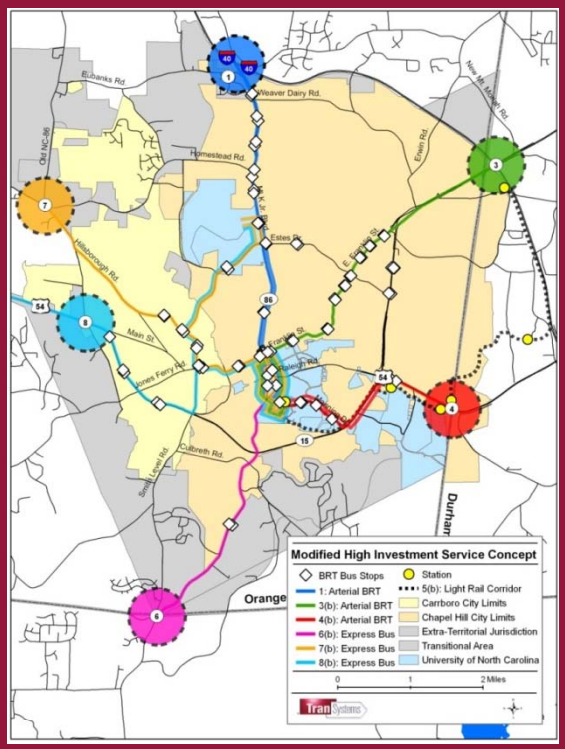
Chapel Hill and Carrboro 2035 Long Range Transit Plan

Town of Chapel Hill NC
Town of Carrboro NC
University of North Carolina at Chapel Hill

September 2009



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Chapel Hill and Carrboro
2035 Long Range Transit Plan

Prepared for

Town of Chapel Hill, North Carolina
Town of Carrboro, North Carolina
University of North Carolina at Chapel Hill

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Section 0: Executive Summary

The Towns of Chapel Hill and Carrboro are nationally recognized as great places to live, work and go to school. While boasting world-class educational opportunities, the small town ambiance of these enviable communities is threatened by increasing traffic congestion. As a result of general population and employment growth including continued expansion of the University of North Carolina at Chapel Hill's (UNC) main campus and anticipated development of the University's Carolina North campus, community leadership initiated a long range transit plan to seek alternatives to building more and wider roads.

This Study seeks to:

- Assess the impact of anticipated future population and employment and resulting growth in travel demand
- Identify the role public transit could play in mitigation of future congestion and potential roadway expansions
- Suggest land use policies and guidelines that support and complement the viability of the transit system.

Through the guidance of the Transit Study Policy Committee[1], this Chapel Hill Long Range Transit Plan (LRTP) provides a vision of the community and the public transit system in 2035. The LRTP recommends:

- Introduction of higher level transit services along six "gateway" corridors
- Expansion of local bus service to support the gateway services
- Further study of impact of parking policies and land use policies to support transit growth

The Transit Study Policy Committee has reviewed the analysis and recommends the proposed Plan be submitted for a thorough public review process. The Committee acknowledges that the Plan outlines a broad strategy and includes a menu of transit options for further consideration. A series of intermediate actions will be necessary to support these long term strategies. As this process proceeds some options eliminated by the Policy Committee may be reconsidered.

The Committee also recognizes that the Plan should be consistent with the adopted Durham-Chapel Hill-Carrboro Urban Area Long Range Transportation Plan. The Policy Committee believes that the Chapel Hill Long Range Transit Plan that emerges from public review and input should be adopted by the governing bodies of Chapel Hill, Carrboro and the University of North Carolina.

This executive summary highlights the LRTP in these sections:

- Overview of the Community and Plan Assumptions
- Findings which lay the foundation of key aspects of the LRTP
- Overview of the Recommended Plan
- Next Steps

0.1 The Community and Plan Assumptions

As seen in Figure 0-1, the Towns of Chapel Hill and Carrboro, North Carolina are part of the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO) area which is located in metropolitan Raleigh-Durham North Carolina. As shown in Figure 0-2, the community is also home to the University of North Carolina at Chapel Hill with 30,000 students and faculty and the North Carolina Hospital. Combined, the Chapel Hill-Carrboro community has a population of nearly 70,000 people. According to regional projections, the combined community population is

[1] The Transit Study Committee is composed of elected officials of the Towns of Chapel Hill and Carrboro as well as senior management of the University of North Carolina.

expected to grow to nearly 102,000 people by 2035. Along with this growth will be increased travel demand and anticipated traffic and congestion.

Growth in the Chapel Hill/Carrboro area is expected as a result of robust regional growth, including continued expansion of the University main campus and anticipated development of Carolina North. Over the next 50 years, Carolina North is planned to become a major employment center and will include classrooms, medical and research facilities. The Carolina North campus will also incorporate residential and retail uses.

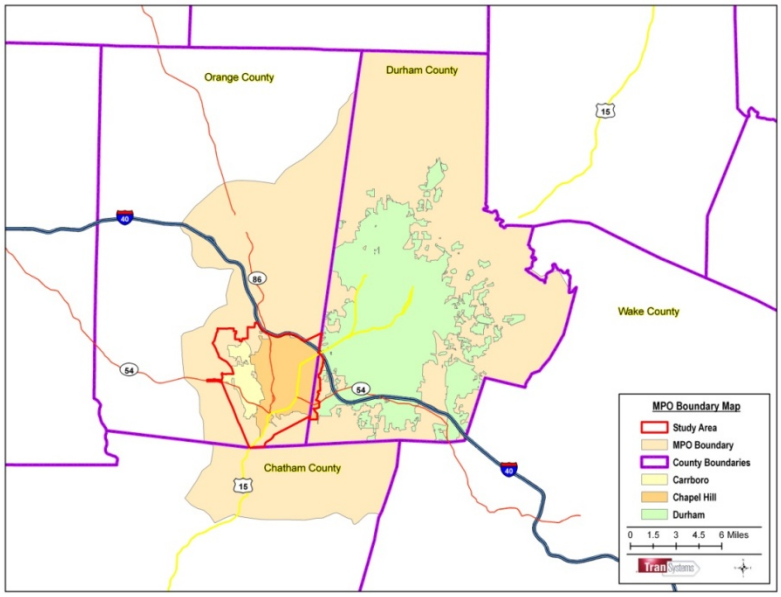
Although Chapel Hill-Carrboro has a relatively modest population the community is served by a vibrant transit system that rivals those of much larger communities. Chapel Hill Transit (CHT) operates almost 100 vehicles and has daily ridership of over 30,000 when UNC is in session. As the community is considered a desirable place to live and work, increasing pressures from a growing daytime population will result in continued growth of traffic at the interstate interchanges and along both arterial and local streets. The anticipated development of Carolina North will generate additional travel demand and the community leadership seeks to expand transit opportunities as an alternative to further roadway expansion.

0.1.1 Plan Assumptions

The Chapel Hill/Carrboro LRTP makes the following assumptions about transit:

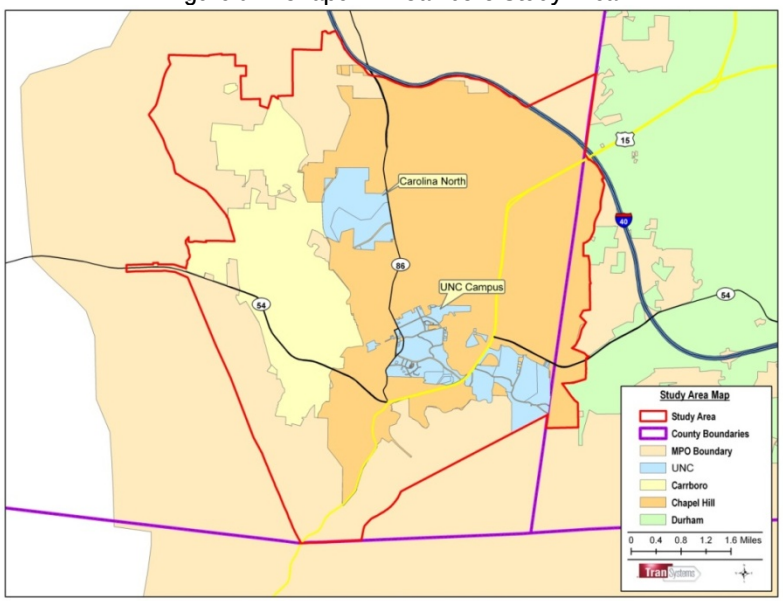
- Future transit service will expand along major travel corridors as well as throughout the Chapel Hill-Carrboro service area. Travelers would be intercepted at the community boundaries at "gateway" park and ride facilities.
- Future Chapel Hill Transit service will include a mix of local bus routes, express services and higher capacity technologies such as Bus Rapid Transit (BRT).[2]
- Expanded regional transit services, including express service and the implementation of regional light rail will support the Chapel Hill Transit system. Such regional services will be developed by entities outside of Chapel Hill-Carrboro.

Figure 0-1: Chapel Hill-Carrboro in the Durham-Chapel Hill-Carrboro Area



[2] BRT is special service characterized by distinctive service branding, high capacity and high speed vehicles, dedicated running ways, use of traffic signal priority, and upgraded stations.

Figure 0-2: Chapel Hill-Carrboro Study Area



0.2 Findings

The building blocks for the LRTP are based on three basic findings. These findings are crucial foundations to the plan:

1. Analysis of 2035 travel demand suggests that six main corridors will be used by commuters to access the Chapel Hill-Carrboro community. The traffic levels in these corridors can justify an investment in a higher order of public transit.
2. Future travel demand necessitated the need for improved transit services
    - Three service delivery concepts may be appropriate for higher level transit service. These include light rail (LRT), bus rapid transit (BRT) and enhanced express service (EEB). Light rail was found to be cost prohibitive if used as a Gateway service. However, this Plan recognizes LRT as a potential regional service that would serve some of the gateways while going beyond them to connect with Durham and Wake Counties.
    - Expanded local bus service will be necessary to support the Gateway services. The expansion of local transit services will compliment the proposed Gateway services, providing improved access to the Gateway stations and increasing local mobility.
3. Transit supportive land use policies, including parking policy need to be implemented along major transportation corridors and in the downtown to allow the preferred service concept to realize its maximum potential in attracting additional transit trips.

These findings are discussed in greater detail below.

0.2.1 Future Travel Demand and Gateway Corridors

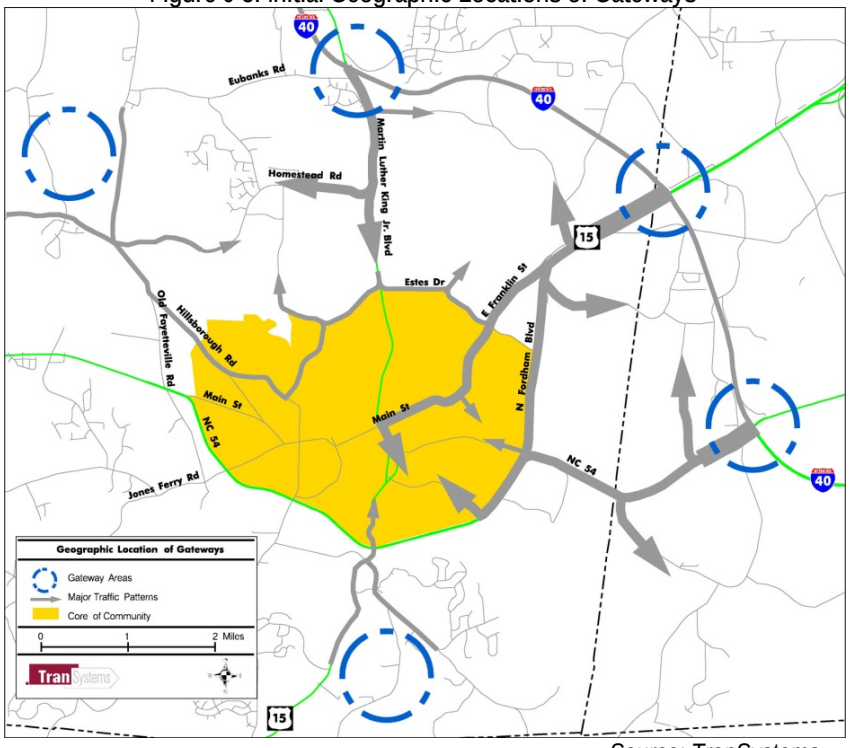
This LRTP utilizes the Raleigh-Durham regional travel demand model called the Triangle Regional Model (TRM) to project 2035 travel demand in and out of Chapel Hill-Carrboro. The purpose in using the TRM is to establish a consistent link with the overall region. The TRM is the basis of transportation planning in the Raleigh-Durham metropolitan area and is utilized by both of the area's MPOs including the DCHC. The TRM for this LRTP incorporates the latest 2035 projections of land use, socioeconomic characteristics, and demographics for the study

area. The land use information also includes population and employment assumptions about the Carolina North development. The TRM is also used throughout the LRTP to test transit service concepts.

The TRM, as analyzed for the study area, shows that 70 percent of commuters entering Chapel Hill-Carrboro are from Durham County. These commuters come from the north and east via NC 86 (Martin Luther King, Jr. Blvd.), US15/501 (Franklin and North Fordham Blvd), and East NC54 (Raleigh Road). The main commuter destination is the core of the community which consists of downtown Chapel Hill-Carrboro, UNC main campus, and Carolina North. Other commuters are entering the community via Hillsborough Road, West NC 54 (Main Street), and South US 15/501 and are destined for the core as well.

Initial locations in which to intercept travelers external to Chapel Hill and Carrboro as well as relative importance of key corridors are found in Figure 0-3.[3] The Figure shows the general gateway locations as blue circles. The major travel patterns are shown with gray lines with arrowheads. Important travel corridors are represented in the Figure as thicker the gray lines. Less important corridors are represented by thinner lines.

Figure 0-3: Initial Geographic Locations of Gateways



Source: TranSystems

0.2.2 Travel Demand and Service Concept

In defining the transit market, a conceptual service plan was developed to capture the broader trip making evident in the study area. The service concept has two basic elements: *Gateway* services which are intended to intercept travelers entering Chapel Hill and Carrboro and, second, *Enhanced Local Bus* services were are intended to provide mobility within the towns.

[3] An additional Carrboro gateway is added later in the study.

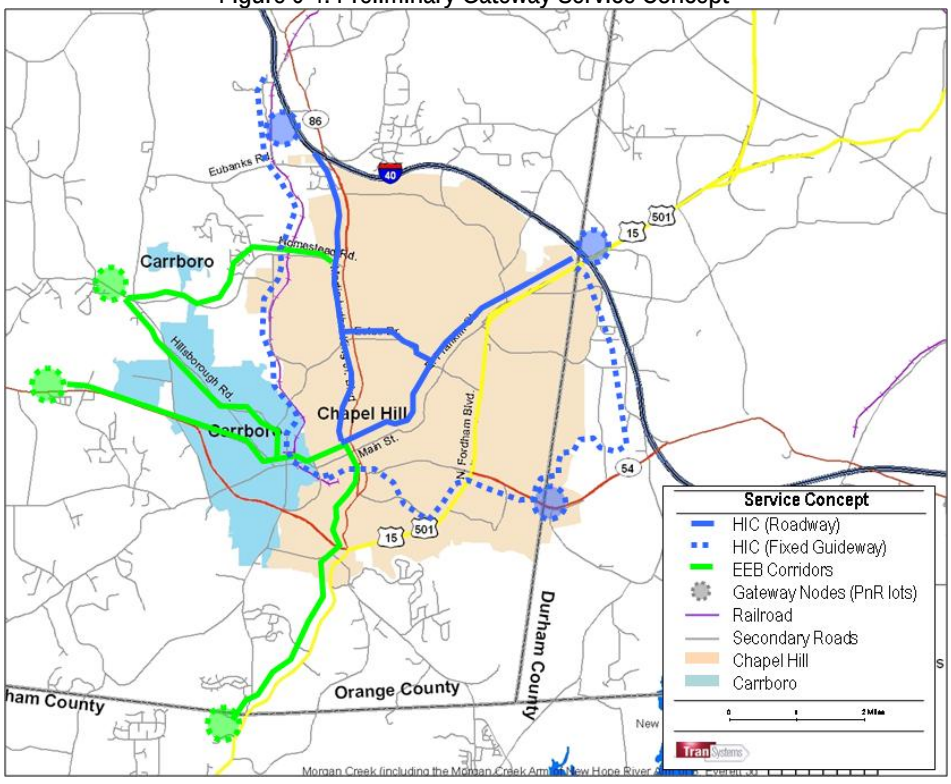
The Gateway portion of the service concept consists of two different types of services:

- High Investment Corridors (HIC)—bus and rail.
- Enhanced Express Bus Corridors (EEB)-bus.

The High Investment Corridors are designed to serve the large markets originating from the Durham and Wake County areas and therefore involve consideration of investment technologies designed for a high volume of ridership. These technologies include light rail, streetcar, and bus rapid transit (BRT).[4] The HIC serves the prime three entry points into the community from Durham County which, by 2035, will account for 70 percent of the travelers entering Chapel Hill-Carrboro. The Enhanced Express Bus (EEB) Corridors do not include consideration of rail modes but consider BRT options as well as limited-stop, Express Bus services. EEB is considered here as the volume of potential riders is less than half of what is expected for the HIC thus the need for rail modes is not apparent. The refinements made to overall Gateway Service Concept include additional corridors as well as refinements to the routing and the identification of general locations for the Gateway nodes where travelers can park-and-ride.

The set of corridors or gateway services is shown in Figure 0-4. The *Enhanced Local Bus* portion of the concept includes services with greater frequencies and geographic coverage than the current CHT system. The local bus system underlies the gateway services and covers much of Chapel Hill and Carrboro.

Figure 0-4: Preliminary Gateway Service Concept



Source: TranSystems

[4] BRT is special service characterized by distinctive service branding, high capacity and high speed vehicles, dedicated running ways, use of traffic signal priority, and upgraded stations.

Developing the Service Concept: Identifying Transit Technologies

A number of viable transit modes or technologies that can potentially comprise the above service concept are analyzed below. This section discusses an array of these technologies for the gateway and enhanced express bus services. The evaluation of suitable technologies involves the determination of which mode is the most cost effective in serving the intended markets.

Table 0-1 summarizes the technologies considered for the gateway services. Other technologies, such as commuter rail and heavy rail, are not considered because they are not deemed practical for the Chapel Hill-Carrboro community. Such services are intended for long distance, regional travel while the travel distances within the community are short at about five to six miles in length. The purpose of the study, to remind the reader, is to develop transit strategies that are localized, leaving regional service planning to other entities.

The technologies in Table 0-1 were evaluated for cost-effectiveness using conceptual operating characteristics including assumptions for service frequencies, length of peak periods and hours in which the service would operate. Capital and operating costs assumptions are from recent work done in the Raleigh-Durham area involving similar technologies. For HIC technologies, the deployment for each technology type is varied. For example, light rail (LRT) was tested using one, two, or three cars per train set. In all, for the HIC services, nine variations are tested. For the EEB services, five combinations of deployment are reviewed involving BRT and Express Bus. The analysis concluded that assuming the highest level of ridership, BRT and express bus are the most cost effective modes in the HIC and EEB corridors respectively. While LRT was deemed cost prohibitive as a gateway service, it was recognized that LRT as a regional service, going beyond Chapel Hill-Carrboro boundaries, should be reflected in this LRTP.

