of owner occupied housing prices.

Percent change in sale price for owner occupied housing near new bicycle facilities compared with control tracts. Source: Poindexter et al. 2007 ⁵.

Facility	% Change in Study tracts	% Change in Control tracts	T-Value	Sig. 05	N
Apple Valley	76.26%	69.22%	0.17	Not Sig.	7
Thompson Bridge	45.87%	79.25%	-0.81	Not Sig.	5
Big River Regional Trail	81.25%	82.40%	-0.04	Not Sig.	9
Luce Line	70.10%	60.05%	0.33	Not Sig.	12
Hutchinson Spur	53.16%	63.60%	-0.56	Not Sig.	22
Midtown Greenway	74.22%	84.18%	-0.43	Not Sig.	27
Midtown Greenway Phase 1	61.57%	83.55%	-0.68	Not Sig.	12
Midtown Greenway Phase 2	84.34%	84.68%	-0.01	Not Sig.	15
All	67.18%	73.35%	-0.12	Not Sig.	82

These findings indicate that bicycle facilities do not appear to have a measurable impact on the value of owner occupied housing near the facilities, at least in the short run. As a result, we assume that impacts on housing value are zero for the purposes of this analysis.

REDUCTIONS IN ENERGY USE AND GREENHOUSE GAS EMISSIONS

The table below provides estimates of the reductions in annual energy (gasoline) and greenhouse gas (CO₂) emissions associated with the proposed project.

	New Bicycle Commuters	Reduction in Auto Commuting Trips/Yr	Reduction in Auto Errand Trips/Yr	Reduction in Miles Driven/Yr (1)	Gallons Gasoline Saved/Yr (2)	Reduction in CO ₂ (lbs)/Yr (3)	Reduction in CO ₂ (metric tons)/Yr
Non-University	115	27,025	41,348	136,747	6,574	128,857	59
University	671	157,685	241,258	797,886	38,360	751,854	342
Total	786	184,710	282,606	934,633	44,934	880,711	400

(1) Assumes conservative average of 2 miles per round-trip.

(2) Assumes average 20.8 mpg (conservative estimate based on US EPA 2008 average fuel economy for new cars).

(3) Assumes 19.6 lbs CO₂/gal gasoline.

If we consider that the average vehicle miles driven each year is 15,000 miles (<http://www.fueleconomy.gov/feg/feg2009.pdf>), the number of “equivalent” cars removed is 62 cars.

SUMMARY -- BICYCLING ACTIVITY

	Existing Pre-Project	New With Project	Total Post-Project	Percentage Change
Non-University Bicycle Commuters	243	115	358	+ 47%
Non-University Total Cyclists	18,117	8,696	26,813	+ 48%
University Bicycle Commuters (Off-campus only)	1,492	671	2,163	+ 45%
University Total Cyclists (On and Off-Campus)	6,468	2,911	9,379	+ 45%

SUMMARY -- PROJECT COSTS AND BENEFITS

	Annual Project Costs	Annual Project Benefits	Additional Jobs	Local Payroll Supported
Project Construction (1)	\$812,227/yr annualized (\$15.92 million one-time cost)		159 construction 118 indirect	\$6.6 million construction, \$4.5 million indirect
Project Operations and Maintenance	\$18,000/yr		0	0
Benefits of Improved Bicycle Facilities for Bicycle Commuters		\$4.27 million/yr		
Health Benefits of Recreational Cycling		\$1.49 million/yr		
Recreation Benefits of Recreational Cycling		\$13.4 million/yr		
Benefits of Reduced Auto Congestion, Pollution, Maintenance		\$157,000/yr		
Benefits of Improved Bicycling Safety (Death and Injury Costs Avoided)		\$237,950/yr		
Residential Property Value Benefits		Negligible		
Reduced Parking Facility Requirements at UNCW (1)		\$84,700/yr annualized (\$1.66 million one-time cost)		
Increased Access to Jobs for Residents of Economically Distressed Areas			Number of accessible jobs approximately doubled	
Reduction in CO ₂ Greenhouse Gas		400 metric tons/yr		

(1) Annualized cost assumes amortization over 30-years at 3% cost of funds.

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