CHAPTER 3 OUTLINE:
Overview
Current Bicycle Use
Demand
Demand Analysis
Summary of Public Input
Benefits Analysis

CHAPTER 3: DEMAND + BENEFIT ANALYSIS

OVERVIEW

The need and demand for a more accessible, safe and functional bicycle system is paramount throughout the Raleigh urban area. This is clearly articulated by community residents who attended open house meetings, and is becoming increasingly important given today's climate of increasing gas prices. Deficiencies in the current bicycle network and bicycle crash information are described in Chapter 2, presenting another case for needed improvements. The benefits of a more bicycle-friendly community with an increased number of bicyclists is also clear because of positive impacts on public health, air quality, transportation, and recreation.

This chapter presents current bicycle use, demand analysis, a summary of public input, and a benefits analysis. All of these elements support the development and implementation of this Plan within the broader context of Raleigh's vision for the future.

CURRENT BICYCLE USE

Regardless of the availability or condition of existing bicycle facilities, a number of residents bicycle throughout Raleigh to destinations such as work, shopping centers, parks, and neighbors' homes. Census data provides information regarding the means of transportation to work and an important starting point to understanding current use.

Raleigh Mode Share Statistics

Regarding commuting patterns, the mean travel time to work for Raleigh residents is about 19 minutes, four minutes lower than the State average. While a number of people live and work in Raleigh, there are a number of commuters to RTP. Here's how Raleigh residents get to work:

Table. 3.1 Means of Transportation to Work, Raleigh, NC (2000)

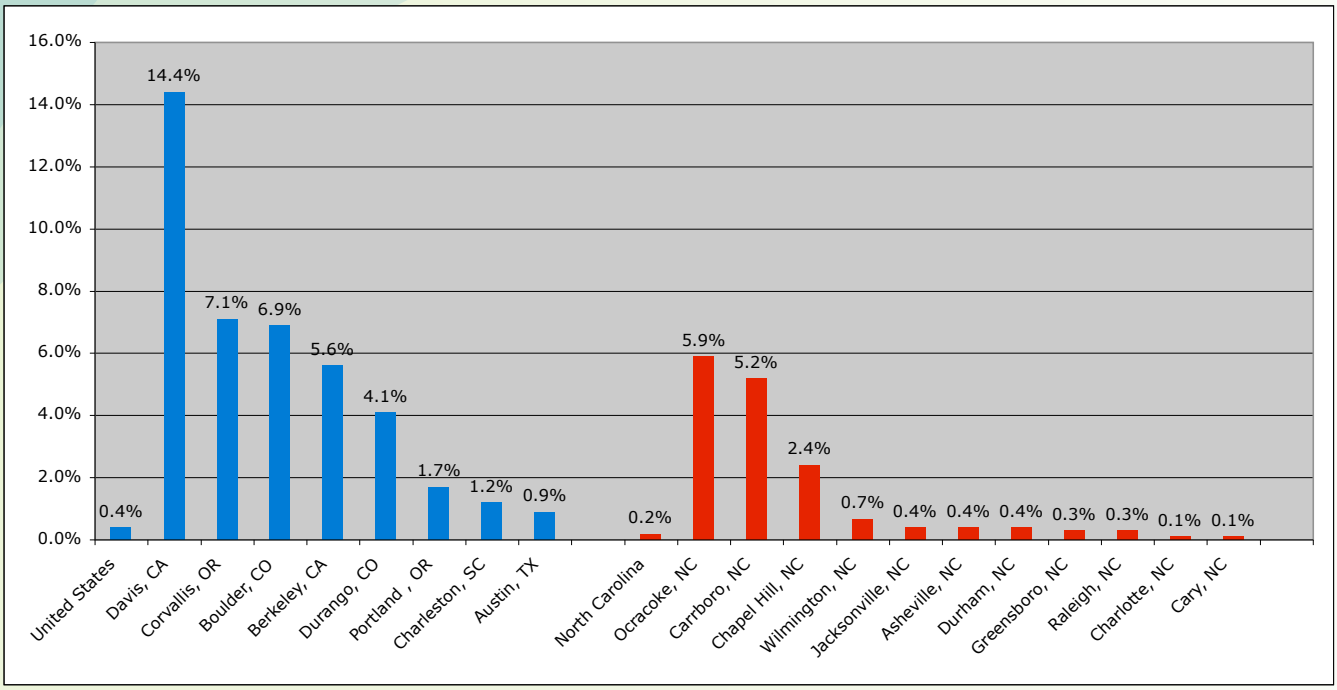
Workers over age of 16, 2000 Census:	151,655	(100%)
Drove alone	119,290	(78.7%)
Carpooled	17,417	(11.5%)
Worked at home	4996	(3.3%)
Walked	4383	(2.9%)
Bus or trolley bus	3,077	(2.0%)
Other means	1215	(0.8%)
Taxi	517	(0.3%)
Bicycle	**508**	**(0.3%)**
Motorcycle	176	(0.1%)

Source: U.S. Census Bureau, Census 2000 Summary File 3, Table P30 Means of Transportation to Work. 'Scooters' and 'mopeds' were technically part of the 'Motorcycle' category for the 2000 Census, however, according to the individual respondent's interpretation, they may have been reported in the 'Other means' category.

There is a significant difference between the numbers of people bicycling/walking to work as compared to driving to work. This is very typical across the United States (see graphs below). At 0.3%, Raleigh has a slightly higher percentage of bicycle commuters compared to the State average.

The graphs below show how Raleigh stacks up locally, statewide, and nationally in terms of bicycle commuting. As demonstrated above, bicycle-commuting statistics can serve as an indicator for total number of bicyclists, and is one of the most reliable benchmarks available from which to compare between communities.

Percentages for Bicycle Commuting (2000):
Comparison of National, Statewide, and Local Examples



Source: U.S. Census Bureau, Census 2000 Summary File 3, Table P30 Means of Transportation to Work.

When compared to cities and towns that represent model bicycling communities, the City of Raleigh still appears to have plenty of room for improvement. Nevertheless, the City is right on the State and national average. Two of Raleigh's neighbors (Chapel Hill and Carrboro) rank in the Top 10 in the State in bicycle percentage mode share.

DEMAND

A variety of demand models are often used to quantify usage of existing bicycle facilities, and to estimate potential usage of new facilities. The purpose of these models is to provide an overview of the demand and benefits of bicycling in Raleigh. As with all models, the results show a range of accuracy that can vary based on a number of assumptions and available data. The models used for this study incorporate information from existing publications as well as data from the U.S. Census. All data assumptions and sources are noted in the tables following each section of the analysis.

U.S. Census data provides a useful baseline for quantifying demand. In the 1990 Census, Raleigh's combined bicycle/pedestrian mode share was 2.3%, with 5,769 people walking or bicycling to work. In the year 2000, the number of bike/walk commuters had increased to 6,535, but the overall mode share had been reduced to 1.8% due to increased use of other forms of transportation. The 1990 – 2000 US Census trend data is shown in the Table 3.2 below.

Table 3.2 Selected Characteristics by Place Of Work (1990 and 2000)

Selected Characteristics (Universe: All Workers)	1990		2000		Change 1990 to 2000	
	Number	Percent	Number	Percent	Number	Percent
Workers 16 years or over	**249,943**	**100**	**360,165**	**100**	**110,222**	**44.1**
Sex						
Male	133,480	53.4	195,945	54.4	62,465	46.8
Female	116,463	46.6	164,225	45.6	47,762	41.0
Mode to work						
Drove alone	196,816	78.7	287,165	79.7	90,349	45.9
2-person carpool	28,103	11.2	33,040	9.2	4,937	17.6
3-or-more-person carpool	8,253	3.3	14,100	3.9	5,847	70.8
Bus or trolley bus	3,302	1.3	3,280	0.9	-22	-0.7
All other transit[1]	23	0.0	85	0.0	62	269.6
Bicycle or walked	**5,769**	**2.3**	**6,535**	**1.8**	**766**	**13.3**
Taxicab, motorcycle, or other mode	2,343	0.9	3,225	0.9	882	37.6
Worked at home	5,334	2.1	12,735	3.5	7,401	138.8

Source: U.S. Census Bureau, Census 2000 Census Transportation Planning Package (CTPP 2000) Geographic Area: Working in Wake County, North Carolina

More recent data is available from the 2005 American Community Survey (ACS), which shows separate data for walking and bicycling. The ACS shows a 0.3 bicycling mode share for Raleigh in 2005, with 540 people bicycling to work. It is important to note that the Census and ACS data only counts trips to work, and does not capture Raleigh's significant amount of travel to schools, other utilitarian travel or recreation. The model in the following section uses Census data as a baseline, along with documented sources to incorporate the full range of bicycle mobility in Raleigh.