Table 0-1: Potential Technologies for Services

	High Investment Corridors				
			Enhanced Express Bus		
Characteristic	LRT	Streetcar	BRT busway	BRT arterial	Express Bus
Vehicle type and ROW	• Rail cars in exclusive ROW infrastructure	• Rail cars in arterial streets	• Buses in exclusive ROW facility	• Buses on exclusive lane in arterial street	• Limited-stop service in mixed traffic
Intersections with mixed traffic	• No	• Few	• Few	• Yes	• Yes
Infrastructure at stops	• Stations	• Enhanced shelters	• Stations	• Enhanced shelters	• Shelters
Payment and boarding	• Off-vehicle fare payment • At grade, multiple door boarding	• Off-vehicle fare payment • Multiple door boarding	• Off-vehicle fare payment • At grade multiple door boarding	• Off-vehicle fare payment • Multiple door boarding	• On-board payment • One-door boarding

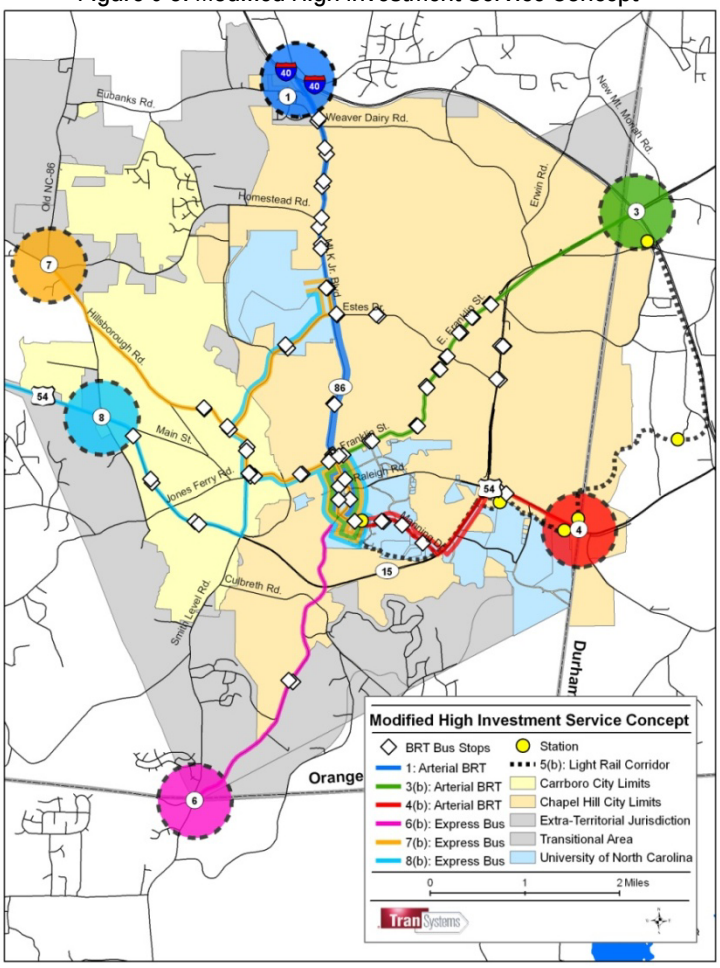
Preferred Service Concept

The preferred service concept involves BRT and express bus technologies (see, again, Figure 0-4) and is named the "Modified High Investment Service Concept." This concept is shown in Figure 0-5. It should be noted that Figure 0-5 includes Light Rail Transit (LRT) as a regional mode and separate from the gateway concept which is local in nature. However, it is shown as LRT which could be added in the future. Eventually, an LRT service could replace either or both of the BRT services at Gateways 3 and 4.

The Modified High Investment Service Concept is a combination of the two investment scenarios developed for the LRTP. The first of these was called the "Low Investment scenario" with the second called the "High Investment

scenario." The Low Investment scenario consists of arterial BRT services on gateways 1, 3, and 4. It also consists of EEB serving gateway corridors 6, 7, and 8. The High Investment concept is similar to the Low Investment concept except it involves the operation of BRT in an exclusive busway (in the LRT corridor) instead of the gateway 4 (East NC54) service. Also the High Investment assumes Gateway 1 (MLK) would have a grade separated busway. The preferred concept retains the gateway services of the Low Investment scenario with transit service in the fixed guideway corridor as considered in the High Investment scenario. As mentioned, the fixed guideway corridor would have regional LRT instead of Gateway BRT service as originally considered for the High Investment scenario.

Figure 0-5: Modified High Investment Service Concept



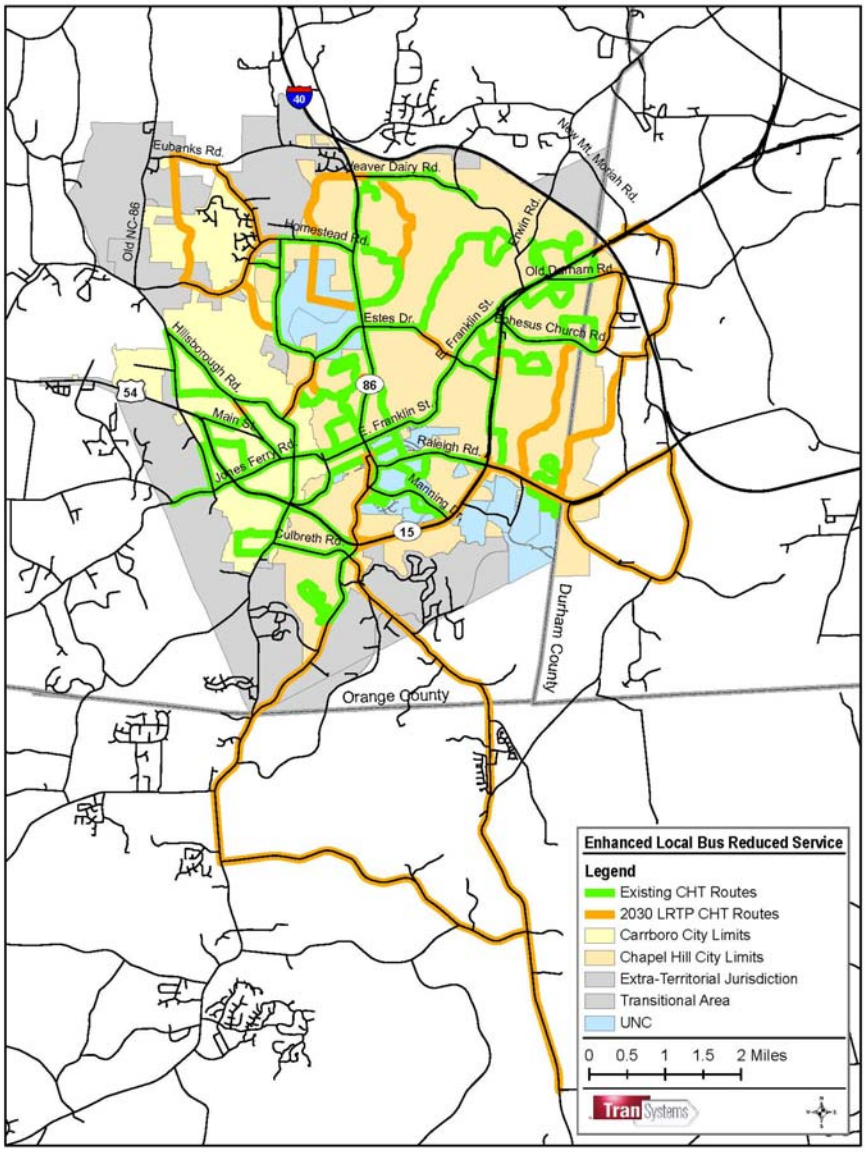
It is assumed that services on Gateways 3 and 4 would be re-evaluated as plans for regional LRT move forward. The Modified High Investment Service Concept would also include the enhanced local bus system described below. Together, the Modified High Investment Strategy and the Enhanced Local Bus Service comprise the "preferred service concept" to be further analyzed.

Enhanced Local Bus Service

While the current CHT system provides good geographic coverage, a local transit system that can compete with the attractiveness of the automobile would need not only more extensive coverage than the current service but will also need more frequent service and expanded hours of service. The 2030 and 2035 adopted long range plans developed by the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization contain an extensive bus network for Chapel Hill Transit. That network includes services with, respectively, 10-minute and 20-minute peak and off-peak service frequencies. It also contains services in support of a regional commuter rail service as well as bus services supplied

by the Triangle Transit Authority (TTA). Further, services similar to some of the gateway services described above were included in both plans. Figure 0-6 depicts a map of the Enhanced Local Bus service used as part of the "preferred service concept". In this LRTP, the local transit networks included in the 2030 and 2035 plan's were modified and tailored to the gateway service concept. This includes eliminating routes which duplicate the gateways or support a planned, fixed guideway service. The 2030 plan calls for 53 routes as a part of 2030 CHT system including the commuter rail service. Thus, they are eliminated for the purposes of the 2035 LRTP ultimately leaving 23 routes as part of the LRTP.

Figure 0-6: Enhanced Local Bus



Modeling the "Preferred Service Concept"

The "preferred service concept" consists of the Modified High Investment Strategy and the Enhanced Local Bus network. These were modeled using TRM and combined with an off model technique to evaluate the effects of potentially restrictive parking policies which are not able to be accommodated in the current regional model. An off model technique is used that associates travel trips with parking supply at UNC and Carolina North. Trips that could not be accommodated by the parking supply are generally and proportionally assigned to the new transit network.

Table 0-2 presents the model results for the Modified High Investment Service Concept[5] using the off-model parking analysis as well as the TRM analysis. As can be seen in Table 0-2 the projected Gateway service ridership is substantially increased by restrictive parking. Out of 45,386 total Gateway riders under the Low Investment scenario, nearly 33,600 daily riders (adding parking deficit related ridership for both UNC main campus and Carolina North) would be attributed to the parking restrictions. This represents almost 75 percent of the Gateway riders or a 285 percent increase over the model results in which no restrictive parking policies were assumed. Restrictive parking policies will be a key ingredient in a future transit strategy.

A parking analysis more rigorous than conducted in this study is recommended.

0.2.3 Need for Transit Supportive Land Use Policies to Support Expanded Transit Services

It is recognized that even with exceptional transit service within the community, other policies will be needed to promote transit as a preferred mode of choice for residents, employees and visitors. Policies for future development that promote transit supportive design and the expanded use of bicycles and walking will be necessary. Additional policies needed include controlling the availability of parking on the UNC main campus, Carolina North, and the downtowns of Chapel Hill and Carrboro.

Transit Supportive Development

Experience from around the country suggests that that success in expanding transit use depends on many factors, including transit supportive and coordinated land development. Transit supportive policies include a mix of uses – housing, retail, office – and higher density. The other key factors include provision of an attractive, safe and inviting pedestrian environment, and the use of public space integrated with the transit station and commercial space to create a "sense of place." This type of development is often called Transit Supportive Development or TSD.

The development and implementation of a TSD strategy is not only essential for the future success of transit it is also an integral criterion in the federal government's evaluation of Small Starts and Very Small Start funding proposals. Projects can receive higher ratings in communities with robust land use policies which include TSD regulations.

Working with the Towns of Chapel Hill and Carrboro, 20 sites were identified as potential locations for TSD. (See Figure 0-7). These sites represent properties that are located on potential transit corridors. For each property, the gross and net developable area was determined. In discussions with representatives from the Town Planning Departments, a land use mix and development density was defined for each property, based on the surrounding land use patterns, site configuration and planning objectives. Based on the land use mix and development density defined for each site, the resulting number of residential units and square footage of office and retail space was calculated.

In addition, a set of design guidelines to implement a TSD strategy is developed in this LRTP. The purpose of these TSD Design Guidelines is to ensure that new development around transit stops/stations/corridors supports transit use, encourages ridership, reduces auto dependency and leverages the transit investment. These design guidelines support the Town of Chapel Hill's existing Design Guidelines and are supplemental to those Guidelines. The guidelines establish basic principles that include pedestrian oriented design, building design, site layout, connectivity, density, and transportation amenities.

[5] Since the Gateway and local bus portions of the Modified High Investment Service Concept is the same for these services as under the Low Investment scenario, the ridership numbers reflect the Low Investment scenario.

Table 0-2: 2035 Ridership Forecast for Modified High Investment Service Concept Using TRM and Off- Model Parking Analysis

RIDERSHIP

Daily Ridership

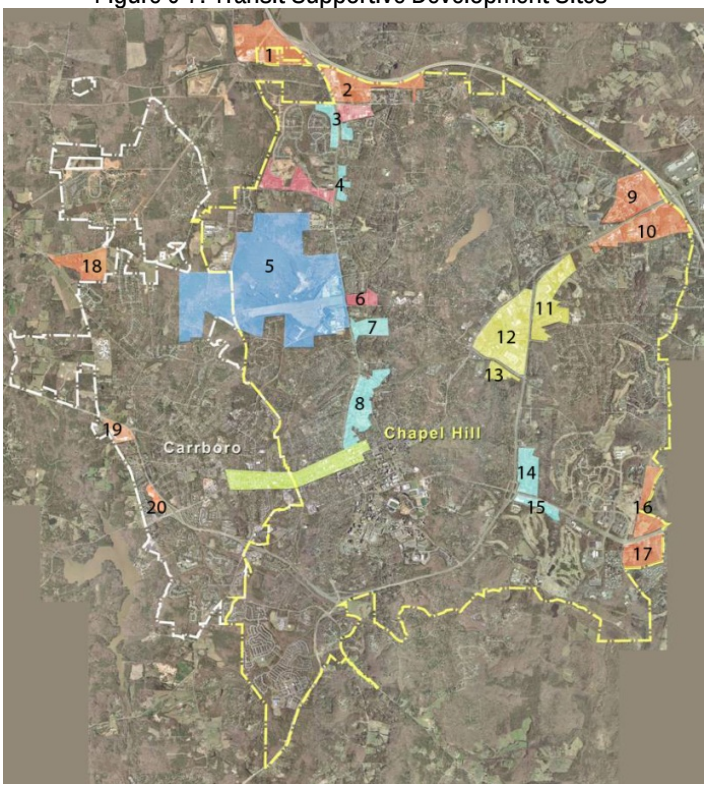
	Gateway Services												Local Bus	Grand Total
Modified High Investment	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**	**Total GW**		
Model Run	2,832	1,253	714	1,618	1,699		1,666	302	417	606	690	11,798	43,184	54,981
Due to Parking Deficit at UNC Main	5,037	3,276	1,865	4,230	7,621		2,764	378	521	952	1,080	27,723	9,241	36,964
Due to Parking Deficit at Carolina N	1,872	693	395	1,701	0		585	80	110	201	228	5,865	1,955	7,820
Totals	9,741	5,222	2,973	7,549	9,319		5,014	760	1,049	1,760	1,998	45,386	54,379	99,765
Gateway P&R Parking Spaces	4,067	3,226	1,385	3,648	5,457		1,436	70	671	162	565	20,688		
New Riders	7,931	4,723	2,243	7,502	4,137	N/A	887	0	0	0	0	28,513		

Annualized Ridership

Modified High Investment	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**	**Total GW**		
Model Run	829,700	367,200	209,100	474,200	497,800		488,100	88,500	122,200	177,700	202,300	3,456,800	12,652,800	16,109,600
Due to Parking Deficit at UNC Main	1,475,900	959,800	546,400	1,239,300	2,232,800		809,700	110,700	152,800	279,000	316,300	8,122,700	2,707,600	10,830,300
Due to Parking Deficit at Carolina N	548,500	203,000	115,600	498,400	0		171,300	23,400	32,300	59,000	66,900	1,718,400	572,800	2,291,200
Totals	2,854,100	1,530,000	871,100	2,211,900	2,730,600		1,469,100	222,600	307,300	515,700	585,500	13,297,900	15,933,200	29,231,100
New Riders	2,323,700	1,383,700	657,200	2,198,200	1,212,100		259,800	0	0	0	0	8,034,700		

Notes: *GW= gateway; CN= Carolina North; UNC=University of North Carolina main campus*
Modified High Investment ridership reflects ridership totals for the Low Investment scenario.

Figure 0-7: Transit Supportive Development Sites



0.3 Recommended Plan

The recommended Chapel Hill/Carrboro Long Range Transit Plan calls for the development a network of "gateway" and local bus services to enable residents, employees, and visitors to use transit instead of cars while within the Chapel Hill-Carrboro community. Gateway services provided in the six corridors would include a combination of:

- Higher level transit services such as BRT
- Improved local service to provide connectivity
- Connections to regional transit services
- Park and ride facilities where practical
- Transit supportive development

This network is identified as the "Modified High Investment Service Concept" and anticipates the implementation of regional Light Rail Transit (LRT) service connecting gateways at NC54 (East) and US15/501 (East). If LRT were to move forward, gateway services proposed in those corridors might need to be re-evaluated.

The primary gateway services (corridors 1, 3, and 4) would utilize "Bus Rapid Transit" BRT service. BRT is special service characterized by distinctive service branding, high capacity and high speed vehicles, dedicated running ways, use of traffic signal priority, and upgraded stations. Figure 0-8 and Figure 0-9 show, respectively, the stations and vehicles envisioned for the service. The remaining gateway services (6, 7, and 8) would use standard vehicles in express service though they will be branded similar to the BRT service and, as planned for BRT, have upgraded

stations. All these services would utilize state-of-the-art passenger information systems to enable riders to know when their buses are expected to arrive. The gateway services would be supported by a much increased local system. It is assumed that services on Gateways 3 and 4 would be re-evaluated as plans for a regional LRT move forward. The Modified High Investment Service Concept, described on page 0-7 would also include the enhanced local bus system described on page 0-8. Together, they comprise the "preferred service concept".

Table 0-3 and Table 0-2 (on page 10), present statistical information about the Gateway and Enhanced Local Bus components of the recommended system.

Table 0-3: Summary Gateway Service Statistics

Priority/Service	Frequency (weekdays mins)		Days of Operation	Service Day (hours)	Peak Vehicle Requirement*	Vehicle Hours		Gateway Parking Spaces	Estimated Daily Ridership
	Peak	Off Peak				Daily	Annual		
Initial Implementation									
GW 1--Martin Luther King Jr., Blvd	5	8	Mon-Sun	17	11	120	33,240	4,067	9,741
GW 3B (via Franklin)	10	15	Mon-Sun	17	8	80	23,040	1,385	2,973
GW 3C (via Estes)	10	15	Mon-Sun	17	6	63	18,705	3,648	7,549
GW 3B/3C Total	5	8	Mon-Sun	17	14	143	41,745	5,034	10,522
Future Implementation									
GW 3A I40 to UNC via US 15/501	10	15	Mon-Sun	17	9	97	28,591	3,226	5,222
GW 4 via NC 54	5	8	Mon-Sun	17	12	126	34,770	5,457	9,319
GW 6 via US15/501 South	10	15	Mon-Sun	17	11	120	34,664	1,436	5,014
GW 7 to Carolina North	10	15	Mon-Sun	17	7	80	23,040	671	1,049
GW 7 to UNC Main Campus	10	15	Mon-Sun	17	9	97	28,591	70	760
GW 7 Total	5	8	Mon-Sun	17	16	177	51,631	741	1,808
GW 8 to Carolina North	10	15	Mon-Sun	17	10	103	30,121	565	1,998
GW 8 to UNC Main Campus	10	15	Mon-Sun	17	8	97	28,591	162	1,760
GW 8 Total	5	8	Mon-Sun	17	18	200	58,712	727	3,759

**Includes spares, does not incliude ADA paratransit vehicles.*

The enhanced local bus service anticipates (in 2008 dollars) a $43.5 million annual operating cost and $49 million in initial capital costs. The capital costs include the acquisition of expansion vehicles, expansion of the CHT Millhouse Road operations center and the installation of additional passenger amenities such as shelters.

0.3.1 Initial Implementation and Funding

The results of the TRM and off-model parking analysis (Table 0-2) were used to identify two gateway corridors for more detailed analysis in the form of conceptual operating plans. The conceptual operating plans for these "prototype" corridors form the basis of cost information for the remaining services. The Transit Study Policy Committee identified Gateway 1 (MLK Boulevard) and two branches of Gateway 3 (US 15/501 via Franklin and via Estes to Carolina North) as corridors to be developed further. Gateway 4 was not targeted because the committee believed that corridor (along with the HIC rail corridor in the Modified High Investment Service Concept) would be studied through a regional transit planning process that is underway. The remaining gateways (6, 7, and 8) are not selected because they show relatively modest ridership levels.

The operating plan for each prototype gateway is conceptual. It includes a running way definition, ridership estimate, station and vehicle description, and operating parameters (i.e. span of service, fleet size, headway, running time). For both of these gateways, the five characteristics of the service are defined:

1. *Running Way improvements*—which include adding travel lanes, signal priority, and other enhancements to the street in which the BRT service would operate.
2. *BRT Station improvements*—which would be up-graded versions of the standard bus stops with shelters now in use by CHT. An example of upgraded stations is found with Kansas City's BRT serviced branded as "MAX." See Figure 0-8 for one such station.
3. *Gateway Park-and-Ride Facilities*— which are parking facilities to intercept people entering the community who will park their vehicles and board the BRT to their final destination.
4. *Vehicles*—which are primarily the BRT vehicles, and in the case of the priority corridors, are articulated vehicles similar to ones now in use in Chapel Hill. See Figure 0-9.
5. *Operating Facility and Miscellaneous*—which include additional vehicle storage and maintenance areas at CHT's main operating base.

Figure 0-8: BRT Station— Shelter and Station Sign for the MAX BRT Service in Kansas City

Figure 0-9: Chapel Hill Transit Articulated Buses

Table 0- 4 below summarizes capital costs for both BRT corridors. All capital costs are projected (in 2008 dollars) to range from about $133 million to just over $142 million. As can be seen from the table, well over 60 percent the costs are associated with the Gateway park-and-rides. The MLK service would have nearly 4,100 parking spaces at the gateway with the US15/501 service having just over 5,000 parking spaces.

The projected number of park ride spaces at GW1 could also be reduced if regional transit services were expanded in conjunction with the provision of park ride facilities in outlying areas. The total cost of providing park ride at any of the Gateways will also depend on whether the spaces are surface or provided in a structure. Opportunities for the integration of parking into a joint development may also be possible and might reduce the overall cost.

Table 0-4: Preferred Gateway Corridor Capital Costs—2008 Dollars

	Gateway			
	MLK *(GW 1)*	**Franklin/Estes** *(GW 3B/C)*		
Item		**Totals**	Franklin Only (GW 3B)	Estes Only (GW 3C)
Vehicles	$ 9,693,000	$ 12,285,000	$ 7,006,500	$ 5,278,500
Ops Facilities & Miscellaneous	1,210,000	1,540,000	770,000	770,000
Gateway Park & Rides (deck parking)	82,359,000	101,929,000	29,849,000	78,101,000
Stations	3,591,400	4,317,900	2,158,950	2,158,950
Running Way	36,099,000	22,018,500	21,019,500	999,000
Gateway Parking Spaces	*4,067*	*5,034*	*1,385*	*3,648*
Totals	$ 132,952,400	$ 142,090,400	$ 60,803,950	$ 87,307,450

Operating Costs

Based on the above conceptual operating plans, the Martin Luther King, Jr. (Gateway 1) and US 15/501 (Gateway 3 serving downtown Chapel Hill and the UNC Main Campus via Franklin and Carolina North via Estes) project first year operating costs (in 2008 dollars) of $3.21 million and $4.03 million respectively. Both of these costs assume the base operations shown in Table 0- 5 as well as an assumption for complementary ADA paratransit service.[6] The services would be anticipated to operate on weekdays from about 6:00 am until 11:00 pm for a 17 hour service day. Service would also be provided on Saturdays and Sundays though for shorter periods of time.

Table 0-5: Summary Operating Statistics for Preferred Gateway Services

Service	**Frequency** *(weekdays mins)*		**Days of Operation**	**Service Day** *(hours)*	**Peak Vehicle Requirement***	**Vehicle Hours**	
	Peak	Off Peak				Daily	Annual
GW 1--Martin Luther King Jr., Blvd	5	8	Mon-Sun	17	11	120	33,240
GW 3B/C--US 15/501 (via Franklin/Estes)	5	8	Mon-Sun	17	14	143	41,745

**Includes spares, does not incliude ADA paratransit vehicles.*

[6] Any cost savings by reducing overlapping local service in the preferred corridors have not been taken into account.

Funding Options

There are four main sources of funding that are typically used for public transit services in North Carolina and could possibly help fund the gateway and expanded local services. They are:

1. Passenger Fares—which are charges to people who ride the service.
2. Federal grants and innovative financing—are from a variety of grant programs including Small Starts and Very Small Starts funding.
3. State grants—the State of North Carolina through its Department of Transportation (NCDOT) also has a number of operating and capital funding programs.
4. Local funds—can be from general funds, dedicated taxes, and special assessments and fees.

For Chapel Hill Transit (CHT) all of the above are viable options with the possible exception of passenger fares. Currently, the CHT is fare free. It is assumed that any future BRT system would likewise be fare free. Thus, passenger revenue is not considered a funding source for the BRT service.

In developing either or both of the BRT lines, all of the above funding sources are available. However, the Small Starts program would offer a potentially new source of funding that the towns, to this point, have not previously utilized. Much of the capital funding for the MLK service could come from the federal government's Very Small Starts program. The MLK service would be implemented in phases with a version scaled down from the 2035 plan to match projected demand for services in 2025 or earlier.

This plan also will depend upon the adoption of land use regulations that promote "transit supportive development."

0.4 Next Steps

This LRTP developed conceptual operating plans for two selected gateway corridors. The Plan recommends proceeding with public review of the findings of this Plan and adoption by the Towns of Chapel Hill and Carrboro and the University of North Carolina at Chapel Hill. This Plan included conceptual operating plans for two selected gateway corridors and recommends consideration of Gateway 1—MLK as the first gateway service to be implemented.

Action Steps

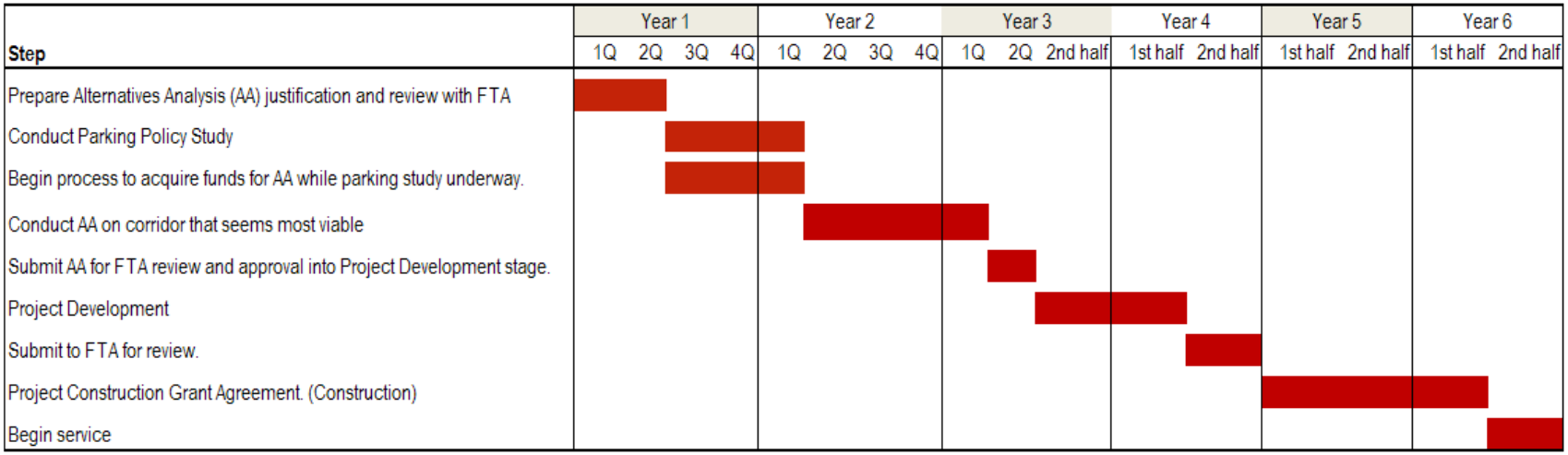
The following steps should be taken to implement the Chapel Hill Long Range Transit Plan:

- *Initiate an extensive public input process to review the findings, strategies and recommendations of the Chapel Hill LRTP.*
- *Consideration of adoption of the Plan by the governing bodies of Chapel Hill and Carrboro.*
- *Development of short range transit plans providing more detail on the implementation of the approved strategies of the Chapel Hill LRTP.*
- *Consider further study of the Martin Luther King Jr. Boulevard corridor including the development of an Alternatives Analysis (AA) study.*

Potential Timeline

The Very Small Starts funding strategy is anticipated to require approximately six years to complete. It is possible this timeline, Figure 0-10, can be further compressed if the communities wished to forego funding under New Starts (using Section 5307 funding or other sources instead). The AA could be reduced in time as well as engineering period (as under project development) could also be made faster.

Figure 0-10: Very Small Starts Implementation Time Line



Section 1: Introduction

The goal of the 2035 Chapel Hill Long Range Transit Plan (LRTP) was to develop a comprehensive transit network serving the Chapel Hill/Carrboro area that would provide a viable transportation alternative for those who live and work in the community. This transit system is intended to reduce congestion, and diminish the need for expanded parking at the University of North Carolina at Chapel Hill (UNC) main campus and UNC's Carolina North development as well as other key locations in the community. This plan also contemplates the development of complementary land use and parking policies that promote the use of transit. A key assumption of this plan is that transit services beyond the community boundaries were considered the responsibility of other providers such as Triangle Transit and were not addressed as part of this plan.

The LRTP recommends the development of a network of "gateway" transit services that intercept travelers at the community boundaries and efficiently move these travelers primarily to the core of the community. The gateway services consist of either Bus Rapid Transit (BRT) or enhanced express bus services emanating from park-and-ride facilities at the periphery and making limited stops. In addition, the local bus network would be enhanced to provide a greater level of frequency and geographic coverage than the current Chapel Hill Transit (CHT) system. The initial gateway service recommended to be implemented is a BRT service linking the interchange near Martin Luther King, Jr. Boulevard (North Carolina State Route 86) and I-40 on the north with the core of the UNC main campus on the south.

1.1 The Study Community

The Towns of Chapel Hill and Carrboro, North Carolina are part of the Raleigh-Durham metropolitan area and Durham-Chapel Hill-Carrboro Metropolitan Planning Organization with a combined population of nearly 70,000. About 40,000 people work in Chapel Hill-Carrboro. The community is also home to the University of North Carolina at Chapel Hill with 30,000 students and faculty and the North Carolina Hospital. In recent years, UNC has begun planning for the development of the former Horace Williams Airport (at the northwest intersection of Estes Drive and Martin Luther King, Jr. Boulevard) with the intention of creating a mixed-use campus called *Carolina North*. Over the next 50 years, Carolina North is expected to become a major employment center when fully built out with classrooms, medical and research facilities. The Carolina North Campus will also incorporate residential and retail uses. Based on 2035 regional projections, the population of Chapel Hill-Carrboro will reach 102,000 and employment of almost 94,000 people—more than double the current employment level. See Figure 1-1 and Figure 1-2 for maps of the community.

Although Chapel Hill/Carrboro has a relatively modest population the community is served by a vibrant transit system that rivals those of much larger communities. Chapel Hill Transit (CHT) operates almost 100 vehicles and has daily ridership of about 30,000 when UNC is in session. As the community is considered a desirable place to live and work, increasing pressures from a growing daytime population will result in continued growth of traffic at the interstate interchanges and along both arterial and local streets. The anticipated development of Carolina North will generate additional travel demand and the community leadership seeks a transit solution to this challenge as an alternative to further roadway expansion.

Figure 1-1: Chapel Hill-Carrboro in the Durham-Chapel Hill-Carrboro Area

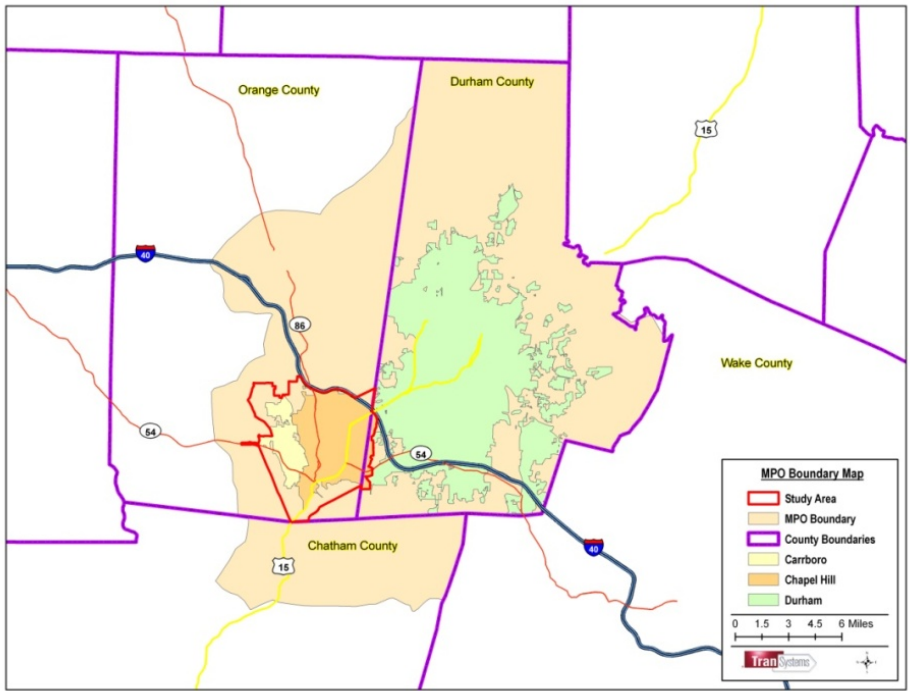
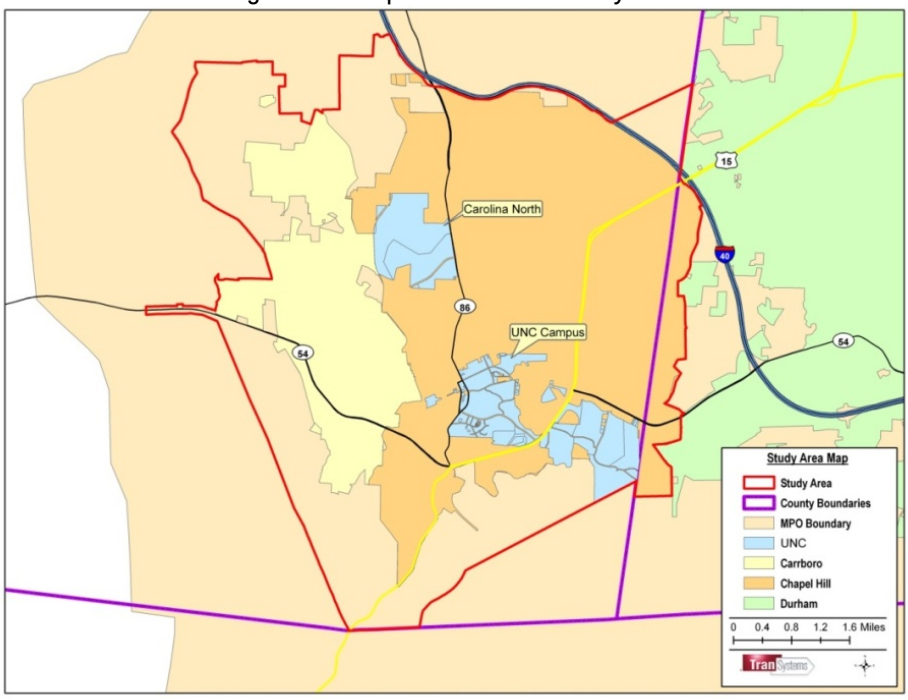


Figure 1-2: Chapel Hill-Carrboro Study Area



1.2 Study Overview

This study began in fall 2006 and was led by a Transit Study Committee. The membership of this committee was comprised of these elected officials of the towns of Chapel Hill and Carrboro as well as senior leadership of UNC and Chapel Hill.

- Kevin Foy, Mayor of Chapel Hill
- Bill Strom, Mayor Pro Tem of Chapel Hill
- Ed Harrison, Council Member, Chapel Hill
- Jim Ward, Council Member of Chapel Hill (later elected Mayor Pro Tem)
- Dan Coleman, Alderman, Town of Carrboro
- Jonathan Howe, UNC
- Jack Evans, UNC/Carolina North
- Anna Wu, UNC
- Carolyn Elfland, UNC
- Roger Stancil, Chapel Hill Town Manager

The Transit Study Committee was supported by a technical committee composed of these Chapel Hill and Carrboro town staff, staff of the Durham Chapel Hill Carrboro Metropolitan Planning Organization (DCHC MPO), as well as staff from Triangle Transit.

- David Bonk, Chapel Hill
- Steve Spade, Chapel Hill Transit
- Patrick McDonough, Triangle Transit
- Mark Ahrendson, DCHC MPO
- Trish McGuire, Carrboro
- Adena Messinger, Carrboro
- Karen Lincoln, Orange County
- Margaret Hauth, Hillsborough
- John Hodges-Copple, Triangle J Council of Governments
- George Alexiou, transportation consultant for UNC

1.3 Report Overview

The LRTP is divided into these eight main sections:

Section 2: : Chapel Hill/Carrboro Transit Market which reviews the Triangle Regional Model (TRM) used to project the impact of the transit system on vehicle traffic in the study area.

Section 3: Defining the Travel Market and Service Concept which analyzes future traffic pattern and develops a conceptual transit network.

Section 4: Evaluation of Transit Technologies begins to define the modes that would work within the conceptual transit network.

Section 5: Forecasting Ridership for the Service Concept which uses the regional travel demand model to test the service concept.

Section 6: Conceptual Operating Plans which defines the characteristics of the leading corridors of the service concept.

Section 7: Transit Supportive Development which discussed the potential to increase land use densities along potential transit corridors.

Section 8: Financial Plan outlines how the services could be funded.

Section 9: Implementation Plan delineates the next steps.

Section 2: Chapel Hill/Carrboro Transit Market

This study included a review of the Triangle Regional Model (TRM) by Cambridge Systematics[7]. The purpose of this review was to evaluate the effectiveness of the TRM in estimating future transit ridership for the Chapel Hill–Carrboro study area in response to proposed changes in transit service and land development that may be recommended as part of the long-range transit study. The review was based on documentation prepared in connection with a model update conducted in 2006, together with examination of the transportation networks and other input data files that were used to develop and calibrate the most recent version of the model.[8]

2.1 Transportation Network and Zone Structure

This section documents the structure and content of the basic geographic analysis units and transportation networks used to process input data for the TRM and to display the travel demand forecasts resulting from the model.

2.1.1 Transportation Analysis Zones

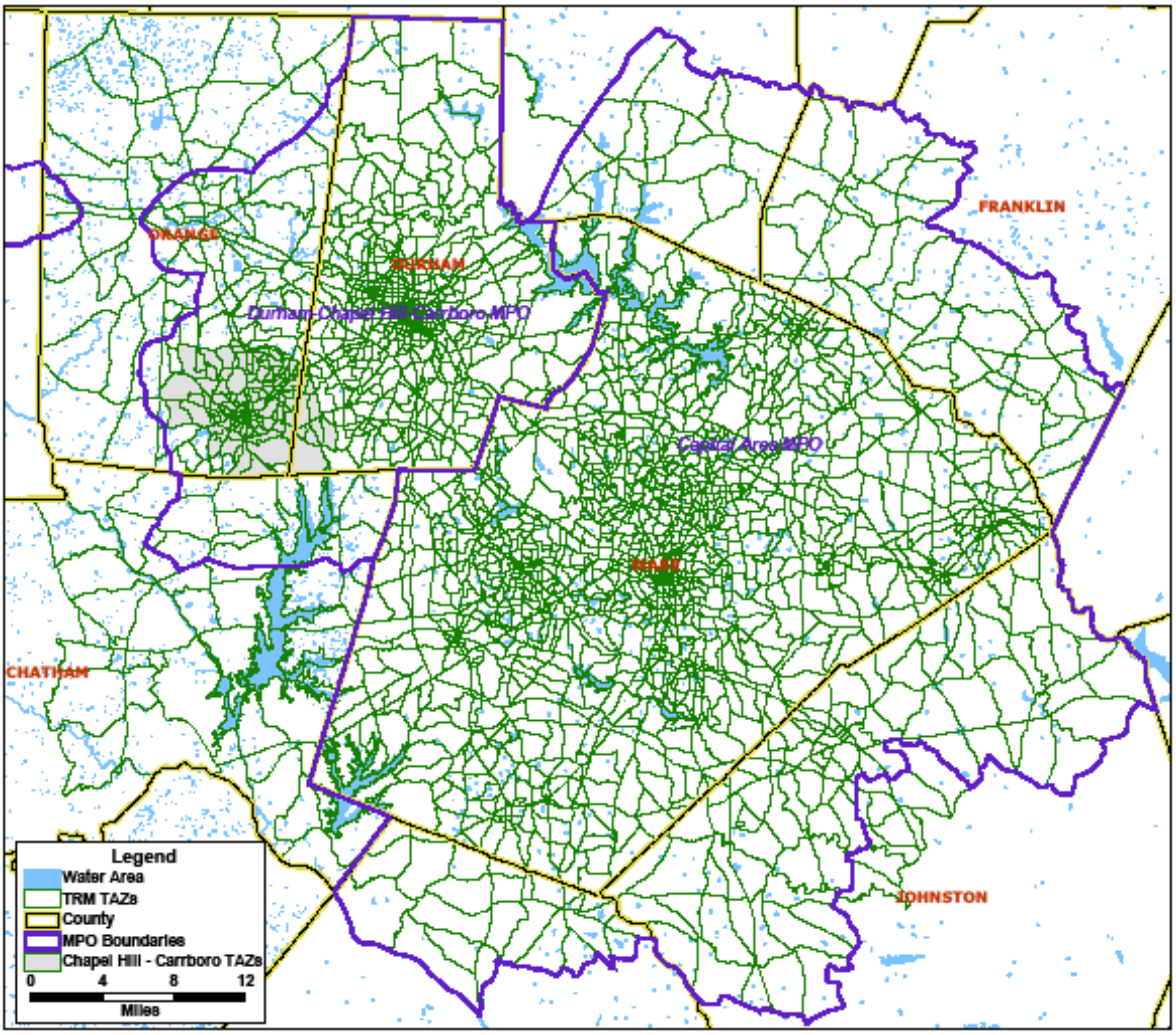
The TRM study area encompasses over 2,600 square miles and includes all of Wake, Durham, and Orange counties, plus portions of five other surrounding counties, as shown in Figure 2-1. The study area is divided into 2,317 internal transportation analysis zones (TAZ) that vary in size from 0.01 to 23.0 square miles, with many of the smaller TAZs located in the higher density urban cores of Raleigh, Durham, and Chapel Hill-Carrboro.

The area of interest to this study comprises the Towns of Chapel Hill and Carrboro, located in southeastern Orange County and southwestern Durham County, as shown in the shaded area of Figure 2-1. This area includes approximately 150 TAZs, ranging in size from 0.01 to 3.5 square miles, with an average area of approximately 0.33 square miles. This smaller TAZ size makes it potentially feasible to model nonmotorized trips between adjacent TAZs.

Based on the TRM documentation, the zonal data, which includes employment, transit access, parking information, and socioeconomic information, appears to be adequate. The employment and population data is stored at the TAZ level, and includes nine types of employment: industry, retail, highway, office, service, and four special generator employee categories, including university, shopping centers, airports, and hospitals. The population data includes the number of households, population mean income, number of dwelling units, and university beds. The TAZ-level data includes the size and area type of the TAZ, the percentage of the TAZ that is within a short or long walk to transit in the morning peak and midday time periods, and the average parking cost in the TAZ. This data could be expanded to include more information on the parking in each TAZ, potentially, including number of spaces and categorizing the parking costs into price ranges, rather than one average price.

[7] This section was written by Cambridge Systematics
[8] *Triangle Regional Model 2006 Documentation*, prepared by PB Americas, Inc. January 4, 2007.

Figure 2-1: Triangle Regional Model Area



Source: Cambridge Systematics

2.1.2 Highway Network

The highway network used in the TRM consists of 11,744 road segments, representing approximately 4,269 centerline miles of roads functionally classified as collectors, minor or major arterials. This represents about 37 percent of the total public road mileage in the study area. Roads not explicitly included in the TRM network are predominantly local streets; they are represented by 4,832 connector links to TAZ centroids. In general, the highway network segments coincide with, and form the TAZ boundaries.

The network input data includes the number of lanes, speed limit, signal density, functional classification, median/left-turn treatment, and turn penalties. The highway network does not include data pertaining to bicycle or pedestrian service characteristics.

This level of highway network detail is typical in travel modeling practice. It allows for a fairly complete network assignment of motorized trip movements between TAZs, but requires intrazonal movements (i.e., trips that begin or end in the same TAZ) to be represented as simple summary tabulations, and limits the amount of network detail that can be attributed to local streets for modeling walk or bicycle trips (e.g., presence of sidewalks, pedestrian signals, or bike lanes).

2.1.3 Transit Network

The TRM transit network is a separate network database built using a subset of the highway network segments. The transit network covers approximately 3,746 highway centerline miles, or about 88 percent of the TRM highway network. Not all links represent actual bus routes; some represent highway access to a transit park-and-ride facility. In addition, the transit network includes 10,657 connector links to TAZ centroids (more than four connectors per TAZ centroid), depicting access options to different bus routes and different walk distances.

The inclusion of auto access links and multiple centroid connectors to different bus routes provides considerable flexibility in modeling new transit service configurations, such as intermodal transfer points and suburban park-and-ride facilities linked to express transit.

The transit route system data inputs include the route name, travel time, local/express indicator, peak-period headway, off-peak period headway, transfer costs, in-vehicle travel time (IVTT) weight for local routes, IVTT weight for express routes, waiting time weight, and fare. The transit stops data includes the location and the nearest highway node. The transit mode transfer data includes the "to and from" companies, the time cost, transfer cost, and the alighting and boarding stops. The transit network data inputs appear to be adequate from the model documentation.

As will be seen later in this study, the Transit Study Committee (see Section 1.2) directed that modeling of LRTP service options not include regional transit serving Chapel Hill and Carrboro. The purpose of this decision was to focus on services solely within the community.

2.2 Modifications for this Work Program

The TRM was determined to be reasonably well-suited for the evaluation of alternative transit service options and for transit-oriented development policy initiatives as part of the long-range transit improvement plan in the Chapel Hill-Carrboro region. There is considerable flexibility available in the transit coding and mode choice level-of-service variables to account for most, if not all, proposed transit options, and the consistent use of income/auto availability market segments provides a more realistic reflection of changes in behavior by both transit captives and choice riders.

The fact that the mode choice model incorporates an "auto intercept" choice greatly facilitates exploration of improved service to existing or proposed intercept lots. This would otherwise have been a concern.

Other potential limitations which require employing additional interpretation of results included:

- Zonal and network densities are much higher in the urban centers within the Triangle region than along the edges. Therefore, the model is probably best suited to evaluate projects located in these urban areas.

- The home-based school trip attractions are based on population figures rather than school employment or student population statistics. This could lead to projected home-based school trips to TAZs which have no primary school facilities.

The model does not account for potential time period shifting (from peak to off-peak), which could be a consequence of increased or reduced congestion.

As mentioned above, the Transit Study Committee (see Section 1.2) directed that modeling of LRTP service options not include regional transit serving Chapel Hill and Carrboro.

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Section 3: Defining Travel Market and Service Concept

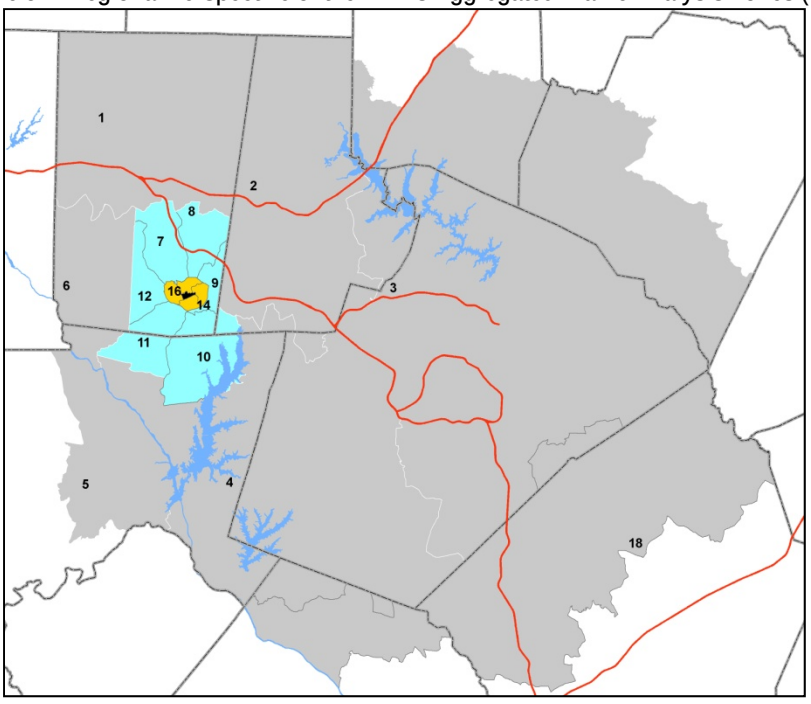
The purpose of this section is to define the 2035 travel market for the Chapel Hill/Carrboro area and to develop this market into a service concept. In subsequent sections of this LRTP, the service concept will be further refined into specific services in the form of an operating plan. The travel market was derived from trip tables from the TRM (see Section 2 for a discussion of the regional travel model). From this high level analysis, a transit service concept was developed.

A basic precept in defining the transit market is that travelers to the towns would be intercepted at municipal boundaries. Regional connections extending beyond the corporate limits of Carrboro and Chapel Hill were not considered in this LRTP.

3.1 2035 Travel Market

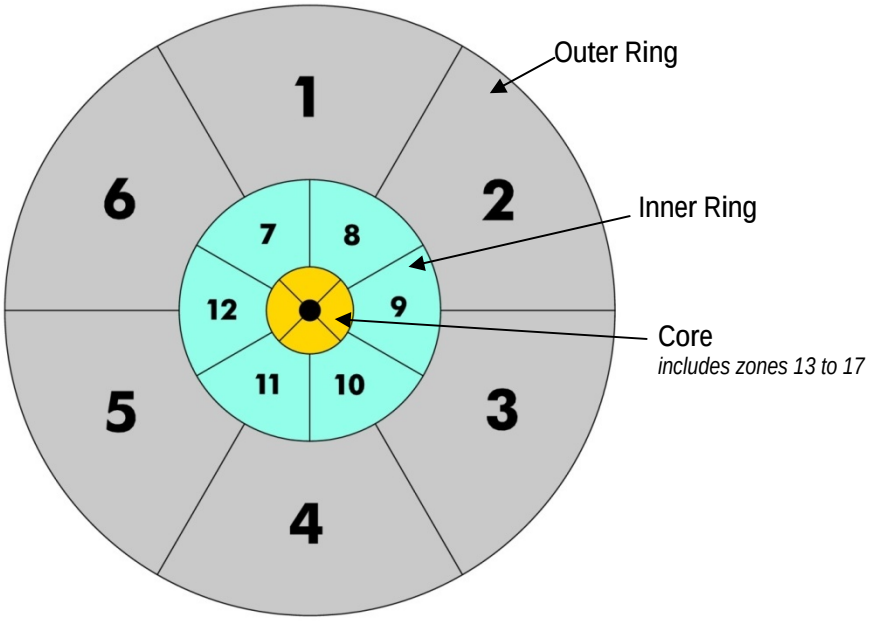
The basic approach to defining the transit market is to develop key travel nodes, nodal connections, and intercept points relying on the TRM. Figure 3-1 provides a regional perspective of this analysis; however, the TRM's Traffic Analysis Zone (TAZ) structure has been aggregated and abstracted into three rings as shown in Figure 3-2 an outer ring in gray (covering one or more counties), an inner ring in blue (covering one or municipalities) and a core ring in orange (downtown and the immediate area including UNC main campus and Carolina North). The core is then further sub-divided to allow for more detailed analysis. Table 3-1 describes each zone in each ring.

Figure 3-1: Regional Perspective of the TRM's Aggregated Traffic Analysis Zones (TAZ)



Source: TranSystems

Figure 3-2: Simplified TAZ Structure



Source: TranSystems

Table 3-1: Description of Analysis Rings

Ring	Defined	Ring Zones
Outer	At this largest perspective, the lower southern third of Orange County is the core of travel patterns investigated. A series of wedges surrounding the core are defined *via* the major transportation system. These are described clockwise starting at the north or 12 o'clock position.	1. NE (Durham County) 2. E (Durham/Wake Co's) 3. SE (Wake/Chatham Co's) 4. SW (Chatham County) 5. W (Orange County) 6. NW (Orange County)
Inner	At this perspective, another series of wedges surrounding the core are defined and are divided *by* the major transportation system. These are described clockwise starting at the north or 12 o'clock position.	7. Northeast 8. East 9. Southeast 10. Southwest 11. West 12. Northwest
Core *(downtown)*	Even at this close-up perspective, the hub and wedge concept is consistently applied. The downtown core is subdivided into areas that roughly consist of major destinations surrounding the physical center of downtown Chapel Hill. These are described clockwise starting at the north or 12 o'clock position.	13. NORTH 14. EAST 15. SOUTH (UNC) 16. WEST (Carrboro) 17. CENTER

Source: TranSystems

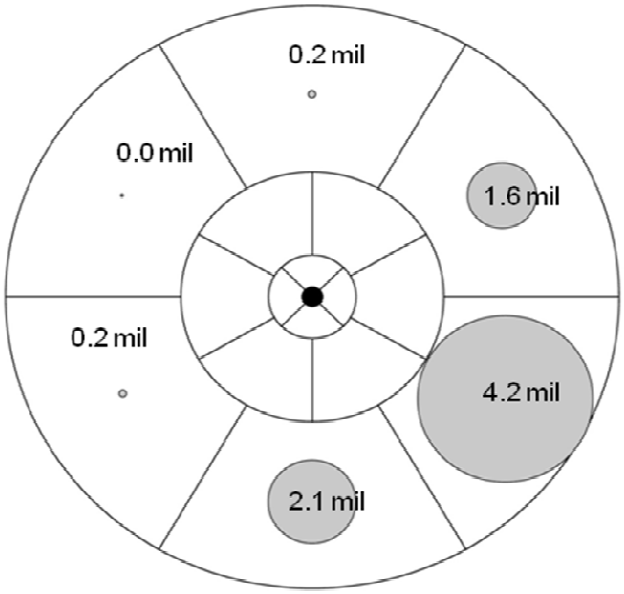
A review of travel patterns associated with these "rings" as well as demographic attributes within these various rings will assist in identifying key nodes or concentrations. The travel patterns are based on year 2035 twenty-four-hour all trips matrix from the TRM. The process uses abstractions of the TAZs before focusing on real geographies. The intent of this analysis is to explore travel patterns within and across the various rings with a focus at the inner ring and core as necessary. A travel exchange matrix has been established from the outer ring and is depicted by desire lines. The primary interest with the outer ring is in the exchange from each wedge to the inner ring and/or core. By

analyzing the travel exchanges, degrees of different intensity were determined. From these top zone or "wedge" exchanges to the core, further analysis can be performed to divide the exchanges to the successive core zones (at the intermediate and micro levels). The inner ring and the cores' internal exchanges are also of interest and are mapped by desire lines. Internal to internal exchanges are also reviewed. The concentration is on the largest exchanges.

3.1.1 Outer Ring Trip Exchanges

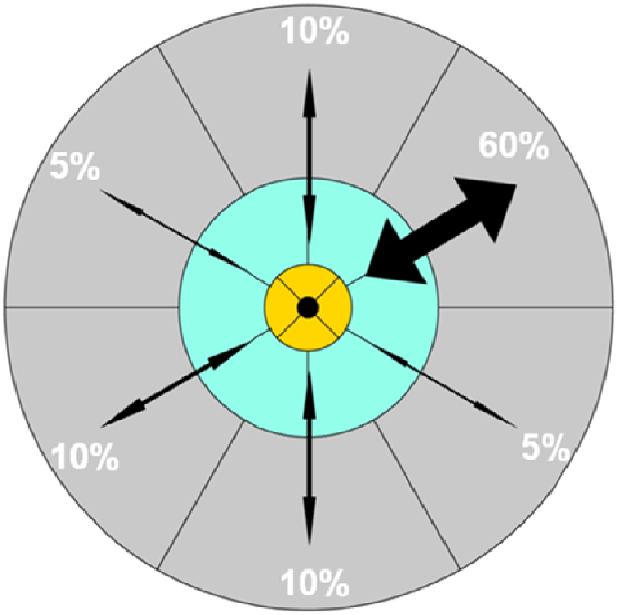
Figure 3-3 shows relative distribution of trips generated in each outer ring zone. These trips occur within the zone and from the zone to other zones. As seen, Zone 3 (which represents Raleigh) regionally generates the most trips (4.2 million). Figure 3-4 shows trip exchanges from the outer ring to the inner ring. The inner ring represents the towns of Carrboro and Chapel Hill. As seen in Figure 3-4, 60 percent of trip exchanges into the inner ring come from Zone 2 of the outer ring. Zone 2 is the city of Durham. So while Zone 3 is the largest, relatively few trips from Zone 3 enter the Chapel Hill/Carrboro area.

Figure 3-3: Outer Ring Trips—2035



Source: TranSystems

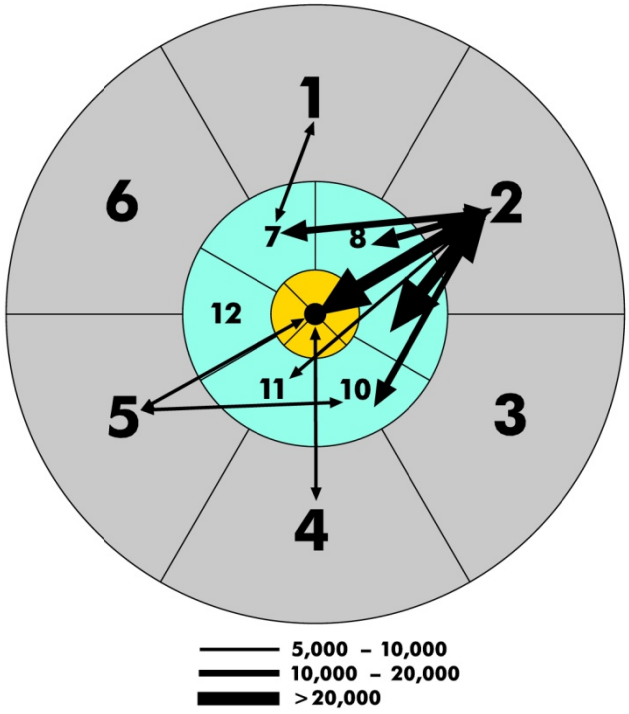
Figure 3-4: Outer Ring Trip Exchanges with Inner Ring and Core—2035



Source: TranSystems

Figure 3-5 shows major travel patterns—patterns of 5,000 or more daily trips. As previously observed in Figure 3-4, Zone 2 (representing Durham) has the highest number of trips entering Chapel Hill and Carrboro. Figure 3-5 shows that major trip exchanges originating in Zone 2 touch the core as well as every Inner ring zone except Zone 12.

Figure 3-5: Zonal Connections—Outer and Inner Rings and Core—2035
(Trips per Day)

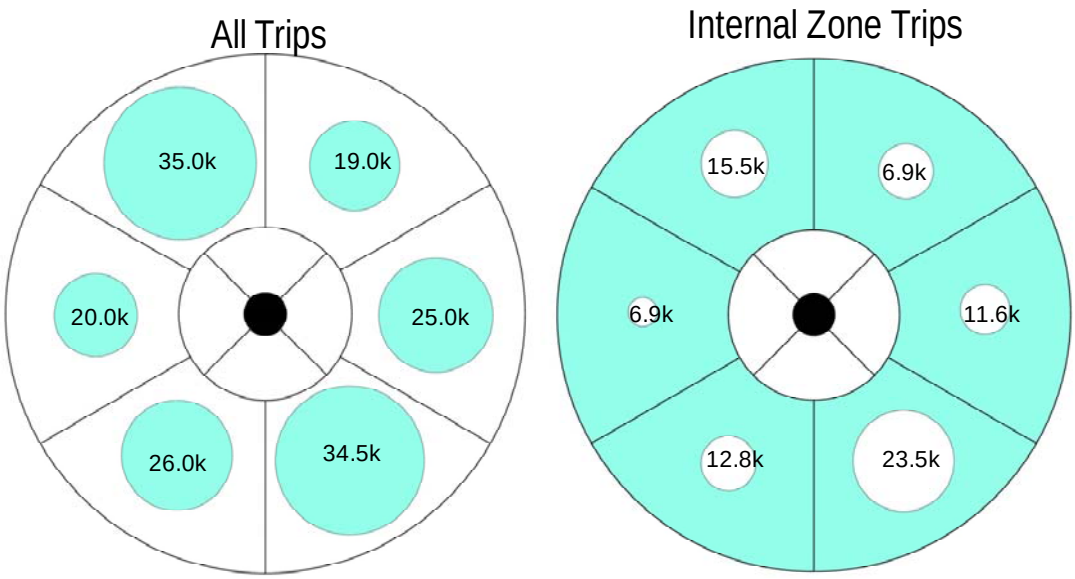


Source: TranSystems

3.1.2 Inner Ring Trip Exchanges

Figure 3-6 compares two types of trips generated in each Inner Ring Zone—total trips and trips that are internal to the given zone. The difference in these two trip types are trips that leave the zone and go elsewhere.

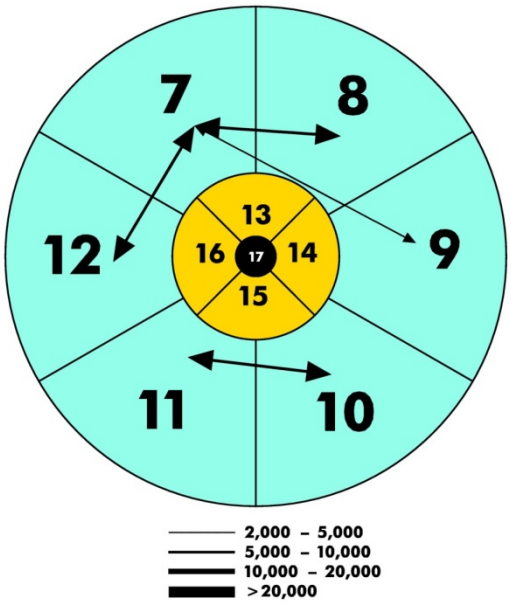
Figure 3-6: Inner Ring Trips—2035



Source: TranSystems

As can be seen, many trips stay internal for a number of the zones. Figure 3-7 shows major trip exchanges between Inner Ring Zones. Only trip exchanges of 2,000 or more per day are shown. Trip movements between zones are fairly extensive.

Figure 3-7: Inner Ring Zonal Trips Exchanges—2035

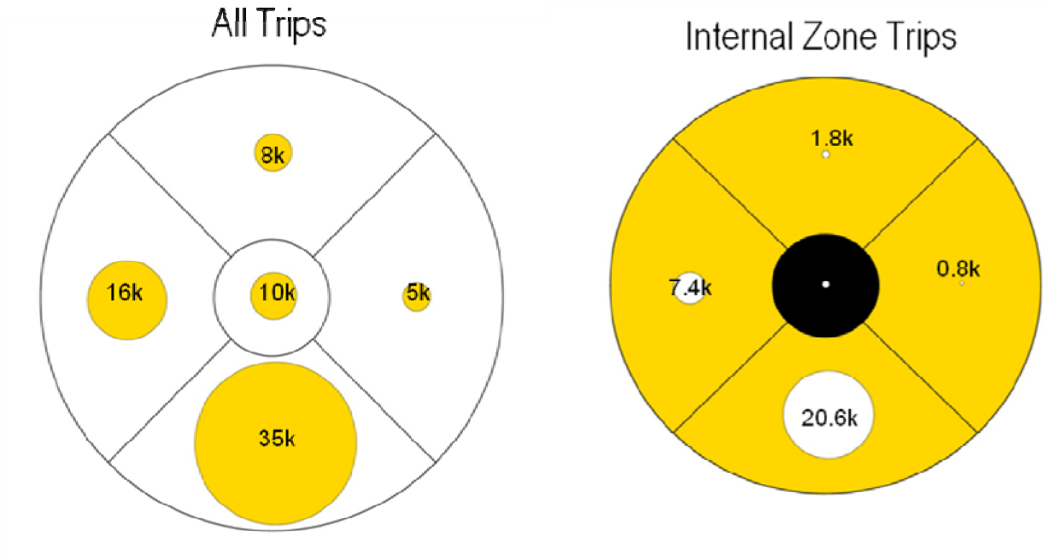


Source: TranSystems

3.1.3 Core Trip Exchanges

Figure 3-8 compares all trips and internal zone trips for the core area. The largest zone, with 35,000 daily trips, also has nearly 21,000 internal trips. This zone represents the main campus of the University of North Carolina (UNC).

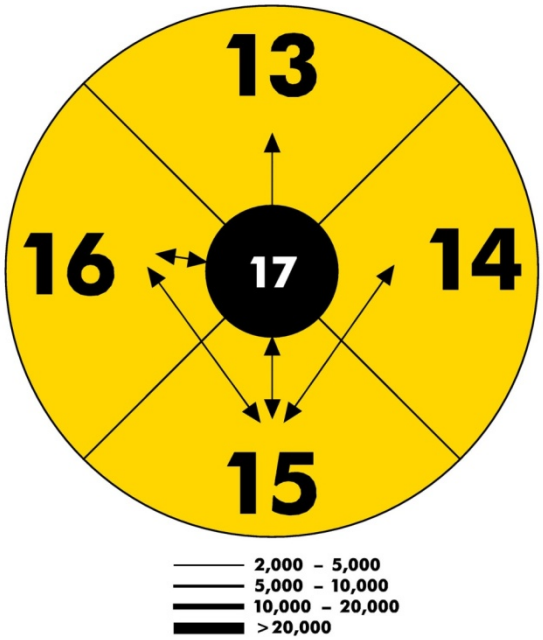
Figure 3-8: Core Trips-2035



Source: TranSystems

Figure 3-9 shows major trip movements between core zones. As before, only trip exchanges equal to or greater than 2,000 are shown. Within the core, many trips are involving Zone 15, the main campus of UNC.

Figure 3-9: Core Zonal Trip Exchanges—2035

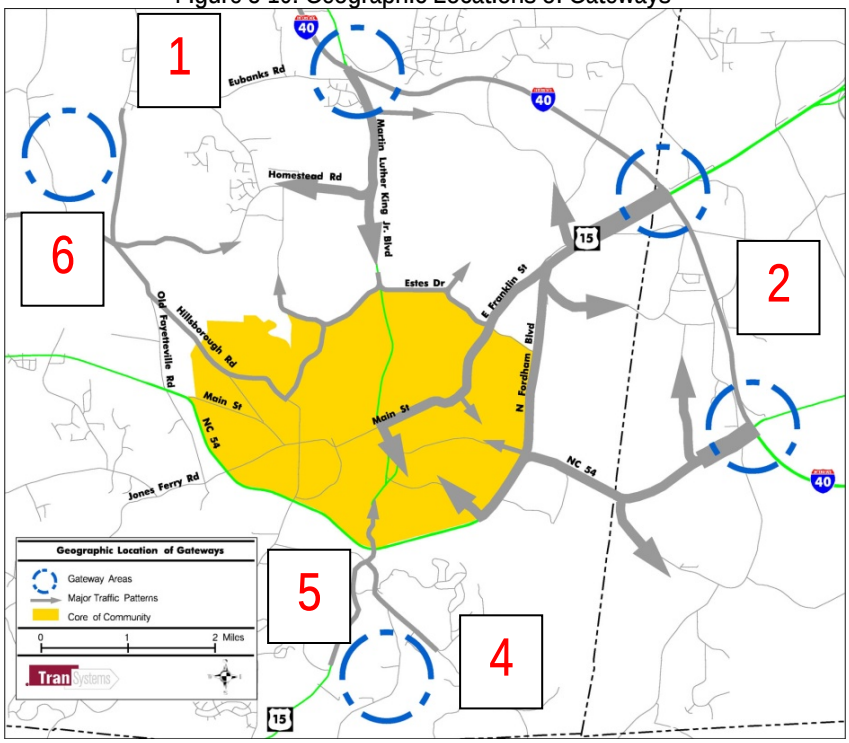


Source: TranSystems

3.1.4 Serving External Trips—Gateway Locations

Locations in which to intercept travelers external to Chapel Hill and Carrboro are shown in Figure 3-10. Figure 3-10 links geographically the information found earlier in Figure 3-5. The Figure shows approximate locations of Outer Ring Zones. Note that there is no Zone 3 since the likely point of entry would be NC 54 via I-40, which is also a point of entry for Zone 2 trips. Similarly, Zones 4 and 5 potentially share a common entry point though NC54 (west side) is another entry point as well. Finally, Zone 6 is shown though it does not have a major trip movement. That area is still a potential entry point and it is shown to provide some geographic coverage.

Figure 3-10: Geographic Locations of Gateways



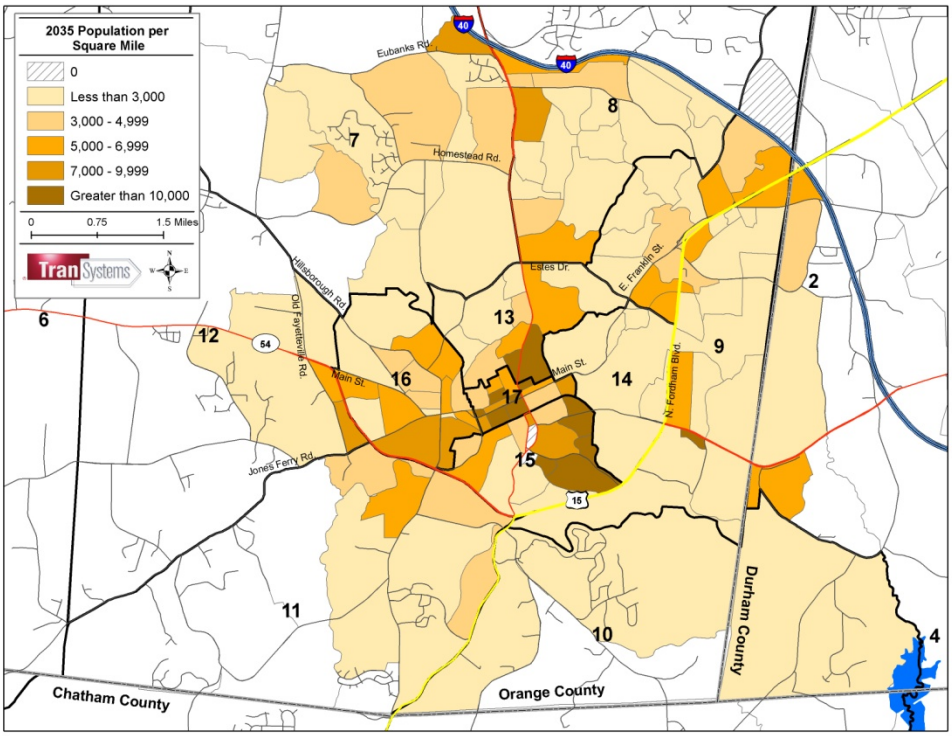
Source: TranSystems

3.1.5 Serving Internal Trips

The preceding analysis showed a considerable level of trip making within the Chapel Hill and Carrboro area. To refine possible travel nodes within the communities, as examination of projected 2035 employment and population by TAZ was made.

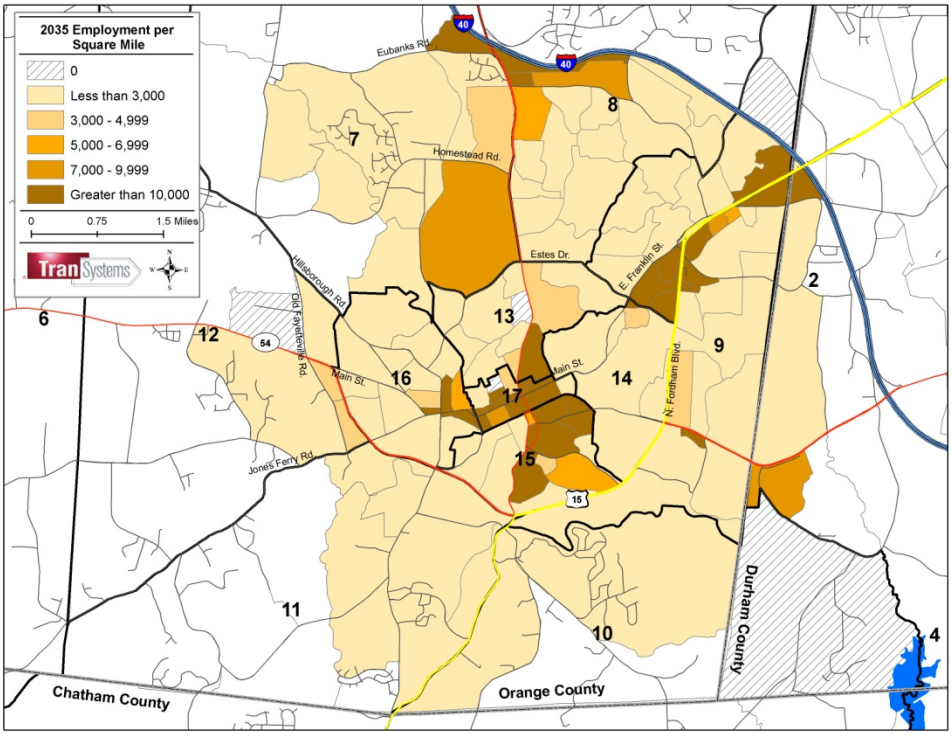
Respectively, Figure 3-11 and Figure 3-12 show projected population and employment densities for 2035.
Figure 3-13 combines the information in Figure 3-11 and Figure 3-12. All three graphics show concentrations of potential transit demand in the core of the communities as well as along US 15/501 on the east and the Martin Luther King, Jr. Boulevard corridor in the north. Figure 3-14 shows areas in 2035 where the combined population and employment density exceeds 10,000 people. The locations are circled and are potential transit hubs within the communities. Some of the areas also match gateway locations as well as downtown Chapel Hill/Carrboro, the UNC main campus as well as the Carolina North development. Another emerging area is along Jones Ferry Road in Carrboro. Given the extensive nature of these concentrations of employment and population in the community, a fairly broad level of local bus service would be needed to connect these locations.

Figure 3-11: 2035 Projected Population Densities in Chapel Hill and Carrboro



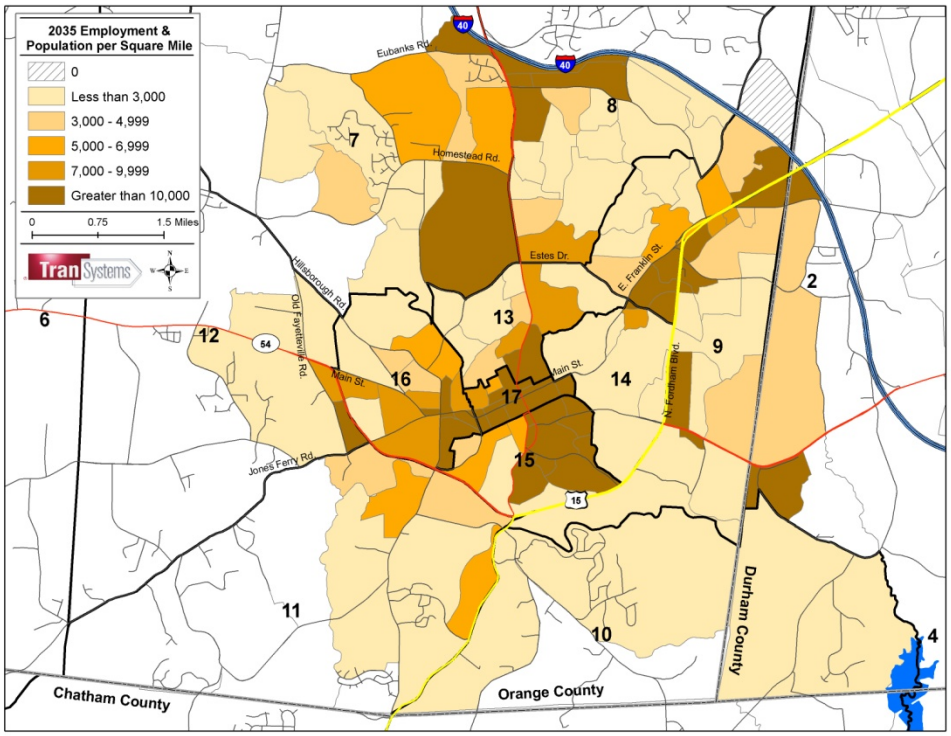
Source: TranSystems

Figure 3-12: 2035 Projected Employment Densities in Chapel Hill and Carrboro



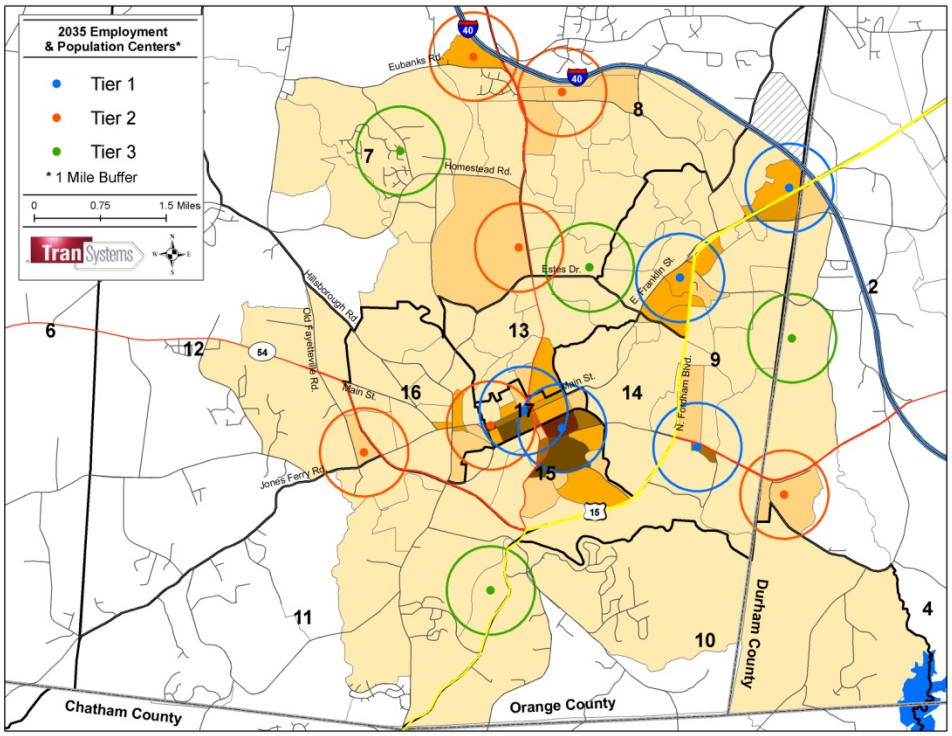
Source: TranSystems

Figure 3-13: Combined 2035 Projected Population and Employment Densities



Source: TranSystems

Figure 3-14: Areas with 10,000 or more Employees and Residents per Square Mile (2035)



Source: TranSystems

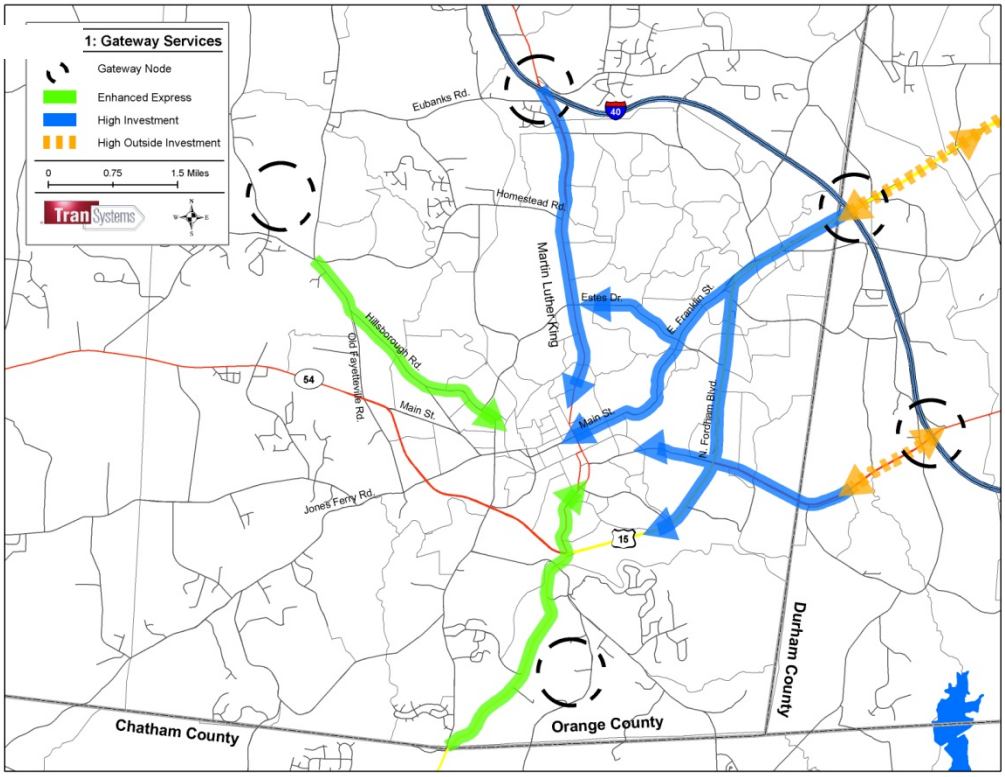
3.2 Service Concept

In defining the transit market a conceptual service plan was developed to capture the broader trip making evident in the study area. The service concept has two basic elements: *Gateway* services which are intended to intercept travelers into Chapel Hill and Carrboro and, second, *Enhanced Local Bus* services, intended to provide mobility within the towns. These concepts will be developed further in later sections of this report.

3.2.1 Gateway Service Concept

Figure 3-15 illustrates the Gateway service concept. Gateway services are composed of high investment and enhanced transit alternatives that directly target people entering the Carrboro/Chapel Hill community using automobiles. The goal of the gateway service is to divert automobile drivers to transit. As seen in the Figure, the gateway nodes are located on the fringe of the communities and would likely be park-and-ride facilities. For high investment gateway concepts on the east (utilizing US 15/501 and NC 54 roadways) investments outside the community boundaries into Durham are shown. It may be worth consideration to extend services into Durham rather than intercepting residents at the Chapel Hill boundary.

Figure 3-15: Gateway Service Concept



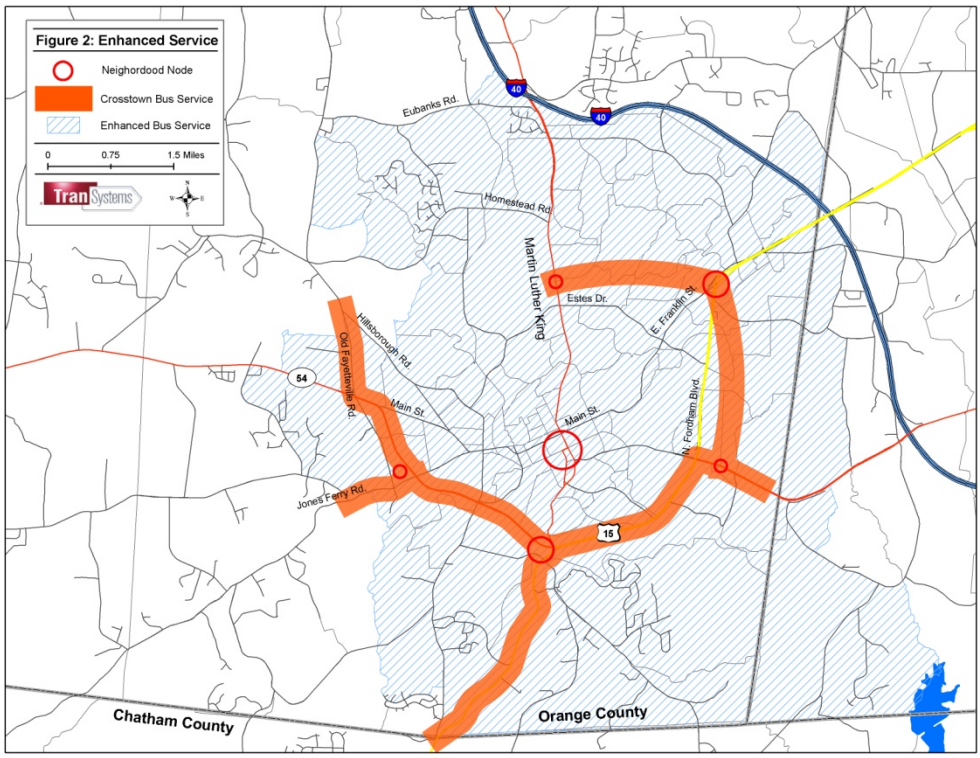
Source: TranSystems

3.2.2 Enhanced Local Bus Service Concept

There are two types of enhanced local bus services shown in Figure 3-16. The first broadly builds on the current network and addresses issues related to service frequency as well as other gaps in service (such as on weekends

and in certain geographic areas). The second creates a new class of service called "crosstowns" which attempt to address travel outside of the core area.

Figure 3-16: Enhanced Local Bus Service

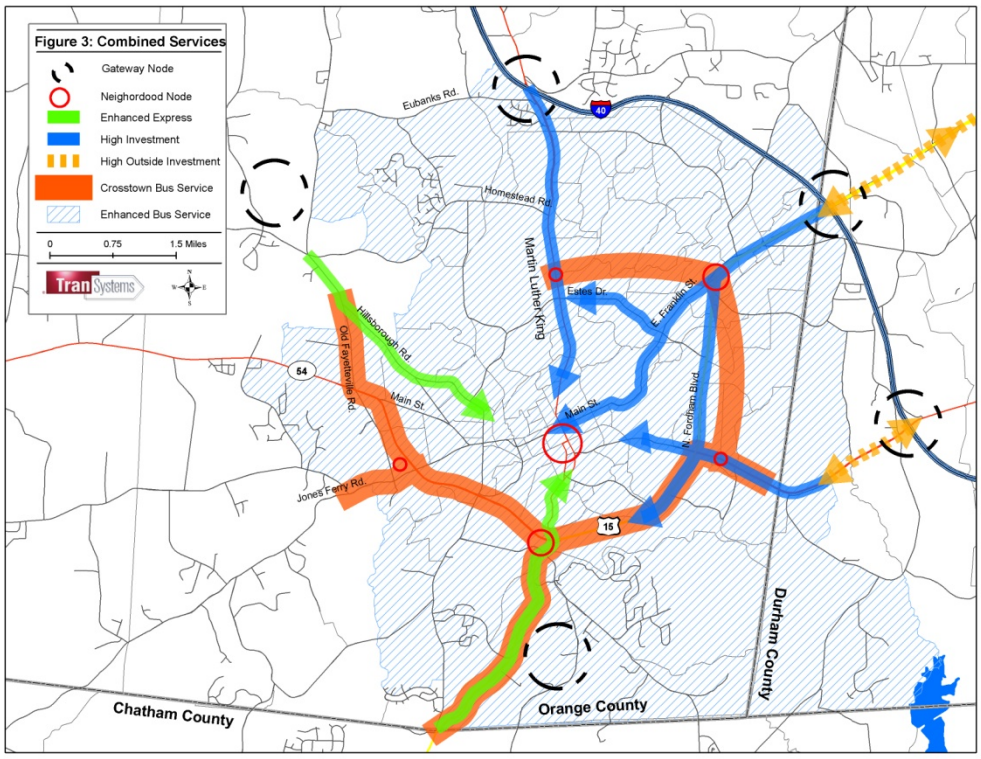


Source: TranSystems

3.2.3 Overall Service Concept

The concept system shown in Figure 3-17 is based on the previously described review of 2035 population and employment densities, existing Chapel Hill Transit system and the 2035 Travel Patterns from the TRM. Using the date from the previously described analyses, the conceptual transit system was developed to address the community's desire for a "ubiquitous" transit system where people going in and staying within Chapel Hill/Carrboro can easily travel without reliance on private vehicles. The concept consists of two main elements described in Sections 3.2.1 and 3.2.2. They are enhanced local bus and "gateway" services, respectively.

Figure 3-17: Draft Conceptual Transit System



Source: TranSystems

Updated Service Concept

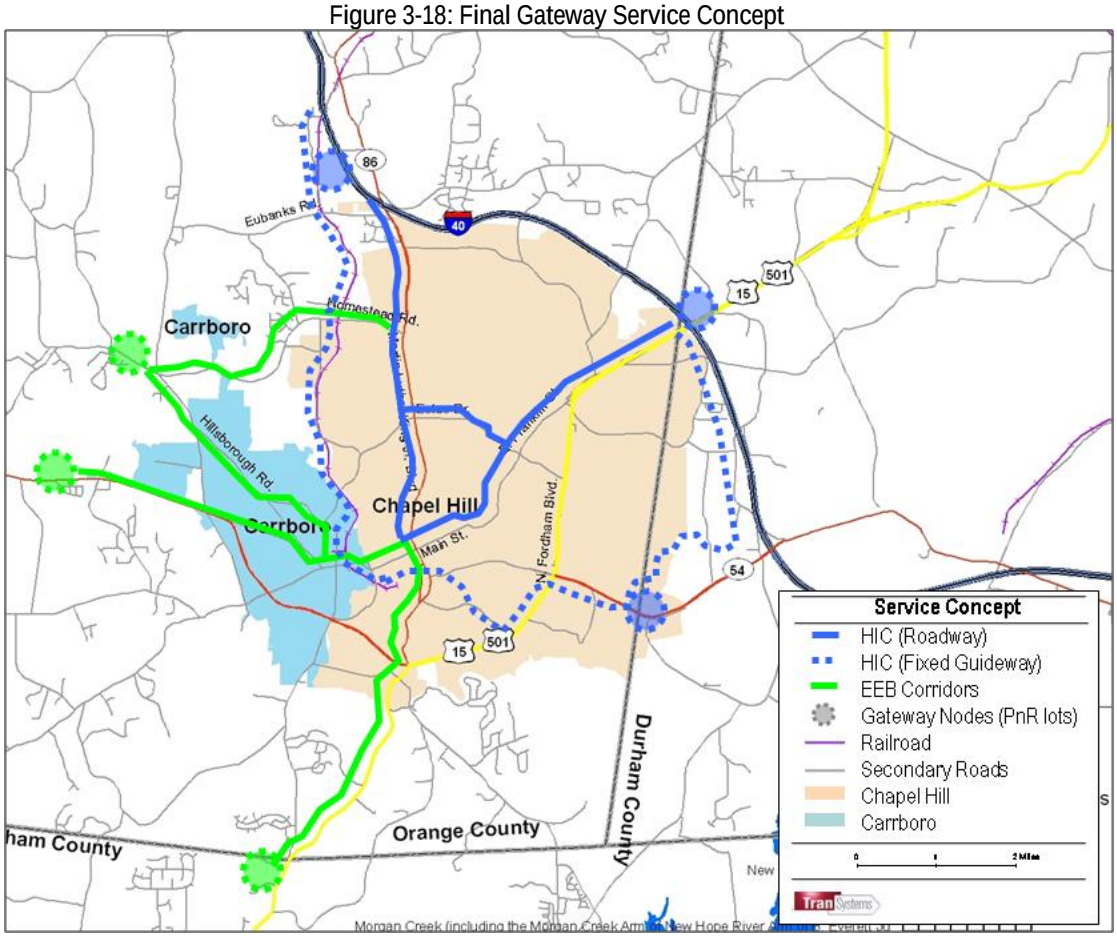
The gateway portion of the service concept in Figure 3-17 was later updated based on comments from the technical and Transit Study Committees. The Gateway service concept consists of two different types of services:

- High Investment Corridors (HIC)
- Enhanced Express Bus Corridors (EEB)

The High Investment Corridors are designed to serve larger markets and therefore involve consideration of some higher investment technologies include light rail and streetcar as well as BRT. The Enhanced Express Bus Corridors do not include consideration of rail modes but consider BRT options as well as limited-stop, Express Bus services. The refinements made to overall Gateway Service Concept include additional corridors of both types as well as refinements to the routing and the start and end location of each corridor, and the identification of general locations for the gateway nodes where travelers could park and ride.

The refined set of corridors or gateway services is shown in Figure 3-18. The enhanced local bus portion of the concept was not changed.

Figure 3-18: Final Gateway Service Concept



Source: TranSystems

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Section 4: Evaluation of Service Technologies

This section evaluates technologies to be applied to the service concept developed in Section 3. After the technologies are determined for each service within the concept, this section will recommend the technologies to be applied to each gateway corridor as well as the assumptions to be made for an underlying local bus network. The goal is to define an overall 2035 system from which corridors can be identified for further analysis. This section discusses an array of technologies for each service type—gateway and enhanced local bus.

4.1 Gateway Service Technologies

This section describes the development of the Gateway Service Concepts. The objectives of these services are to provide viable alternatives to driving to travelers entering Chapel Hill and Carrboro and to serve travelers along the corridors with a high level of service. As part of this analysis, transit technologies that could work as nodal connections for the defined services were evaluated. These concepts are being developed so that the corridors, technology and service characteristics can be selected for more detailed analysis. The later analysis will include application of the regional travel demand model to estimate transit mode share. At this stage of the analysis, mode share is examined at various levels so the implications can be evaluated.

The approach used in this analysis was to:

1. Define corridors for gateway services
2. Estimate 2035 potential market size for services
3. Evaluate technologies for each gateway service
4. Draw conclusions about the most desirable technology for each service and identify the most promising corridors.

These steps, as will be seen, were reviewed with the Transit Study Committee which approved of the recommended technologies and corridors.

There are two types of gateway services—High Investment Corridors and Enhanced Express Bus. Both of these concepts were introduced in Section 3 of this report. In summary, the High Investment Corridors contemplate substantial capital infrastructure such as right of way improvements while the Enhanced Express Bus options do not. The steps in the analysis of each type of service are similar. However, underlying capital and operating assumptions are different for each service. Thus, this discussion will address each service type separately.

4.1.1 Corridor Definition

All services start in outlying areas at a gateway node (i.e. park-and-ride) and end in the central area of Chapel Hill. Service to these two primary trip attractors in the center of Chapel Hill were considered as ending locations for the Gateway services:

- UNC main campus/downtown Chapel Hill/Carrboro
- Carolina North development

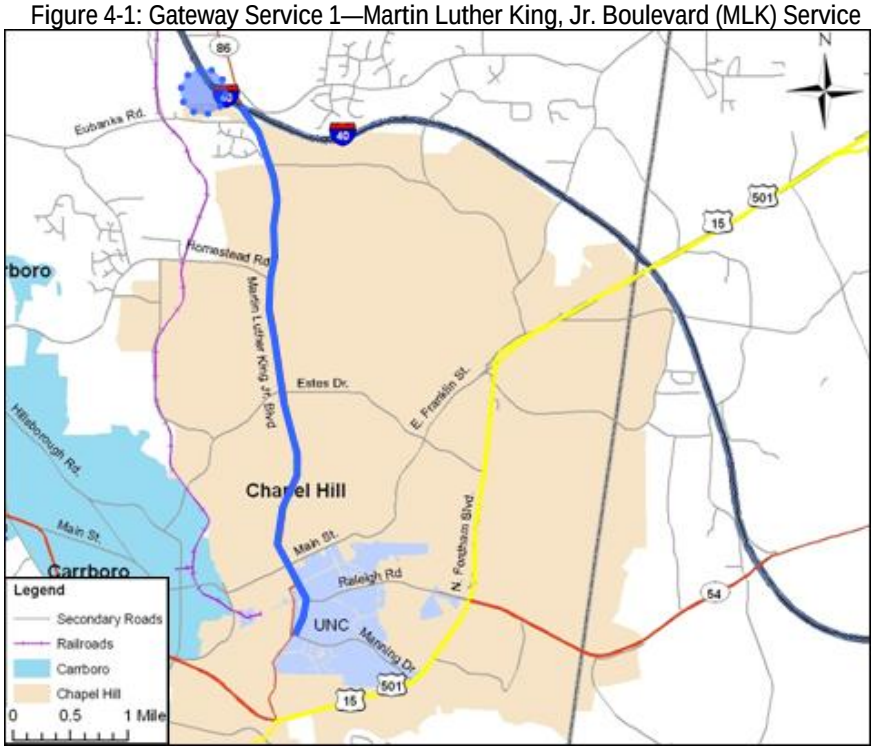
Carolina North is expected to be an important travel generator in 2035. In some corridors, this requires branching of main line services.

This section will first describe the High Investment Corridors and then the corridors involving Enhanced Express Bus.

High Investment Corridors (HIC) Gateway Services
The following describe the services in each corridor in more detail.

Gateway Service 1 serves the north corridor, from I-40 to downtown/UNC, via Martin Luther King Jr. Blvd. or MLK – Columbia Rd. The alignment is 4.8 miles long. This alignment is able to serve both downtown/UNC and the Carolina North development without branched service. As shown in Figure 4-1, a park-and-ride facility would be located at the north end of the alignment to intercept automobile travelers.

Figure 4-1: Gateway Service 1—Martin Luther King, Jr. Boulevard (MLK) Service



Gateway Service 2 serves the Northeast Corridor connecting Durham and Chapel Hill. There are two service options. Service 2A extends from I-40 to downtown/UNC, via US 15/501 – Franklin Street, Main Street, and Columbia Road. The alignment is 5.1 miles long. A park-and-ride facility would be provided at the northeastern end near I-40 and the town line to intercept automobile travelers. Service 2A is shown in Figure 4-2.

Service 2B includes a branched service to Carolina North via Estes Drive. The branch is 1.9 miles long but requires vehicles to operate along the trunk from the park-and-ride facility duplicating the other branch to downtown along the trunk portion, thus 2B is a less efficient operation. However, simply extending the downtown branch northward to serve Carolina North would provide a circuitous service to Carolina North that would not be competitive with automobile travel. Service 2B is shown in Figure 4-3.

Figure 4-2: Gateway Service 2A—US 15/501 (Franklin) Service

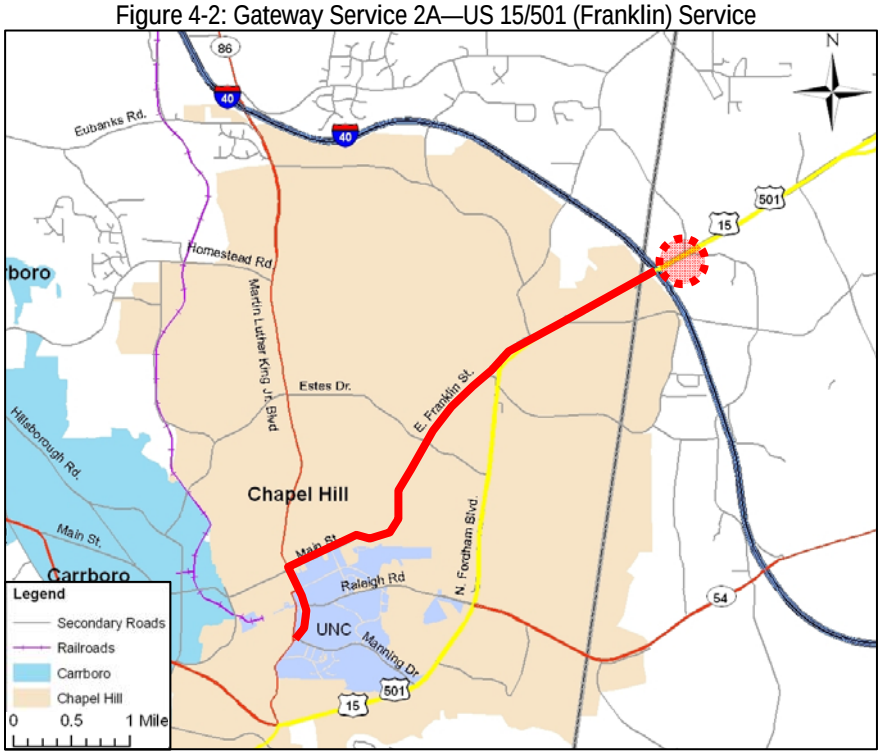
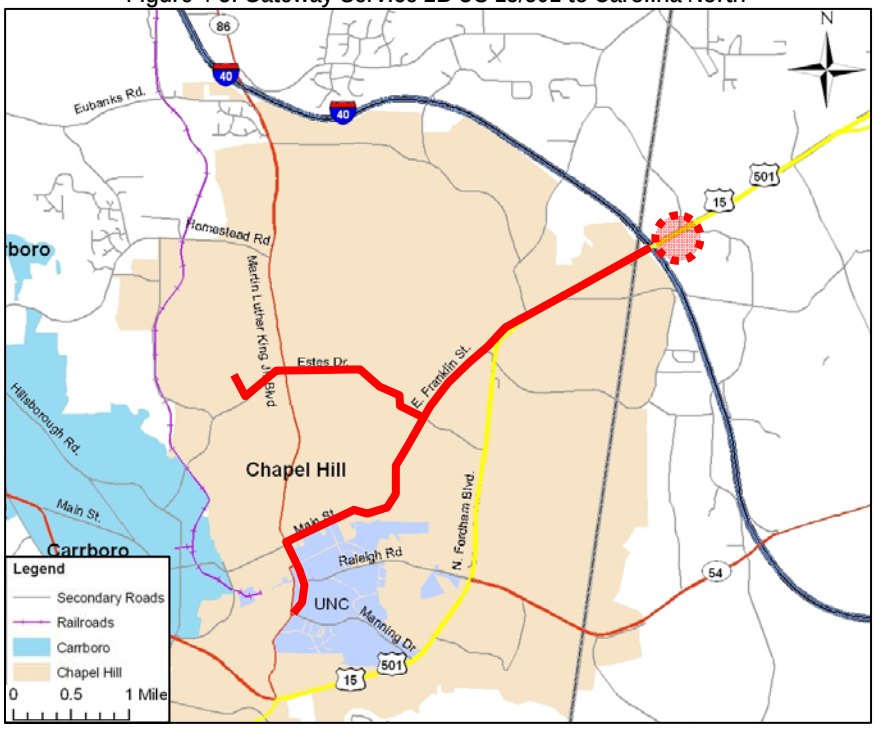
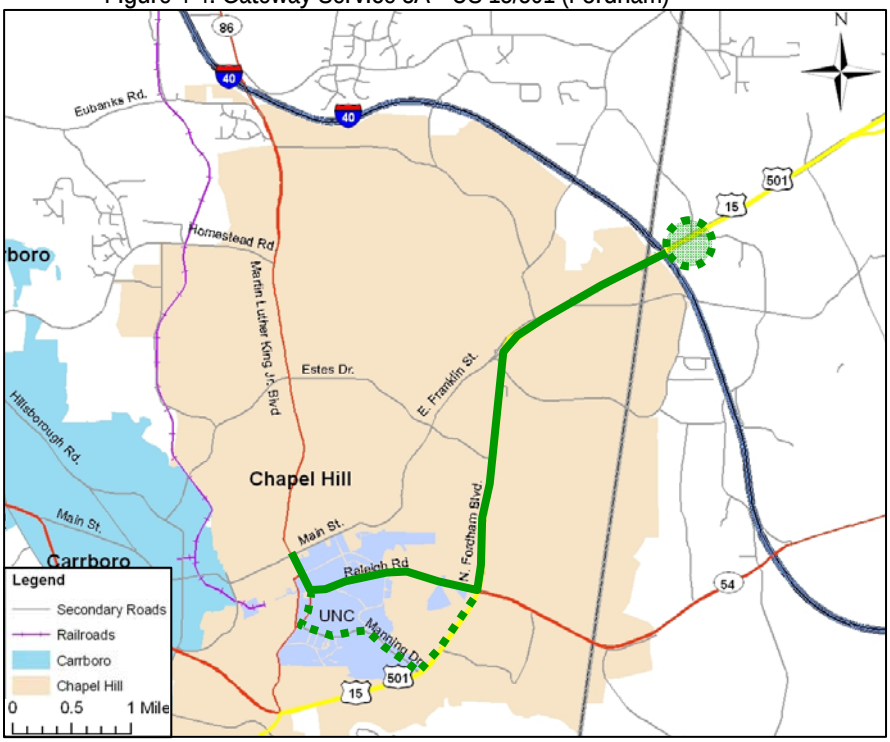


Figure 4-3: Gateway Service 2B US 15/501 to Carolina North



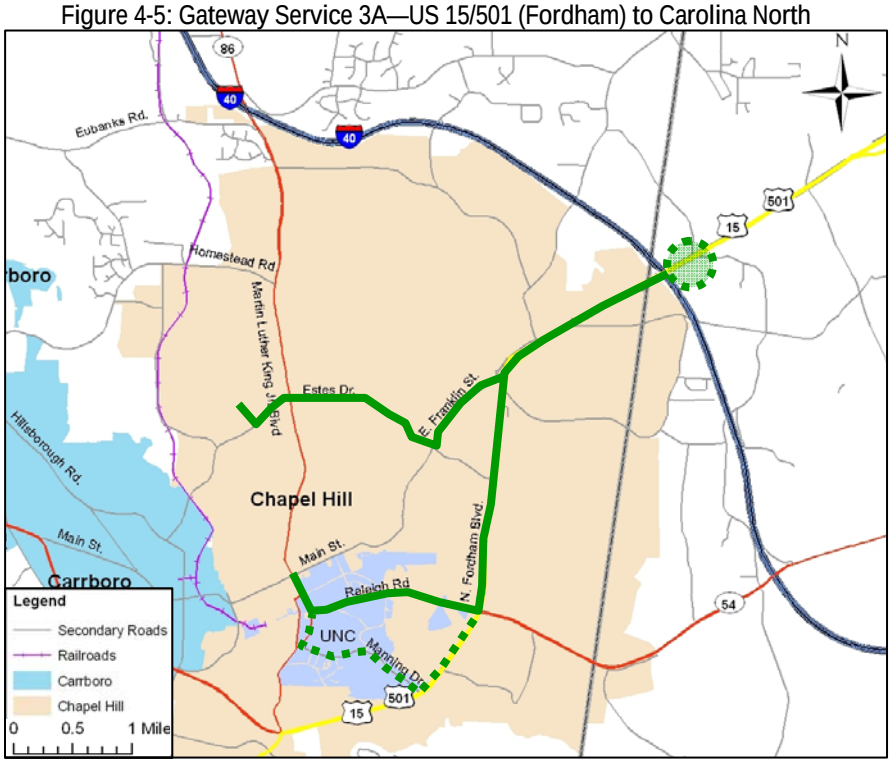
Gateway Service 3 extends from the northeast to the center of Chapel Hill, but uses Fordham Boulevard to shift southward and approaches UNC from the east. There are two variations to this service. Service 3A extends from I-40 to downtown/UNC via US 15/501 – Fordham Boulevard and Raleigh Road. It is 5.6 miles long and has a park-and-ride facility located, as in Service corridor 2 at the I-40 interchange with US 15/501 just beyond the town line. Figure 4-4 below shows the corridor alignment using Raleigh Road; an alternative and perhaps better option is to proceed father south on Fordham Boulevard and use Manning Drive for the last segment approaching UNC. This is a bit longer but offers better access to the hospital complex.

Figure 4-4: Gateway Service 3A—US 15/501 (Fordham)



Service 3B is a variant of 3A that also serves Carolina North essentially using the same branch on Estes Drive as service 2B. The service stays on Franklin Street to reach Estes Drive. Thus, the branch of 3B serving Carolina North is identical to the branch of 2B serving Carolina North. The difference between 3B and 2B is the service to downtown/UNC, since we have defined the Service 3B (like 2B) to include both the branches to downtown/UNC and to Carolina North. See Figure 4-5.

Figure 4-5: Gateway Service 3A—US 15/501 (Fordham) to Carolina North



Gateway Service 4 serves the east corridor and has two variations. Service 4A operates from the Orange County limit to downtown/UNC via NC54, Raleigh Road, and Columbia Road. The alignment is only 2.9 miles in length. While it would be more convenient for travelers using I-40 if the proposed park-and-ride facility were located closer to the interstate, we have shown it at the boundary about two miles from the interstate. This service is also shown using Raleigh Road all the way to UNC but could use Fordham Boulevard and Manning Drive to serve the hospital area better. Figure 4-6 illustrates.

Service 4B extends the 4A alignment to serve Carolina North. The total alignment is then 5.1 miles. See Figure 4-7.

Gateway Service 5 is different from the others in that does not follow arterial alignments but off-road rights-of-way. Service 5A approached Chapel Hill from the north parallel to Corridor 1 but uses the freight rail right-of-way. It extends from I-40 to downtown. The alignment is 6.5 miles long and can serve both Carolina North and downtown Chapel Hill on one line and is shown in Figure 4-8.

Service 5B utilizes a dedicated right-of-way in the Town of Chapel Hill and a segment of right-of-way identified in the TTA Phase 2A rail plan. The alignment parallels 4A but continues north to serve the park-and-riders on US 15/501 shown in services 2A, 2B, 3A, and 3B. While this study has been limited in focus to Chapel Hill and Carrboro, the fact that this alignment is based on the TTA Phase 2A rail plan suggests it could be a component of a larger regional transit improvement. Service 5B connects I-40 with UNC/downtown Chapel Hill and has a length of eight miles. See Figure 4-9.

Service 5C is the union of 5A and 5B. On the one service over the 14.5 mile alignment, there could be a northern and northeastern gateway park-and-ride (and potentially an additional eastern gateway park-and-ride as in Services 4A/4B) connecting to downtown/UNC and Carolina North.

Figure 4-6: Gateway Service 4A—NC54 (East)

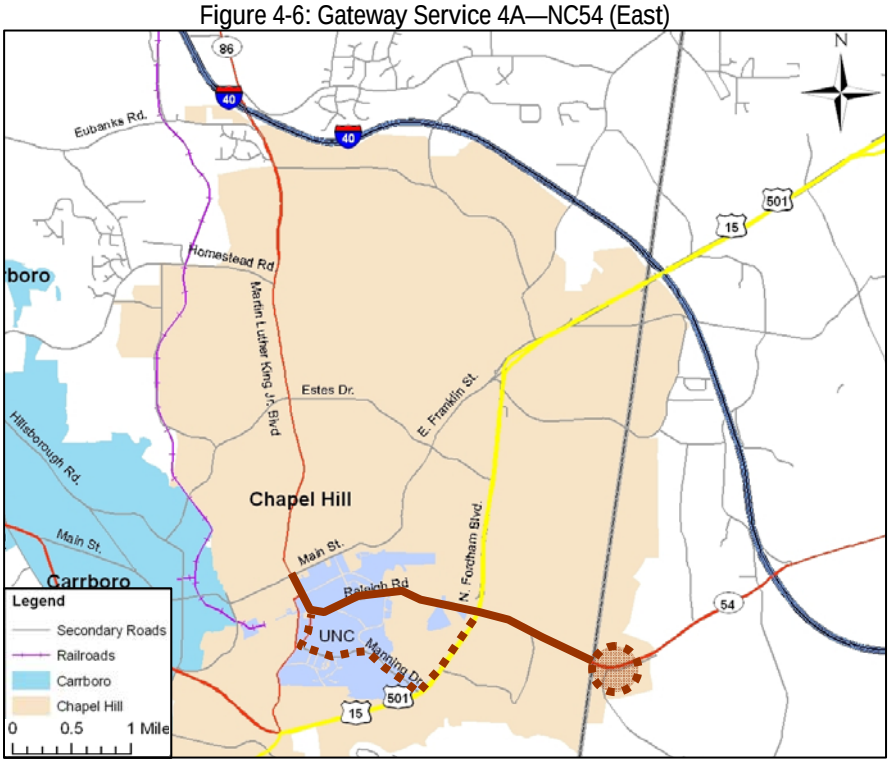


Figure 4-7: Gateway Service 4B—NC54 (East) to Carolina North

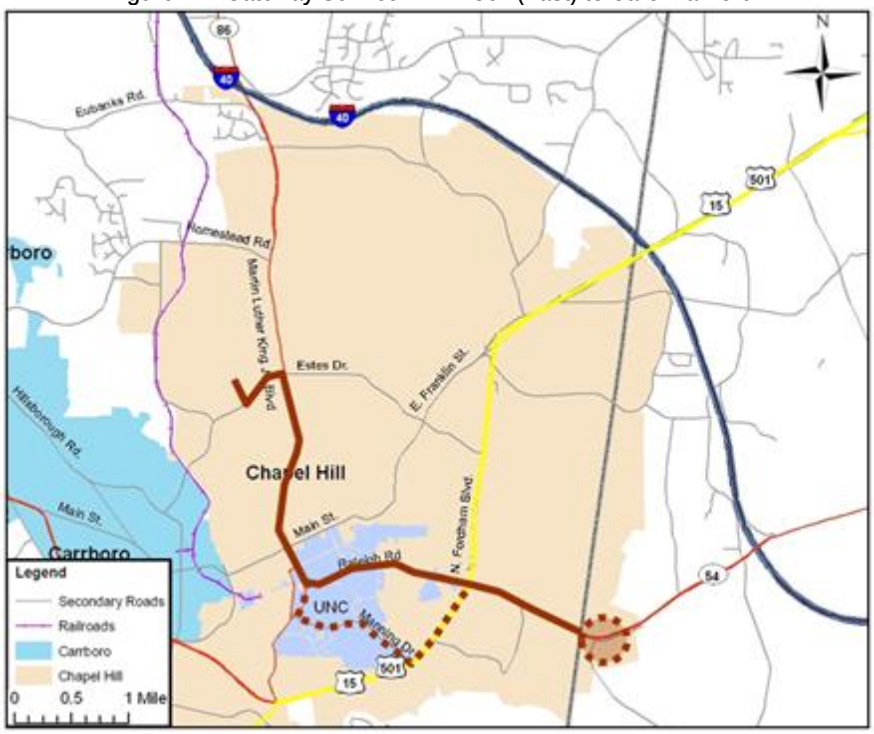


Figure 4-8: Gateway Service 5A—North Rail Corridor

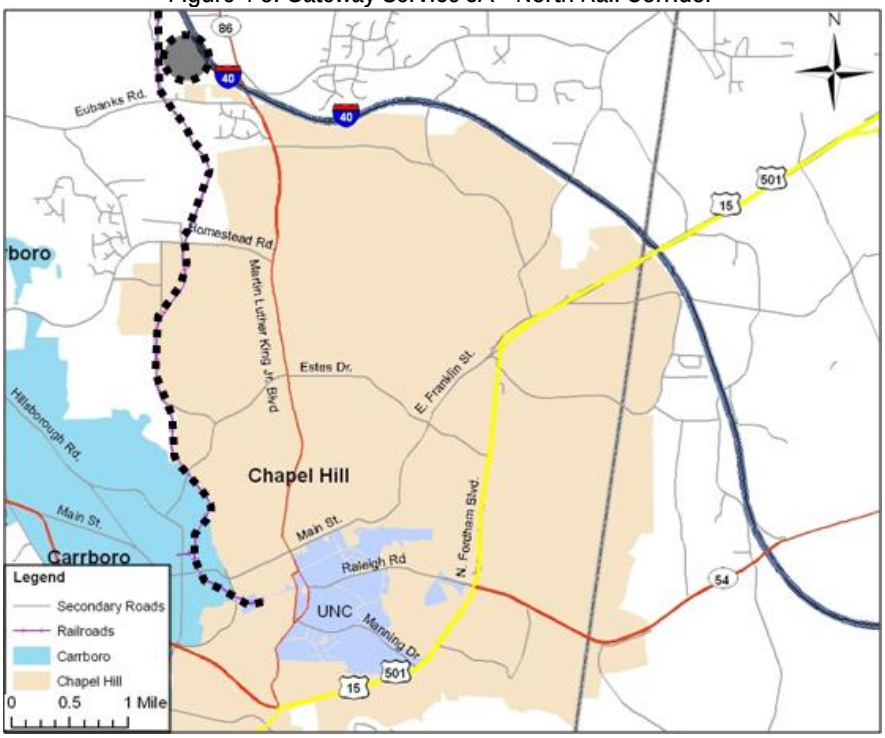
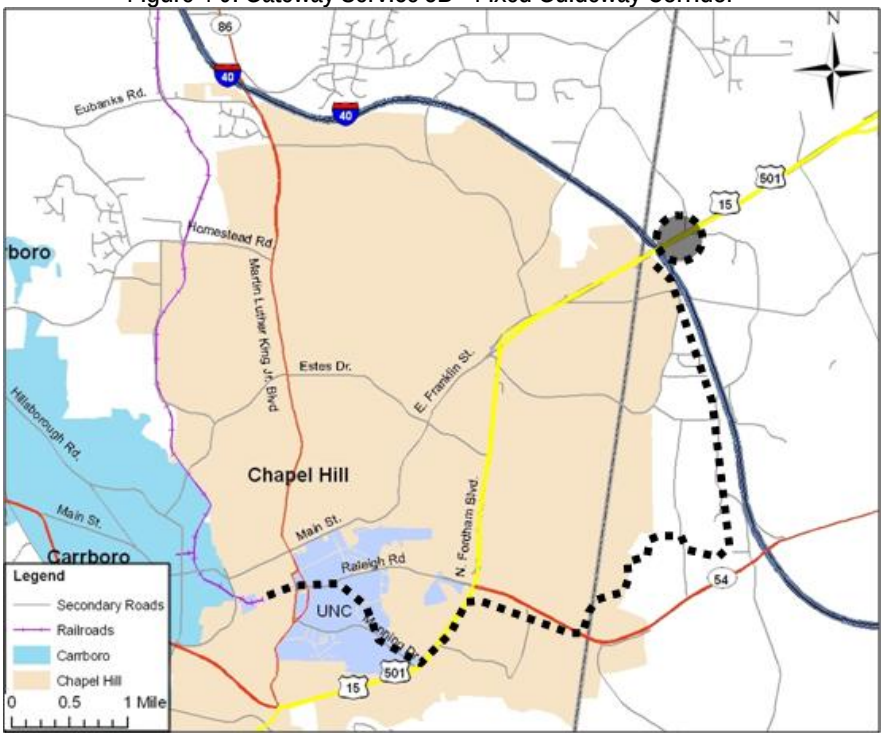


Figure 4-9: Gateway Service 5B—Fixed Guideway Corridor

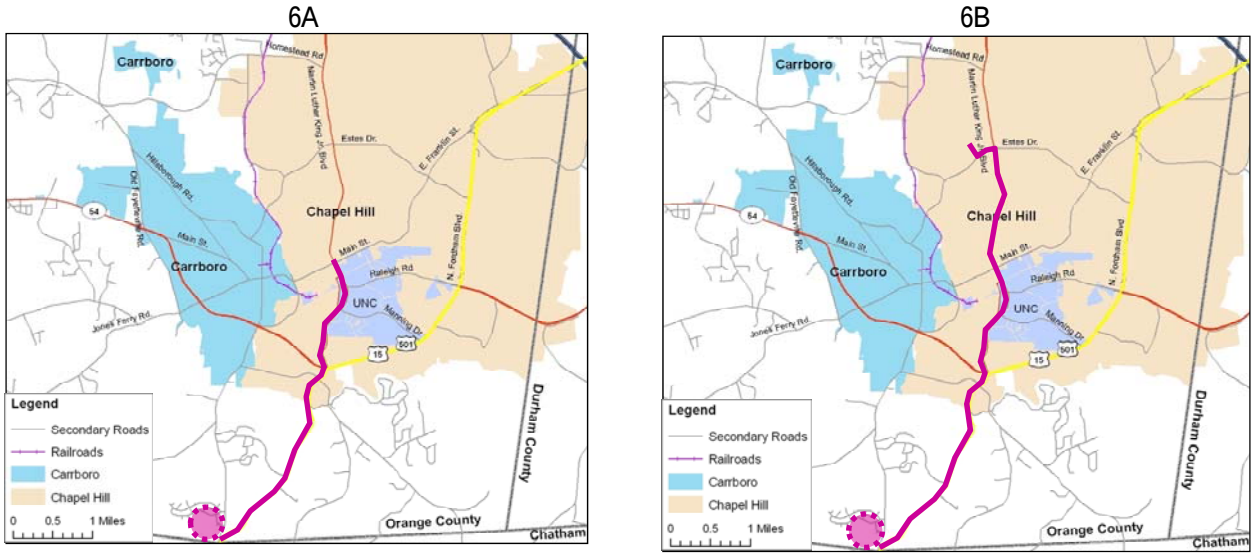


Enhanced Express Bus (EEB)

Similar to the High Investment Corridors, the Enhanced Express Bus corridors all start at one of three gateway nodes with the intention of intercepting travelers entering the community. Each node, as explained earlier, is a park-and-ride facility. The following discusses each corridor. With one exception, each corridor has two basic alternatives. The "A" alternatives serve the downtowns of Carrboro and Chapel Hill as well as the main campus of UNC. The "B" alternatives would service Carolina North, the downtowns of Carrboro and Chapel Hill, and the main campus of UNC.

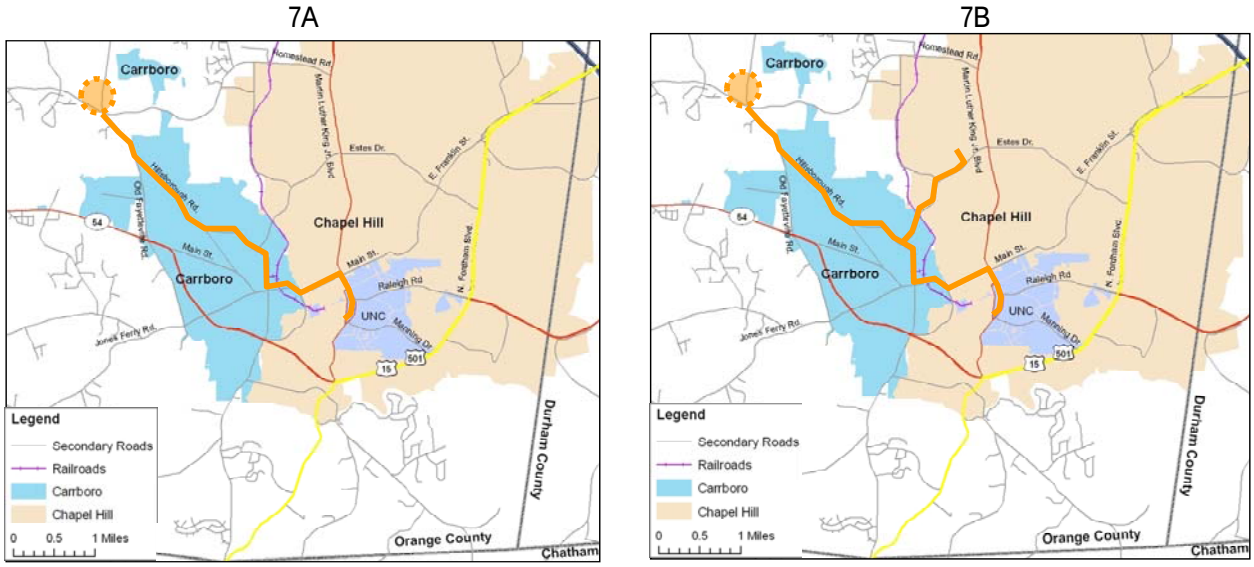
Gateway Service 6 serves the US 15/501 and Columbia corridor south of downtown Chapel Hill and the UNC main campus to the Orange County boundary. Figure 4-10 illustrates the A and B versions of the service. Service 6A is 4.4 miles in length with 6B 6.6 miles in length.

Figure 4-10: Gateway 6—US 15/501 South



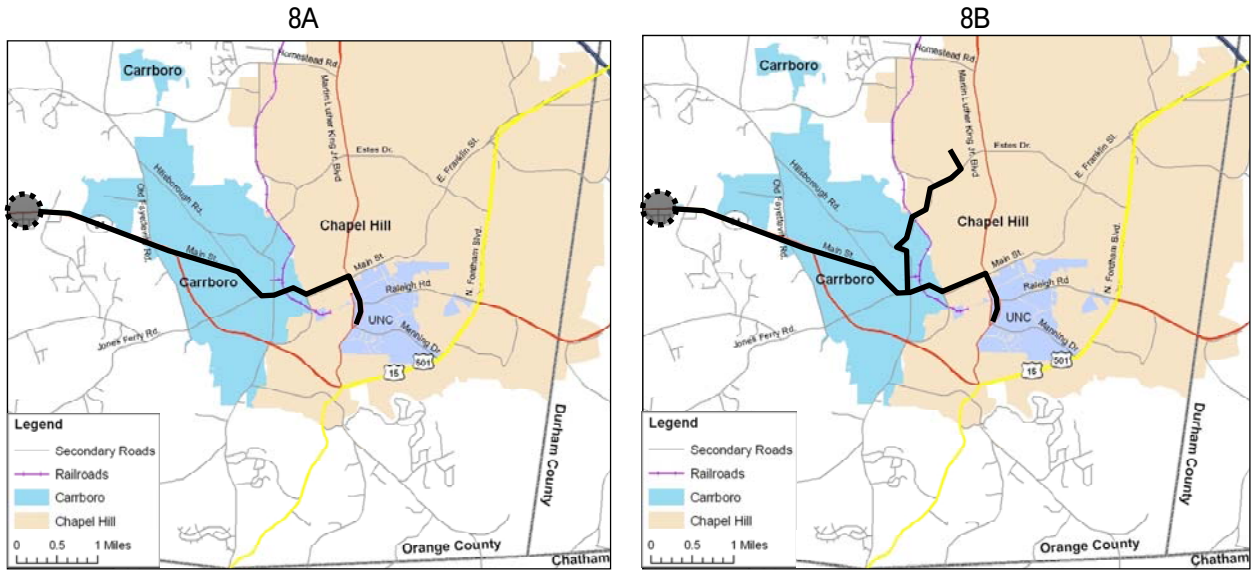
Gateway Service 7 operates from Homestead Road to the downtowns and UNC main campus via Hillsborough Road, Greensboro Road, and Franklin Street to Columbia Road and would be 5 miles in length. The Carolina North branch would connect via Estes Road. This branch would be 1.5 miles in length. See Figure 4-11.

Figure 4-11: Gateway 7—Hillsborough Gateway



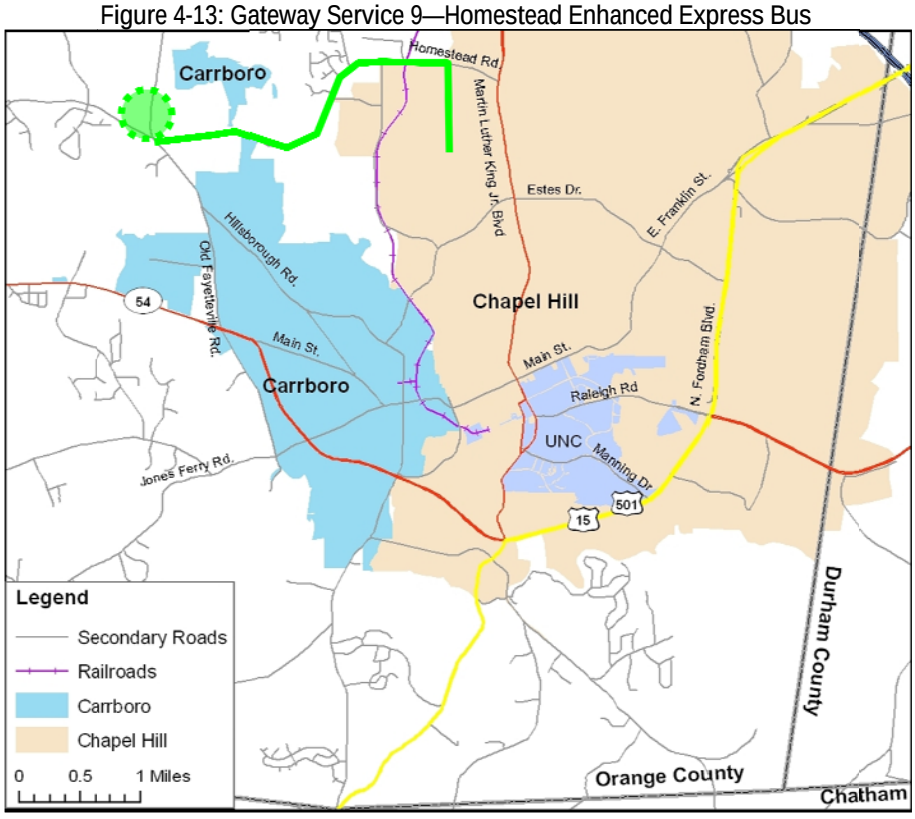
Gateway Service 8 would operate from western Carrboro to the downtowns and UNC main campus via Main Street (NC 54). The "A" segment would be 4.4 miles in length. The "B" segment would serve Carolina North via Estes and is just over 2.1 miles in length. See Figure 4-12 for both segments.

Figure 4-12: Gateway 8—Main Street (NC 54) Enhanced Express Bus



Gateway Service 9 would serve only Carolina North, providing a more direct connection from the Homestead/Hillsborough Road Gateway. The service would operate mainly on Homestead Road and would be 3.5 miles in length. Refer to Figure 4-13.

Figure 4-13: Gateway Service 9—Homestead Enhanced Express Bus



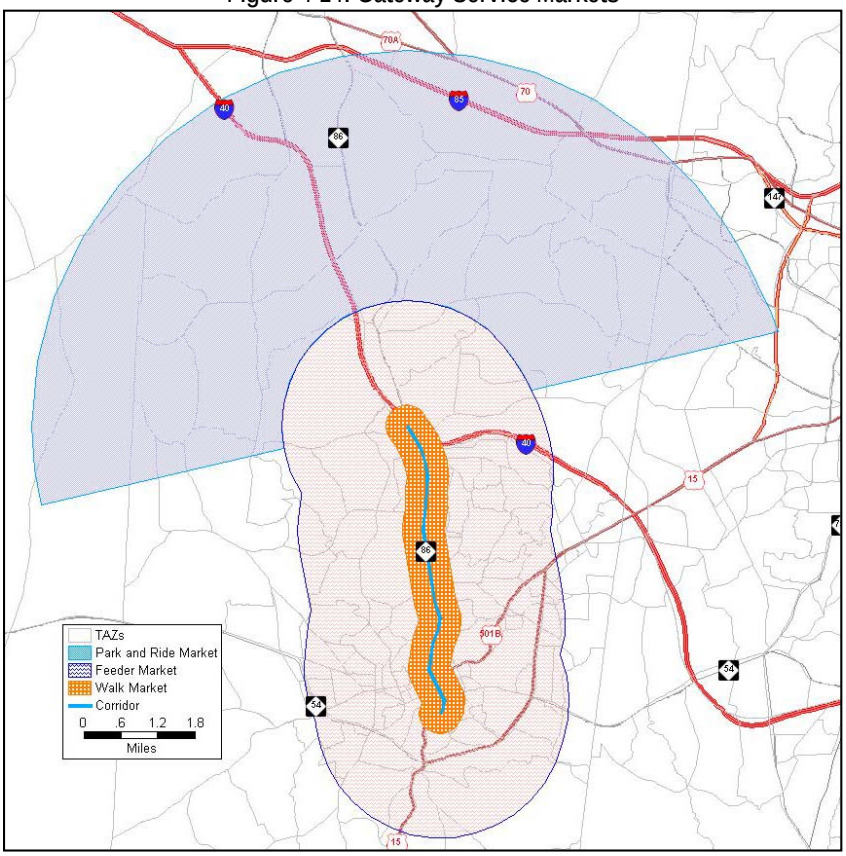
4.1.2 Estimated 2035 Potential Market Size

The market size (potential customers making trips to and from areas near the corridor) was estimated for each Gateway service. The purpose of this analysis is to establish the "best" transit market potential irrespective of a transit technology. By establishing this "best" market, technologies can be evaluated in terms of their cost effectiveness. This is opposite of a traditional approach where a transit technology is first defined and then the potential ridership is determined. Here the market is first established with the notion of finding the best technology for the market. A market segmentation approach was used in determining the demand for service.

The total market was segmented into three submarkets: Walk, Feeder, and Park-and-Ride. The Walk market was defined as within one-third mile of the corridor. The Feeder market was defined as origins within two miles and destinations within one-third mile excluding trips already counted in the Walk market. Feeder refers to trips that use another bus, bicycle, or automobile drop off to reach the corridor service. Finally the Park-and-Ride market was defined as the market with origins within a six mile radius of the Park-and-Ride gateway, excluding the Walk and Feeder market but including destinations within a one-third mile (walk distance) of the corridor. Figure 4-14 illustrates these submarkets.

The resulting sizes of each of the submarkets for each corridor in 2035 are shown, respectively for high investment and enhanced express bus corridors, in Table 4-1 and Table 4-2. Note that this does not presume any particular mode share for transit at this point; the market size includes all person-trips made by auto or transit. Bike and pedestrian travel is not included.

Figure 4-14: Gateway Service Markets



As seen in Table 4-1, the total market for corridor 1 (Martin Luther King, