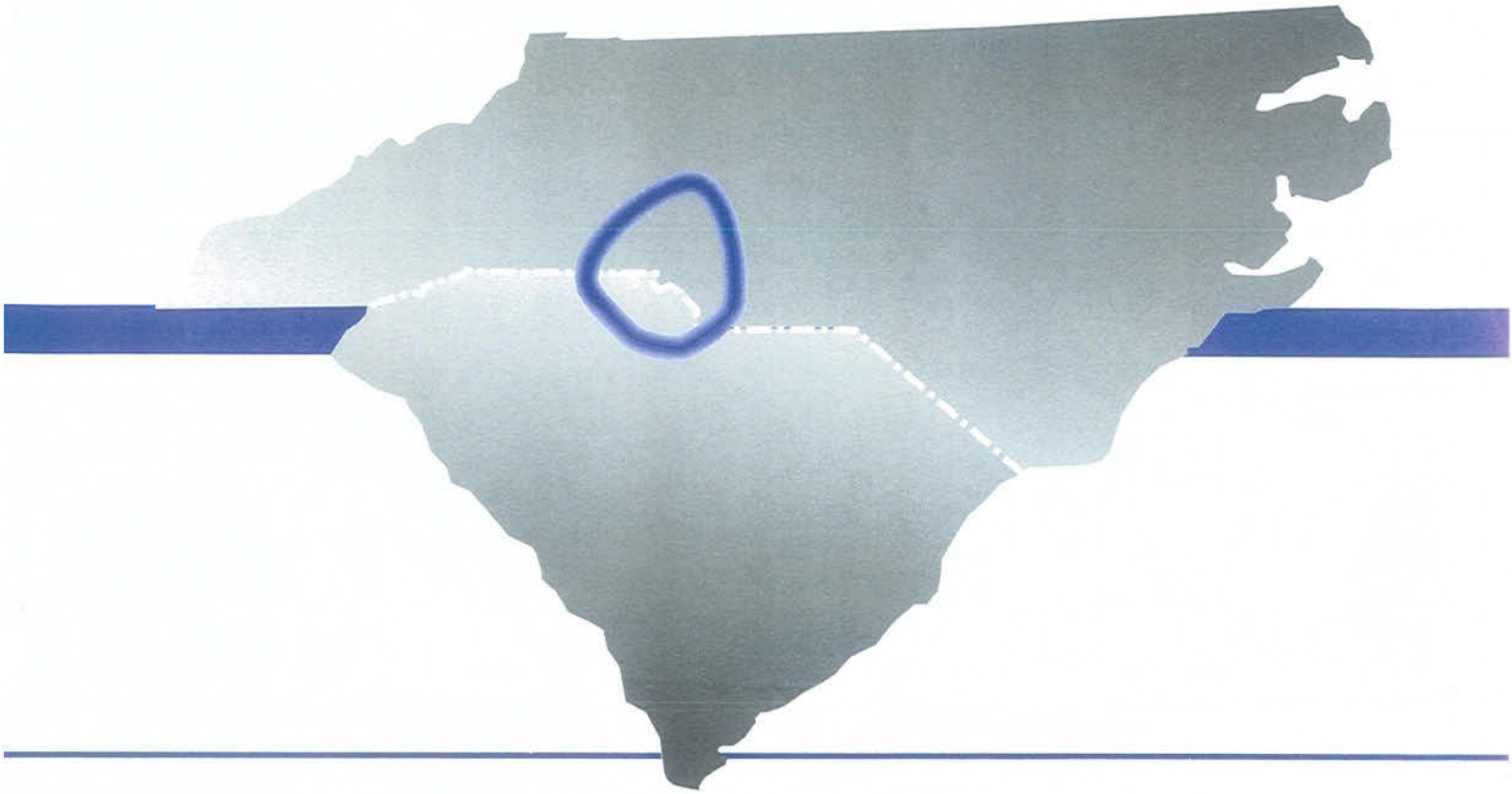
The Carolinas Parkway Phase I Feasibility Study



prepared for
North Carolina Department of Transportation
South Carolina Department of Highways and Public Transportation

prepared by
Parsons Brinckerhoff Quade & Douglas, Inc.

in association with
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SUMMARY

FINDINGS

The Carolinas Parkway is a proposed outer ring road for the Charlotte Metro Region. The Phase I study of a representative Parkway corridor found that the Carolinas Parkway is feasible. Travel benefits would be between $14.2 billion and $16.4 billion (1992 dollars) over the 20 year period following the opening of the Parkway, while construction related costs would be $2.0 billion . A generalized environmental screening found that a Parkway in the study corridor would avoid most natural and manmade features.

RECOMMENDATIONS

Additional detailed studies that would aid in future thoroughfare planning for the region are recommended for Phase II. These studies would consist of:

1. Modeling the travel benefits of a wider variety of Parkway alternatives using TRANPLAN software and a refined set of assumptions.

2. Continuing consensus development.

3. Conducting an environmental screening for selected reasonable corridors that result from items 1 and 2 above.

4. Evaluating study findings and recommending more specific alignments for further study.

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THE CAROLINAS PARKWAY PHASE I FEASIBILITY STUDY

1.0 INTRODUCTION

1.1 Parkway Description and Purpose

The Carolinas Parkway is a proposed outer ring road for the Charlotte Metro Region. It is envisioned as a freeway that would circumscribe Charlotte at a distance of about 30 to 50 miles and connect major towns and cities in that part of the region. The ring road system for the region is designed to link I-77, I-85, and other radial highways and draw the area together. The Charlotte Metro Region consists of 14 North Carolina and South Carolina counties. They are: Cabarrus, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Rowan, Union, Stanly in North Carolina and Cherokee, Chester, Lancaster, and York in South Carolina. They are shown in Figure 1.