DEMAND ANALYSIS

The Raleigh bicycle demand model consists of several variables including commuting patterns of working adults, and predicted travel behaviors of area college students and school children. For modeling purposes, the study area included all residents within the city of Raleigh in 2000. The information was ultimately aggregated to estimate the total existing demand for bicycle facilities in the city. Table 3.3 identifies the variables used in the model. Data regarding the existing labor force (including number of workers and percentage of bicycle commuters) was obtained from the 2000 U.S. Census. In addition to people commuting to the workplace via bicycle, the model also incorporated a portion of the labor force working from home. Specifically,

it was assumed that about half of those working from home would make at least one bicycling or walking trip during the workday. The 2000 Census was also used to estimate the number of children in Raleigh. This figure was combined with data from National Safe Routes to School surveys to estimate the proportion of children riding bicycles to and from school. College students constituted a third variable in the model due to the presence of numerous higher education institutions such as NC State University, Shaw University, Meredith College, Peace College, St. Augustine's College, and Wake Technical Community College. Data from the Federal Highway Administration regarding bicycle mode share in university communities was used to estimate the number of students bicycling to and from campus. Finally, data regarding non-commute trips was obtained from the 2001 National Household Transportation Survey to estimate bicycle trips not associated with traveling to and from school or work.

Table 3.3 summarizes estimated existing daily bicycle trips in Raleigh. The table indicates that over 55,000 trips are made on a daily basis, with most trips made by college students. The model also shows that non-commuting trips comprise the vast majority of existing bicycle demand.

Table 3.3 Aggregate Estimate of Existing Daily Bicycling Activity in Raleigh

Variable	Figure	Calculations
Employed Adults, 16 Years and Older		
a. Study Area Population [1]	276,579	
b. Employed Persons [2]	151,655	
c. Bicycle Commute Percentage [2]	0.3%	
d. Bicycle Commuters	455	(b*c)
e. Work-at-Home Percentage [2]	3.3%	
f. Work-at-Home Bicycle Commuters [3]	2,502	[(b*e)/2]
School Children		
g. Population, ages 6-14 [4]	28,807	
h. Estimated School Bicycle Commute Share [5]	2%	
i. School Bicycle Commuters	576	(g*h)
College Students		
j. Full-Time College Students [6]	39,251	
k. Bicycle Commute Percentage [7]	10%	
l. College Bicycle Commuters	3,925	(j*k)
Work and School Commute Trips Sub-Total		
m. Daily Commuters Sub-Total	7,459	(d+f+i+l)
n. Daily Commute Trips Sub-Total	14,917	(m*2)
Other Utilitarian and Discretionary Trips		
o. Ratio of "Other" Trips in Relation to Commute Trips [8]	2.73	ratio
p. Estimated Non-Commute Trips	40,723	(n*o)
Total Estimated Bicycle Trips	**55,641**	(n+p)

Notes:
Census data collected from 2000 U.S. Census for City of Raleigh.

(1) 2000 U.S. Census, STF3, P1.
(2) 2000 U.S. Census, STF3, P30.
(3) Assumes 50% of population working at home makes at least 1 daily bicycle trip.
(4) 2000 U.S. Census, STF3, P8.
(5) Estimated share of school children who commute by bicycle, as of 2000 (source: National Safe Routes to School Surveys, 2003).
(6) Source: Citytowninfo.com for City of Raleigh.
(7) Review of bicycle commute share in 7 university communities (source: National Bicycling and Walking Study, FHWA, Case Study #1, 1995).
(8) 27% of all trips are commute trips (source: National Household Transportation Survey, 2001).

SUMMARY OF PUBLIC INPUT

Another expression of need and demand comes from public input throughout this planning process. Input received in this Plan clearly shows a desire for bicycle improvements in Raleigh. Public input was obtained through two chief methods: public workshops and comment form (available online and as hardcopy). A complete, graphic summary of public input may be found in Appendix A.

During public workshops, attendees spoke with City and consultant staff and marked on maps indicating their visions and ideas for bicycle facilities in Raleigh. Through map markups and discussion, it was clear that there was a desire for improved bicycle facilities, especially along a few major routes:

Hillsborough Street
Glenwood Avenue
Six Forks Road
Avent Ferry Road

Covering a larger breadth of bicycle issues, the comment form was completed by more than 700 people. Selected questions and most common responses are presented below, along with a brief statement of expressed need:

Question: How do you rate present bicycling conditions in the Raleigh area?

53% described current bicycling conditions in Raleigh as poor
46% described current bicycling conditions in Raleigh as fair
1% described current bicycling conditions in Raleigh as excellent

Expressed Need: A comprehensive approach to bicycle facility, program, and policy development is needed.

Question: What bicycling destinations would you most like to get to?

80% would like to bicycle to existing trails and greenways;
72% would like to bicycle to Downtown;
70% would like to bicycle to work;
70% would like to bicycle to parks.

Expressed Need: A bicycle network that connects multiple land uses and destinations is important. Connectivity to the Downtown area, office centers, and existing greenways and parks is particularly needed.

Question: Which statement best describes your comfort level on a bicycle.

44% preferred riding off-road paths or clearly designated bicycle lanes
41% were comfortable in any on-road situation
15% preferred only riding in an off-road path

Expressed Need: An on-road and off-road bicycle network composed of multiple facilities is needed for different types of bicyclists.

Question: Which of the following factors prevent you from bicycling or from bicycling more often?

77% said a lack of bicycle lanes, shoulders, or paths
67% said 'inconsiderate motorists'
62% said high-speed traffic
63% said narrow lanes
53% said heavy traffic

Expressed Need: There is a need for better bicycle facilities in the on-road environment and a need for off-road facilities to avoid traffic issues. Also, a traffic calming and educational effort should be considered for motorists and bicyclists.

Question: Which of the following changes would encourage you to bike more often?

84% said more bicycle lanes
67% said more off-road bicycle paths

Expressed Need: Bicycle lanes and off-road bicycle paths are critical for encouraging people to bicycle more often.

Question: How do you feel drivers in your area typically behave around bicyclists?

70% felt that motorists pass bicyclists too closely
60% felt that motorists drive too fast

Expressed Need: A traffic calming, law enforcement, and an educational campaign should address motorist behavior.

Question: How do you feel bicyclists in your area typically behave?

57% felt that bicyclists were courteous, obeying all traffic laws
39% felt that bicyclists fail to comply with traffic laws

Expressed Need: An educational and law enforcement effort should address bicyclist behavior.

Question: What do you think are the top three roadway corridors (in Raleigh City limits) most needing bicycling improvements?

Top 10 Roadways were:

1. Hillsborough Street
2. Glenwood Avenue
3. Capital Blvd.
4. Six Forks Road
5. Falls of Neuse Road
6. Wade Avenue
7. Blue Ridge Road
8. Atlantic Avenue
9. Western Blvd.
10. Avent Ferry Road

Expressed Need: Major arterials were identified as the top roadway corridors for improvements. This is likely because of their ability to connect multiple, major destinations and because of their poor bicycling conditions at the time of this study. Hillsborough Street and Glenwood Avenue were the clear leaders for this question.

BENEFITS ANALYSIS

In addition to models quantifying demand for non-motorized facilities, a variety of models can also quantify the benefits of such facilities. Models were used in this analysis to estimate the positive air quality, public health, transportation, and recreation benefits associated with existing and future bicycle travel in Raleigh.

Air Quality Benefits

Non-motorized travel directly and indirectly translates into fewer vehicle trips, and an associated reduction in vehicle miles traveled and auto emissions. The variables used as model inputs generally resemble the variables used in the demand model discussed earlier. Data including population, employed persons and commute mode share were used for this analysis. In terms of daily bicycle trips, assumptions regarding the proportion of persons working at home reflect those used in the demand model. Other inputs included data regarding college student and school children commuting patterns.

Additional assumptions were used to estimate the number of reduced vehicle trips and vehicle miles traveled, as well as vehicle emissions reductions. In terms of reducing vehicle trips, it was assumed that roughly 73 percent of bicycle trips would directly replace vehicle trips for adults and college students. For school children, the reduction was assumed to be about 53 percent. To estimate the reduction of existing and future vehicle miles traveled, a bicycle roundtrip distance of eight miles was used for adults and college students; and one mile for school children. These distance assumptions are used in various non-motorized benefits models. The vehicle emissions reduction estimates also incorporate calculations commonly used in other models, and are identified in the footnotes of Table 3.4.

Estimating future benefits required additional assumptions regarding Raleigh's population and anticipated commuting patterns. According to the U.S. Census, approximately 151,000 people were employed in Raleigh in 2000. A workforce population of 212,000 was used for the 2009-10 base year, to reflect growth projections that are consistent with the City's Draft Comp Plan Update. In terms of commuting patterns, the bicycling mode share was increased to address anticipated higher use generated by the addition of new non-motorized facilities and enhancements to the existing system. The estimated proportion of residents working from home was also grown slightly.

Table 3.4 summarizes existing and potential future air quality improvements associated with bicycling in Raleigh. Bicycling currently removes over 5,300 weekday vehicle trips, thus eliminating nearly 40,500 vehicle miles traveled. Bicycling also prevents nearly 24,000 tons of vehicle emissions from entering the ambient air each weekday. Bikeway network enhancements are expected to generate more bicycling in the future. This growth is expected to improve air quality by further reducing the number of vehicle trips, vehicle miles traveled and associated vehicle emissions.

It should be noted that this model only addresses commute-related trips. Unlike the demand models, this model does not account for air quality improvements associated with recreational non-motorized travel. Quantifying the benefits of recreational travel could further improve the air quality benefits of bicycling.

Table 3.4 Existing and Potential Future Air Quality Benefits

Vehicle Travel Reductions	*Existing*	*Future*
Reduced Vehicle Trips per Weekday (1)	5,329	13,841
Reduced Vehicle Trips per Year (2)	1,390,996	3,612,517
Reduced VMT per Weekday (3)	40,498	104,748
Reduced VMT per Year (2)	10,570,085	27,339,218

Vehicle Emissions Reductions	*Existing Future*	
Reduced PM10 (tons per weekday) (4)	745	1,927
Reduced NOX (tons per weekday) (5)	20,201	52,248
Reduced ROG (tons per weekday) (6)	2,940	7,605
Reduced PM10 (tons per year) (7)	194,490	503,042
Reduced NOX (tons per year) (7)	5,272,358	13,636,802
Reduced ROG (tons per year) (7)	767,388	1,984,827

Note: VMT means Vehicle Miles Traveled

(1) Assumes 73% of bicycle trips replace vehicle trips for adults/college students; 53% reduction for school children.

(2) Weekday trip reduction multiplied by 261 weekdays per year.

(3) Assumes average round trip of 8 miles for adults/college students; 1 mile for school children.

(4) PM10 reduction of 0.0184 tons per mile.

(5) NOX reduction of 0.4988 tons per mile.

(6) ROG reduction of 0.0726 tons per mile.

(7) Weekday emission reduction multiplied by 261 weekdays per year.

Other Benefits

Bicycling generates benefits beyond air quality improvements. Non-motorized transportation can also serve recreational purposes, enhance mobility and improve health. The "BikeCost" model, made available by the National Pedestrian and Bicycle Information Center, quantifies these benefits and provides a starting point for identifying the potential cost savings of improving Raleigh's bikeway network.

Several modeling assumptions should be discussed. First, the BikeCost model is project-specific, requiring specific information regarding project type, facility length and year of construction. Because this study focuses on a larger study area, several variables were used. The model is based on a 100-mile network of on-street bike lanes, with an expected 2017 "mid year" of construction. The model also requires other inputs obtainable from the 2000 U.S. Census, including bicycle commute mode share, average population density and average household size.

Based on the variables described above, the BikeCost model estimates annual recreational, mobility and health benefits. The benefits were quantified based on a combination of research from previous studies as well as other factors (identified in the footnotes of Table 3.5).

Table 3.5 summarizes the estimated benefits of an enhanced bikeway system in Raleigh. Except for mobility benefits, the model outputs are represented on an aggregate basis. Potential annual recreational benefits range from a low estimate of about $7.9 million to a high estimate of over $175 million. Annual health benefits range from about $311,000 to almost $6.2 million. Mobility benefits were estimated on a per-trip, daily and annual basis. The roughly $3 per-trip benefit of an expanded network could translate to an annual benefit of over $757,000. Decreased auto usage could also generate monetary benefits. As Raleigh is generally urban in character, the enhanced network could generate about $1.7 million in annual savings from reduced vehicle trips.

(1) Recreational benefit estimated at $10 per hour (based on previous studies). Assumes one hour of recreation per adult. $10 value multiplied by the number of new cyclists minus the number of new commuters. This value multiplied by 365 days to estimate annual benefit.

(2) Assumes an hourly time value of $12. This value multiplied by 20.38 minutes (the amount of extra time bicycle commuters are willing to travel on an off-street path). Per-trip benefit then multiplied by the daily number of existing and induced commuters. This value then doubled to account for roundtrips, to reach daily mobility benefit. Daily benefit then multiplied by 50 weeks per year and 5 days per week.

Annual per-capita cost savings from physical activity of $128 based on previous studies. This value then multiplied by total number of new cyclists.

Table 3.5 Estimated Aggregate Annual Benefits of an Enhanced Bikeway Network

Recreational Benefits (1)	Low Estimate	Mid Estimate	High Estimate
	$7,877,339	$118,248,217	$175,119,297

Mobility Benefits (2)	Per-Trip	Daily	Annually
	$3.17	$3,222	$757,065

Health Benefits (3)	Low Estimate	Mid Estimate	High Estimate
	$311,019	$4,181,559	$6,175,942

Decreased Auto Use	Urban	Suburban	Rural
	$1,659,839	$1,021,439	$127,680

Source: Benefit-Cost Analysis of Bicycle Facilities ("BikeCost") Model, Pedestrian and Bicycle Information Center.