The Carolinas Parkway concept evolved over several years and was formally proposed in January 1992 by the Carolinas Transportation Compact (CTC) in their report: "Moving Together" A Regional Transportation Vision For The Next Century. The CTC is a cooperative organization that advocates a regional approach to transportation issues and planning in the Charlotte region. The CTC is made up of representatives from the North Carolina Department of Transportation (NCDOT), the South Carolina Department of Highways and Public Transportation (SCDHPT), and 13 North and South Carolina counties. Their report presented the findings of a long-range transportation planning effort that involved government, business groups and citizen groups. The Carolinas Parkway is viewed in the CTC's vision as the region's main ring road. Coordination between land use and transportation planning is seen by the CTC as necessary to create an attractive, efficient regional transportation system that will support regional economic development objectives.

As a result of dialog between state and county agencies and the CTC, it was agreed that the Carolinas Parkway concept should be tested to determine the travel efficiency and benefit it might contribute to the region's transportation system. A joint funding agreement was made between the NCDOT and the SCDHPT to test the Carolinas Parkway concept.

1.2 Parkway Feasibility Study

A three-phase Parkway study program was developed jointly by NCDOT, SCDHPT, and Parsons Brinckerhoff Quade & Douglas, Inc (PB).

Phase I was designed to focus on determining the Parkway's potential for generating regional travel benefits. The study program calls for Phase II to focus on optimizing the Parkway location (from the perspective of both travel benefit and environmental impact avoidance), examining partial ring road concepts, and identifying other highway improvement plans that would need to be changed to complement Parkway construction. The development of transportation program recommendations related to the construction of the Parkway and any associated improvements, including financing concepts, is to be the objective of Phase III.

Initiation of Phases II and III is dependent upon a positive finding in each preceding phase.

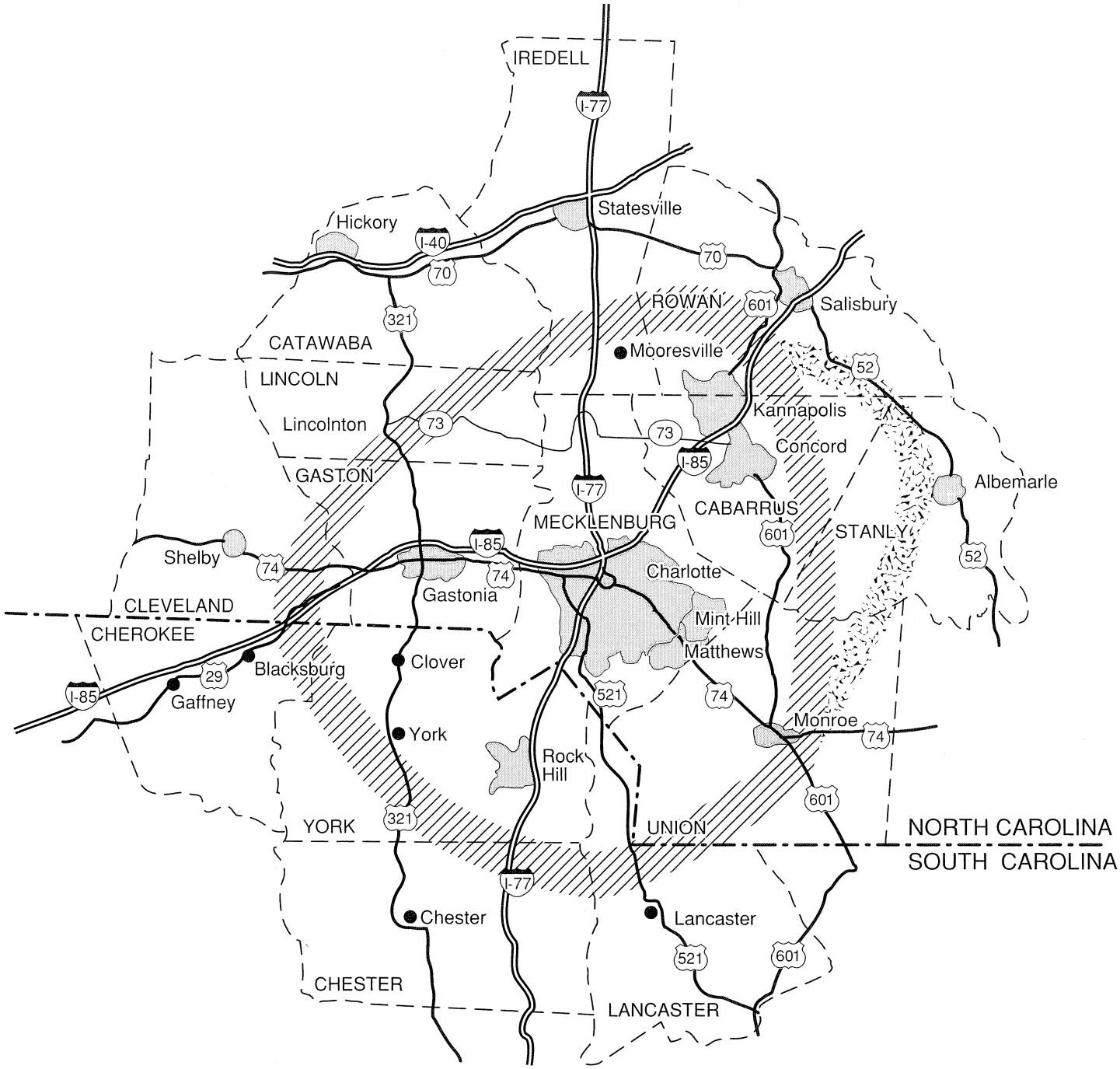


Figure 1
Charlotte Metro Region

1.3 Phase I Study Purpose and Scope

The purpose of Phase I of the Carolinas Parkway study was to determine the feasibility of the Parkway and particularly to determine if cost savings for regional travelers over a 20-year time period (2010 to 2030) would justify investment in this outer ring road. It included the generation of socioeconomic forecasts, estimates of future travel characteristics, and a feasibility assessment that considered environmental impact issues, Parkway cost, and regional travel benefits. Travel characteristics were determined by augmenting the TransCAD highway network model developed by the University of North Carolina at Charlotte's (UNCC) Center for Interdisciplinary Transportation Studies.

The Parkway corridor assessed in this study is shown in Figure 1. This corridor was jointly developed by representatives of the NCDOT and the SCDHPT and is similar to the corridor proposed by the CTC. An alternative corridor, which involves moving the eastern side of the corridor farther east, was also examined and is shown in Figure 1. Many other locations for the Parkway are of course possible, but consideration of a wide range of Parkway location options was not considered essential to achieving the purpose of the Phase I study.

The study team was assisted by a Steering Committee. Its members included representatives of the NCDOT, SCDHPT and CTC. Committee members provided direction, information and review comments that helped ensure the compatibility of the study assumptions and methods with local, state and federal planning projects and policies.

1.4 Report Organization

This report summarizes the Phase I study's findings and the data, methods and assumptions used in reaching its conclusions. The sections of this report that follow present:

- Phase I study findings on Parkway feasibility.
- Socioeconomic forecasts used in predicting future travel characteristics on the region's streets and highways, including descriptions of population, household and employment forecasts by county and the approach used in calculating the forecasts.
- Estimates of future travel characteristics, including vehicle-miles traveled on the region's streets and highways, the average annual daily traffic on the Carolinas Parkway and the approach used in analyzing future travel.
- The Parkway feasibility assessment, including discussions of environmental impact potential, cost and regional travel benefits. Both study findings and methods are presented.
- Recommendations for Phase II studies.

2.0 PHASE I STUDY FINDINGS

The Phase I study found that the Carolinas Parkway is feasible. Implementation of the approximately 187-mile Parkway project would change regional travel patterns by diverting traffic from other major roads to the Parkway. Traffic reduction on other roads in the region would reduce costs to highway travelers in the region. User benefits would be between $14.2 billion and $16.4 billion (1992 dollars) over the 20 year period following the opening of the Parkway.

The Carolinas Parkway would cost approximately $2 billion dollars in 1992 dollars. This includes $0.3 billion for the purchase of the right-of-way and $1.7 billion in construction costs.

A Parkway in the corridor assessed would avoid most natural and manmade features. Some changes to this corridor may be necessary in order to minimize the environmental impact of Parkway construction and operation. Any specific location for the Carolinas Parkway would have some impact on community and natural features.

3.0 SOCIOECONOMIC FORECASTS

Total households and retail and non-retail employment were forecast for the Charlotte Metro Region by US census tract. These forecasts were used for traffic generation modeling. Retail activities are defined as those that attract relatively high volumes of commercial or trade traffic, including retail establishments, professional services and government offices. Non-retail activities, consisting of the remaining non-agricultural employment sectors, were assumed to have different travel patterns and fewer trips than do retail type activities.

Socioeconomic forecasts were made for two scenarios, the low Parkway influence and the high Parkway influence. The low Parkway influence scenario assumed that the Carolinas Parkway would have a low influence on the development of the region (i.e., current regional development patterns would continue over the next 40 years as if the Parkway were not built). The second scenario assumed that the Parkway would exert an influence on the patterns of development in the region, attracting future residents and businesses to growth areas along its length. Two scenarios were evaluated in order to determine the sensitivity of potential Parkway travel benefits to development patterns. Forecasts were made for years 2010 (the assumed year that the Parkway opens) and 2030 (20 years after the Parkway opens).

3.1 Forecasts by County

Table 1 shows 1989 population and year 2030 population forecasts by county for the low Parkway influence scenario and the high Parkway influence scenario.

Under the low influence scenario, Mecklenburg County would remain the dominant county in the region. As the county's vacant land is filled, its development would become more dense. Its share of the regional population would rise 1.96 percent. In addition, a greater share of regional residents would choose to locate in York, Cabarrus, Union, Iredell, and Lincoln Counties. They would increase their share of regional population between 0.26 and 1.27 percent. All of the other counties in the region would continue to grow in population but not to the relative extent of these five counties. The other counties' share of the area's population would decline between 0.37 and 1.48 percent.

Under the high influence scenario, Mecklenburg would continue to grow, but its dominance would be diminished somewhat. Its share of the regional population would decline 2.4 percent. The patterns of growth or decline in regional population shares would be the same in the other counties as under the low influence scenario, but they all would have a larger share of the region's population under the high influence scenario than under the low influence scenario. The share of regional population in York, Cabarrus, Union, Iredell, and Lincoln Counties would rise between 0.67 and 1.96 percent. The share of regional population in the remaining counties would decline between only 0.01 and 0.98 percent.

The population forecasts were combined with appropriate multipliers to derive household and employment forecasts. The number of households, non-retail jobs and retail jobs in the region in 1989 and forecast for 2030 under the low and high Parkway influence scenarios is

Table 1
Population Forecasts By County

County	1989 Population	1989 County Share	2030 Low Parkway Influence Population	2030 Low Parkway Influence County Share	2030 High Parkway Influence Population	2030 High Parkway Influence County Share
Cabarrus	97,631	6.03%	191,406	7.30%	200,440	7.64%
Catawba	117,092	7.23%	170,430	6.50%	173,441	6.61%
Cleveland	84,586	5.23%	98,273	3.75%	111,309	4.25%
Gaston	173,841	10.74%	250,978	9.57%	255,997	9.76%
Iredell	91,892	5.68%	155,747	5.94%	170,791	6.51%
Lincoln	49,524	3.06%	87,785	3.35%	97,822	3.73%
Mecklenburg	500,717	30.94%	862,640	32.90%	748,275	28.54%
Rowan	109,463	6.76%	155,275	5.92%	163,305	6.23%
Stanly	51,440	3.18%	66,599	2.54%	68,606	2.62%
Union	82,834	5.12%	159,942	6.10%	171,975	6.56%
Cherokee	44,154	2.73%	69,221	2.64%	71,228	2.72%
Chester	31,968	1.98%	34,086	1.30%	42,116	1.61%
Lancaster	54,401	3.36%	78,398	2.99%	86,428	3.30%
York	129,019	7.97%	241,224	9.2%	260,272	9.93%
TOTAL	1,618,560	100.00%	2,622,005	100.00%	2,622,005	100.00%

presented in Table 2. The share of those households and jobs allocated to each county is also shown.

As expected, household growth in the counties would follow a pattern similar to population growth under either the low or high Parkway scenarios. Employment in both the non-retail and retail sectors would grow in all counties in the region, but their share of regional employment would change. Under the low Parkway scenario, shares of regional employment would change in a pattern similar to population and households but the changes would not be as great, a change between -0.34 percent and 0.63 percent for non-retail employment and between -0.09 and 1.16 percent for retail employment.

Under the high influence scenario, Mecklenburg County's share of regional employment growth would decline at a much greater rate than under the low influence scenario, 3.85 percent for non-retail employment and 7.2 percent for retail employment. All the other counties in the region would have a larger share of county employment under the high influence scenario than under the low.

3.2 Forecasting Approach

The socioeconomic forecasts were completed in the following steps:

1. Socioeconomic data collection.
2. Marketplace interviews.
3. Regional and county forecasts of population, households and employment.
4. Census tract forecasts of population, households and employment.

The census tract forecasts were derived, in part, from the county forecasts. They served as an important input into the future travel analysis. The methods and assumptions used in completing each step of the socioeconomic analysis are described in the following paragraphs.

Socioeconomic Data Collection

Meetings with regional, county and local officials in the region were held to obtain information on the existing and future land use patterns and development policies. Population, household and employment counts for the region were obtained from the North Carolina State Planning Office, the South Carolina Division of Research and Statistical Services, the Centralina Council of Governments, local planning agencies, and the UNCC Center for Interdisciplinary Transportation Studies.

Marketplace Interviews

Marketplace interviews were conducted via a limited telephone survey of regional, county and local land use and traffic planner, developers, and banking officials. The purpose of the survey was to formulate a perspective on the probable impacts of the proposed Parkway on the growth of the various counties and cities in the region.

Regional and County Forecasts

Population. The 1989 population for the region and each county was derived from the average annual growth rate between 1980 and 1990. Population in 1989 was determined and used in the travel modeling because 1989 traffic counts were available for use as the starting point of the traffic model. In calculating future population, a regional total for each of the two future years (2010 and 2030) was derived and then allocated to each county.

The sum of county population forecasts for 2010, prepared by the North Carolina State Planning Office and the South Carolina Division of Research and Statistical Services, served as the 2010 regional forecast. For the purposes of this study, an annual regional growth rate of 1.25

Table 2
Household and Employment Share By County

County	1989 Households	1989 Non-retail Employment	1989 Retail Employment	2030 Low Parkway Influence Households	2030 Low Parkway Influence Non-retail Employment	2030 Low Parkway Influence Retail Employment	2030 High Parkway Influence Households	2030 High Parkway Influence Non-retail Employment	2030 High Parkway Influence Retail Employment
NUMBER	612,828	428,050	403,689	1,146,699	549,138	748,754	1,146,699	549,138	748,754
SHARE									
Cabarrus	6.04%	5.59%	4.41%	7.29%	6.19%	5.34%	7.63%	6.38%	6.30%
Catawba	7.37%	12.01%	7.80%	6.69%	11.41%	7.19%	6.80%	11.79%	7.31%
Cleveland	5.22%	4.99%	3.57%	3.80%	4.65%	3.24%	4.31%	4.64%	4.02%
Gaston	10.59%	11.00%	7.02%	9.51%	11.08%	6.28%	9.68%	11.46%	6.68%
Iredell	5.74%	5.27%	4.57%	6.05%	5.53%	4.66%	6.63%	6.31%	5.69%
Lincoln	3.01%	2.13%	1.58%	3.34%	1.96%	1.50%	3.72%	2.35%	1.76%
Mecklenburg	31.99%	32.91%	51.78%	33.29%	33.54%	51.17%	29.06%	29.06%	44.58%
Rowan	6.87%	4.53%	4.89%	6.10%	4.45%	4.48%	6.42%	4.65%	4.86%
Stanly	3.20%	3.12%	1.77%	2.60%	2.88%	1.60%	2.67%	3.07%	1.67%
Union	4.70%	4.99%	3.38%	5.69%	5.19%	4.52%	6.11%	5.84%	4.91%
Cherokee	2.66%	3.15%	0.65%	2.61%	2.90%	0.56%	2.69%	3.00%	0.82%
Chester	1.86%	1.93%	1.10%	1.23%	1.64%	0.95%	1.52%	1.93%	1.21%
Lancaster	3.22%	2.53%	1.95%	2.90%	2.33%	1.84%	3.20%	2.52%	2.03%
York	7.53%	5.85%	5.52%	8.91%	6.24%	6.67%	9.56%	7.01%	8.16%
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

percent was used to calculate the 2030 regional population forecast. This rate assumes that the rate of population growth will slow in future years. This trend reflects a declining growth rate in national population trends, the maturing of the region, and a continuation of low birth rates. It was assumed that the Parkway will not give the region any advantage over other comparable regions and thus would not increase regional growth.

The regional forecasts for 2010 and 2030 were then broken down by county. The state-generated 2010 county forecasts served as the starting point but were adjusted to reflect influences of planned highway improvements and new construction projects, certain intraregional trends, and the influence of the Parkway (low and high scenarios).

Households. The number of households was calculated by dividing the population numbers by an average number of persons per household. Average persons per household (county and regional) for 1989 and between 1980 and 1990 were obtained from the two states. It was assumed that the recent historic trend toward smaller household sizes would continue. The region experienced a ten-year decline of seven percent between 1980 and 1990. The regional decline between 1990 and 2010 was assumed to be 10 percent. The decline was assumed to be five percent between 2010 and 2030.

Employment. Employment data for 1989 was provided by UNCC. The Catawba Regional Planning Council provided labor force estimates for the South Carolina counties. The employment data was divided into retail and non-retail based on the Standard Industrial Classification codes that were associated with the employment data.

To determine an estimate of 2010 and 2030 county and regional employment, employment as a percent of total population in those years was estimated. In 1989, total employment in the region was 51.39 percent of total population (employment rate of 0.5139 jobs/person). Statewide non-agricultural employment projections for 2000 made by the North Carolina Employment Security Commission indicate that the region will experience a 0.51 percent decrease in the relationship of employment to population over the 11-year period between 1989 and 2000 (or a .046 percent decline annually). This trend was assumed to continue and that total employment will be 50.42 percent of total population in 2010 and 49.50 percent of total population in 2030.

Total 2010 and 2030 employment for the region and by county was divided into retail and non-retail using the assumption that retail type jobs will grow at a faster rate than non-retail jobs. This assumption is supported by North Carolina Employment Security Commission's forecasts for 2000. In 1989, 48.54 percent of employment was in the retail sector. North Carolina forecasts indicate that retail jobs will make up 51.54 percent of jobs in 2000. For this study it was assumed that retail jobs would account for 54.04 percent of jobs in 2010 and 57.69 percent of jobs in 2030. These factors assume that the rate of increase in the percent of retail jobs exhibited in the 1989 to 2000 projections will slow.

Census Tract Forecasts

Population. US census tract data for 1990 were obtained from the two states. The 1989 population for each census tract was derived based on each tract's percent of total 1990 regional population.

For 2010 and 2030, census tracts within each county were assigned a share of that county's population growth based on an assessment of each tract's present development, proximity to transportation improvement projects, growth corridors, other development stimuli, and the Parkway (low and high scenarios).

Households. The forecast population by census tract was divided by the forecast average persons per household of each tract to obtain the number of households in each tract in 2010 and 2030. Average persons per household in each tract for 2010 and 2030 was estimated by adjusting the average persons per household of each tract in 1989 using the factors described for the county forecasts.

Employment. The 1989 retail and non-retail employment data at the census tract level was derived from zip code level data that was assigned to census tracts by the UNCC Center for Interdisciplinary Transportation Studies. Regional and county level employment for 1989 was derived from the census tract data.

Retail and non-retail employment for 2010 and 2030 was estimated by assigning to each census tract a share of the county's anticipated growth in retail and non-retail employment. The allocations were based on an assessment of the tract's proximity to transportation improvement projects or growth corridors, including the Parkway (low and high scenarios).

4.0 TRAVEL ANALYSIS

Future traffic volumes on selected major highways and streets within the study region were predicted based on the household, non-retail and retail employment forecasts described in Section 3.0. TransCAD, a geographic information system (GIS)-based travel forecasting package, was used to develop the traffic forecasting model. Forecasts were made for 2010 and 2030 using both low Parkway influence and high Parkway influence socioeconomic forecasts. These forecasts were used to estimate the travel benefits of the Carolinas Parkway that are described in Section 5.0.

4.1 Travel Estimates

Table 3 presents daily vehicle-miles traveled by road type for 1989 and 2030. For 2030, the vehicle-miles traveled is shown for the no Parkway, low Parkway influence, and high Parkway influence scenarios.

Table 3 indicates that the effects of the Carolinas Parkway on travel in the Charlotte Metro Region would be substantial. In 2030, it would carry 8.8 to 9.6 percent of the vehicle-miles traveled in the region. In addition, the total vehicle-miles traveled would be reduced between 2.7 and 3.3 percent. In all but one case, the vehicle-miles traveled on each type of road in the region would be reduced. These reductions would range between 1.5 and 29.0 percent.

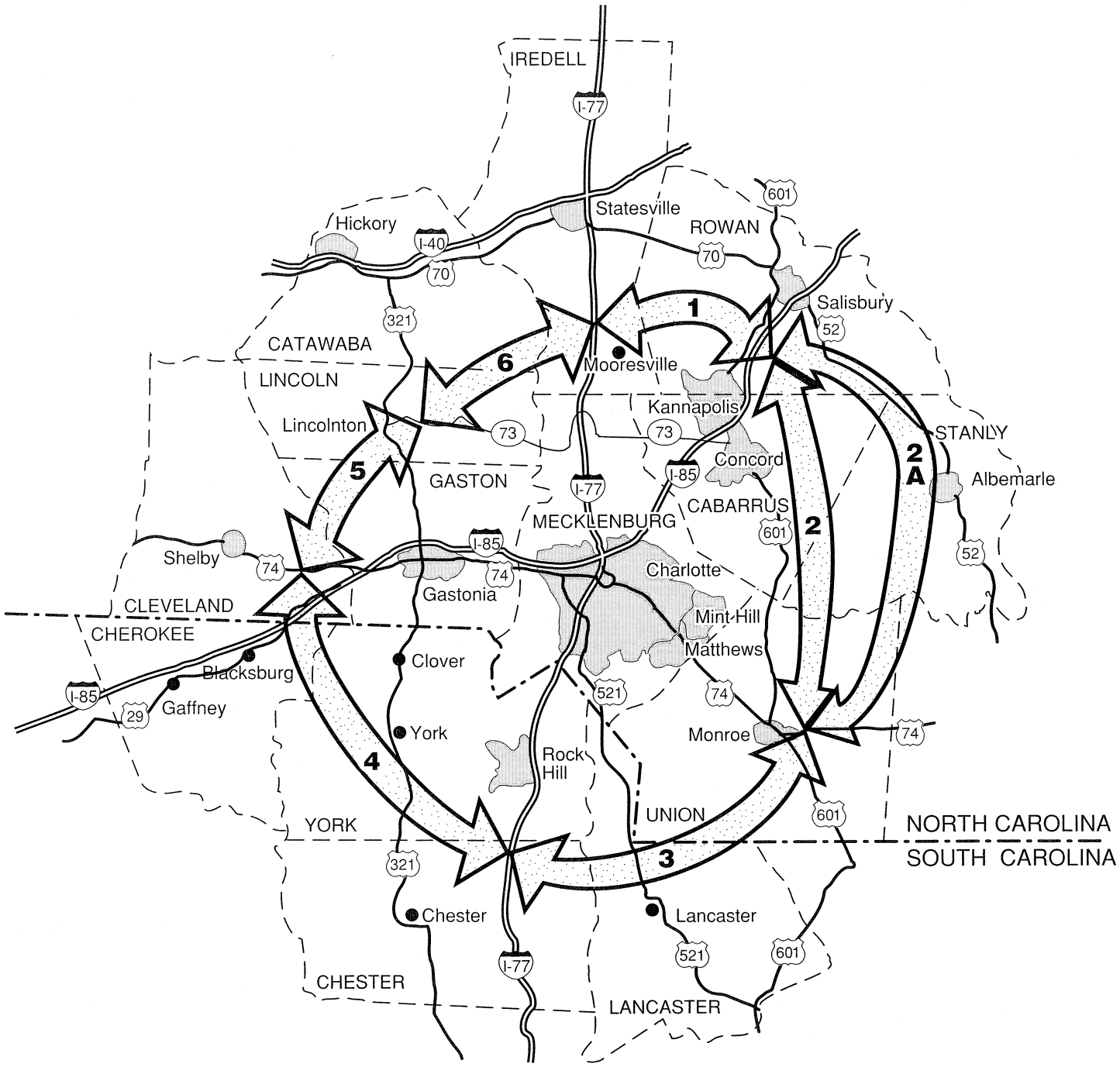
A modified version of the Carolinas Parkway also was modeled for the high influence scenario in 2030. It assumed that the east side of the Parkway is moved further east to Albemarle in Stanly County, North Carolina. This scenario would increase the length of the Parkway by 15.5 miles. The total vehicle-miles traveled under this scenario was found to be 86,846,000 (63,398,000 on modeled links and 23,448,000 on unmodeled links). Under this scenario, 8,356,000 vehicle-miles would be on the Parkway or 9.6 percent (same as for the study corridor) of the total vehicle-miles traveled. The total vehicle-miles traveled in the region would be reduced by 3.5 percent, 0.2 percent more than the original 2030 high influence scenario. Thus, the travel benefits of shifting the east side of the Parkway corridor to the east would be similar to the those of the study corridor. Again, in all but one case, the vehicle-miles traveled by type of road would be reduced.

The Parkway's year 2030 average annual daily traffic (ADT) is illustrated in Figure 2 for six corridor segments. The greatest volumes would occur in the northwestern part of the region as the Parkway passes

Table 3
Forecast Vehicle-Miles Traveled By Road Type

	1989			*2030*						
						Vehicle-Miles Traveled			*% Change in Vehicle-Miles Traveled from No Parkway Scenario*	
Road Type	*Number of Links Modeled*	*Total Miles of Each Type*	*Vehicle-Miles Traveled*	*Number of Links Modeled*	*Total Miles of Each Type*	*No Parkway*	*Low Influence Parkway*	*High Influence Parkway*	*Low Influence Parkway*	*High Influence Parkway*
2-lane urban -- 35 mph	75	92.5	796,373	70	86.5	1,124,473	956,152	971,232	-15.0%	-13.6%
2-lane urban -- 45 mph	54	77.6	711,125	54	78.0	1,587,413	1,494,975	1,456,430	-5.8%	-8.3%
2-lane rural -- 45 mph	39	72.7	700,866	21	44.2	344,982	277,193	289,866	-19.7%	-16.0%
2-lane rural -- 55 mph	451	1,814.8	8,331,811	407	1,640.0	16,551,513	14,545,068	15,130,760	-12.1%	-8.6%
4-lane -- 35 mph	40	50.9	910,064	45	57.5	1,476,227	1,306,313	1,276,961	-11.5%	-13.5%
4-lane -- 45 mph	93	173.0	3,087,738	136	262.4	7,023,658	6,573,847	6,165,278	-6.4%	-12.2%
4-lane -- 55 mph	74	196.3	2,436,575	160	506.0	8,255,966	7,571,932	7,656,055	-8.3%	-7.3%
4-lane freeway (1)	124	343.0	12,200,032	132	382.8	21,044,502	16,217,651	15,797,642	-22.9%	-24.9%
6-lane freeway	18	16.6	816,205	40	54.4	5,642,669	5,082,549	4,450,369	-9.9%	-21.1%
8-lane freeway	9	17.1	1,173,204	10	18.5	2,351,264	1,913,383	1,669,389	-18.6%	-29.0%
6-lane -- 45 mph	5	8.9	442,467	8	10.7	258,213	254,396	253,568	-1.5%	-1.8%
6-lane -- 55 mph	0	0.0	0	2	3.5	38,818	38,880	32,348	0.2%	-16.7%
Carolinas Parkway	0	0.0	0	46	187.4	0	7,687,191	8,366,716	NA	NA
TOTALS FOR STREETS AND HIGHWAYS MODELED (2)	982	2,863.4	31,606,460	1,131	3,331.7	65,699,698	63,919,530	63,516,614	-2.7%	-3.3%
TOTAL REGIONAL VEHICLE-MILES TRAVELED			43,296,425			89,999,388	87,560,807	87,008,869	-2.7%	-3.3%

(1) Excluding the Carolinas Parkway
(2) Every street and highway in the Charlotte Metro Region was not modeled in the link network. A multiplier was used to take these roadways into account and calculate the total regional vehicle miles traveled.
NA=Not Applicable



Parkway Average Annual Daily Traffic in 2030

Number of vehicles

1	39 to 41,000
2	23 to 37,000
2A	17 to 37,000*
3	22 to 45,000
4	28 to 52,000
5	42 to 77,000
6	58 to 87,000

*high influence only

Figure 2
Parkway Traffic
In 2030

through Gaston, Lincoln, Catawaba, and Iredell Counties. The Parkway also would increase traffic on many of Charlotte's radial highways near their juncture with the Parkway.

4.2 Travel Analysis Approach

Base Travel Modeling

The base road network for the travel model included the existing interstate highways, US highways, parts of the state highway system, and some major streets for the region. Basic information coded for each link of these roads included: length, speed, number of lanes, capacity, 1989 traffic volumes, and a travel time penalty. The travel time penalty reflected the differing operational characteristics of rural and urban highways and Interstate, US highways, and state highways and major streets. (A link is defined as a road segment between nodes. A node is defined as an intersection of two or more road segments. An external node is the intersection of a network road segment and a road segment outside the modeled network. Trips with origins and/or destinations outside the modeled network enter and leave the network at an external node.)

Trip productions and attractions (the number of household, non-retail employment and retail employment trips originating or ending at the points where trips enter or leave the network of links) were based on the 1989 socioeconomic information described in Section 3.0 of this report. They were calculated using a spreadsheet created according to the procedures of National Cooperative Highway Research Program Report 187. A deduction factor was applied because approximately 28 percent of travel in the region is on the local (unmodeled) street network. Trip productions and attractions outside the region were assumed to be half of the 1989 average annual daily trip volume on links connected to an external node.

The link network model was calibrated by modeling link volumes for 1989 and comparing the modeled volumes against actual traffic counts and making adjustments in the model that reduced the differences between actual and modeled volumes. The all-or-nothing traffic assignment method was adopted for model calibration and travel forecasting. Pivot points were calculated and used to adjust forecast link volumes to take into account the differences remaining between modeled and actual 1989 volumes.

Forecast Modeling

Planned roads were added to the network when making future travel forecasts. They included:

1. Highway projects included in current state Transportation Improvement Programs, both new roads and road improvements.

2. Highway projects included in long-range thoroughfare plans and local government plans.

3. The Carolinas Parkway.

The 2010 network included items 1 and 3. The 2030 network included all three additions to the basic network. Speed and travel time impedance were assigned to the new and improved links. All nodes on this forecast network were coded to the 1990 US Census tracts and zip code zones in which they were located. The socioeconomic data for 2010 and 2030, described in Section 3.0 of this report, were assigned to the nodes and trip productions and attractions were determined via the spreadsheet used for the basic model. The same time deduction factor was used. Future external productions and attractions were factored up using growth rates. Through trips (external node to external node) on I-85 and I-77 were estimated and taken into account.

Future traffic assignments were made using the all-or-nothing method of assignment. The model results were adjusted using the pivot points determined during base model calibration. Some manual adjustments were made on a few links where the forecasts seemed unreasonably high or low.

5.0 ASSESSMENT OF PARKWAY FEASIBILITY

5.1 Environmental Impact Screening

An environmental impact screening was conducted to determine if there were any major environmental impact issues associated with the Parkway. The focus of the screening was on identifying the proximity of the following natural and manmade environmental features to the Parkway corridor:

- Development (recreation, urban, industrial, airport, school, mining, and major utility).
- Historic properties.
- Churches and cemeteries.
- Natural resources (wetlands, streams, lakes, floodplains, and fish hatcheries).
- Superfund sites (National Priorities List Sites).

Findings

A Parkway in the study corridor would avoid most natural and manmade features. More existing features lie in the east alternative corridor than in the study corridor. Shifts in the study corridor alignment or the east alternative alignment could avoid many of the features identified or reduce the severity of the potential impact. Any location for the Carolinas Parkway would, however, have some impact on natural and manmade features.

In addition to the general observations above, the following more specific observations can be made:

- Wetlands are found throughout the Parkway corridor. Crossings of wetland areas would be required at numerous locations.
- The lands of major parks in the area (King's Mountain National Military Park, Kings Mountain State Park, Landsford Canal State Park, and Andrew Jackson State Park) would not be affected.
- No superfund sites were identified within the Parkway corridor.

Information Sources

The relation of the project to existing development, churches, cemeteries, and natural resources was derived from US Geological Survey 7.5' quadrangle maps. The North Carolina Department of Environment, Health and Natural Resources and the South Carolina Department of Health and Environmental Control, as well as county agencies, were contracted to determine the presence of US Environmental Protection Agency superfund sites, potential and known hazardous waste sites, and landfills. The historic sites were derived from the National Register of Historic Places.

5.2 Cost

The Carolinas Parkway project would cost approximately $2 billion dollars in 1992 dollars. This includes $0.3 billion for the purchase of an 187-mile-long right-of-way with an average width of 350 feet (an average cost of $27,000 per acre). It also includes a $1.7 billion construction cost or $9 million per mile.

The right-of-way cost was based on the experience of the North Carolina Department of Transportation (NCDOT) Right-of-

Way Section on other highway projects in the region.

Construction costs were first estimated based on estimates prepared for the Charlotte Outer Loop and the Raleigh Outer Loop. A cost of $9 million per mile, approximately 10 percent less than the average per mile cost estimates for the Charlotte Outer Loop and the Raleigh Outer Loop, appeared reasonable since the Parkway would be built in less developed areas. To corroborate the $9 million cost, the NCDOT calculated a cost per mile that assumed four lanes, one structure and half an interchange per mile, and a contingency of 20 percent. The result was slightly less than $9 million dollars per mile but close enough to confirm the reasonableness of the $9 million estimate.

5.3 User Benefits

Findings

The implementation of the Carolinas Parkway project would change regional travel patterns by diverting traffic from other major roads to the Parkway. Traffic reduction on other roads in the region would reduce costs to highway travelers in the region. The total benefits to the region's travelers accrued between 2010 and 2030 were estimated. The benefits calculation assumed the entire Parkway is opened for use in 2010. The benefits are shown in Table 4.

User benefits would be $14.2 billion and $16.4 billion for the low and high Parkway influence scenarios, respectively. Travelers on 2-lane rural roads (55 mph) would accrue the greatest benefit because this type of road is pervasive in the region and because it is primarily located outside the center of the region and thus would be more directly affected by the Parkway. The benefit would be greater under the low influence scenario since growth under this scenario is assumed to be more centralized, resulting in less traffic on the outer rural roads.

The freeways also would benefit significantly (the negative number for the 4-lane freeway takes into account travel costs of the new Parkway). The Parkway would also divert traffic from the 6-lane freeways in the region, particularly in the northwestern quadrant where the Parkway would offer an alternative route for I-85/I-77 traffic.

Because the forecast differences are small in vehicle-miles traveled between the proposed Parkway and a Parkway with an eastern alignment near Albemarle, the user benefits for these two location options should be similar.

Approach

A computer model developed by the Statewide Planning Group, NCDOT was used to estimate the benefits to regional travel of the Parkway. The procedure is described in NCDOT's Technical Report #8, Transportation Project Evaluation Using The Benefits Matrix Model (January 1983 and subsequent supplements).

User benefits were calculated as the difference in regional highway user costs between the no Parkway scenario and the Parkway scenarios. The user costs calculated were:

- Vehicle operating costs.
- Travel time costs.
- Accident costs.

All of these costs decrease as the level of service improves on streets and highways (less congestion). In addition to the traffic volume and operating parameters described in Section 4.0, the model took into account the cost of the traveler's time in terms of hourly wages and vehicle occupancy (1.5 persons per vehicle).

Table 4
Parkway User Benefits By Road Type

Road Type	Total Miles of Each Type	2010 to 2030 Regional Travel Cost Savings With Parkway (millions of dollars) High Influence Scenario	Low Influence Scenario	Difference Between High and Low
2-lane urban -- 35 mph	86.5	$847.04	$1,023.56	($176.52)
2-lane urban -- 45 mph	78.0	$672.77	$573.49	$99.27
2-lane rural -- 45 mph	44.2	$274.06	$308.96	($34.89)
2-lane rural -- 55 mph	1,640.0	$5,756.92	$7,367.25	($1,610.33)
4-lane -- 35 mph	57.5	$1,835.89	$1,681.81	$154.09
4-lane -- 45 mph	262.4	$4,843.07	$2,839.10	$2,003.97
4-lane -- 55 mph	506.0	$1,850.22	$2,135.08	($284.85)
4-lane freeway (1)	570.2	($6,763.70)	($6,363.23)	($400.48)
6-lane freeway	54.4	$4,479.59	$2,695.15	$1,784.44
8-lane freeway	18.5	$2,538.84	$1,849.01	$689.83
6-lane -- 45 mph	10.7	$44.30	$45.89	($1.59)
6-lane -- 55mph	3.5	$15.39	($0.18)	$15.57
TOTAL	3,331.7	$16,394.39	$14,155.89	$2,238.50

(1) Including the Carolinas Parkway

The hourly wage (in current dollars) used was $9.19. This is the average wage for the region for the first quarter of 1991. Data for the North Carolina counties was obtained from Employment and Wages in North Carolina, First Quarter 1991, (Employment Security Commission of North Carolina). Data for York and Lancaster Counties in South Carolina was derived by adjusting wage data provided by the UNCC.

6.0 RECOMMENDATIONS FOR PHASE II STUDIES

It is recommended that the Phase II studies consist of:

1. Modeling the travel benefits of a wider variety of Parkway alternatives using TRANPLAN software and a refined set of assumptions.

2. Continuing consensus development.

3. Conducting an environmental screening for selected reasonable corridors that result from items 1 and 2 above.

4. Evaluating study findings and recommending more specific alignments for further study.

Additional Travel Modeling

Modeling the travel benefits of a wider variety of Parkway alternatives is recommended so that the potential of the Parkway concept can be examined in greater detail and the highway networks that would offer the greatest benefit to regional travelers can be identified. This should include:

- Optimizing the location of the Parkway corridor to reflect the most efficient relationship between the Parkway and the rest of the roadway network. A physical location within a single, approximately five-mile-wide corridor was assumed during Phase I (with one variation on the east side).

- Examining the possibility that some segments of the Parkway would not be cost-effective as stand alone projects and examining whether Parkway benefits could be achieved with a partial ring. Phase I studies assumed that the entire Parkway would be built.

- Evaluating alternative design configurations and their effect on user benefits and costs. During Phase I, the Parkway was assumed to be a limited access highway designed to meet Interstate standards.

In order to conduct these studies, it is recommended that the travel model used during Phase I be converted to TRANPLAN software. Both the NCDOT and the SCDHPT are familiar with this model and it would offer the greater flexibility needed for Phase II modeling.

In addition, the modeling evaluation methodology for the Phase I study included two assumptions that are not considered precise enough for the more detailed studies that should be conducted during Phase II. These assumptions and the work needed to generate the more precise information necessary for Phase II are:

- The Phase I traffic model was used without a capacity constraint provision. This is called the all-or-nothing method of traffic assignment and does not take into account changes in travel patterns that result from congestion. Roadway capacity should be considered in the Phase II model.

- Through trips (trips by regional roadway users whose origin and destination are both outside the region) were estimated during Phase I by using parameters from other similar metropolitan areas. During Phase II, an origin-destination study could be

made and the findings incorporated into future model evaluations should funding be available.

Consensus Development

It is recommended that the steering committee continue to fulfill the role it played during Phase I. Input from other CTC constituents also could help in determining the alternatives studied, Parkway features, sensitive areas, and other roadway needs that would be associated with the Parkway.

Environmental Screening

The alternatives found to be reasonable through the Phase II travel modeling and the consensus development process should be screened to determine their potential for environmental impact. The environmental screening would be used to determine the potential impact on natural and man-made features.

Evaluation and Recommendations

With the assistance of the steering committee, the modeling and environmental screening findings and the development goals and objectives of the CTC membership should be integrated. The importance of each of the three factors to a final recommendation could be taken into account using either an objective or subjective weighting system. The study findings and recommendations should aid in future thoroughfare planning for the region.

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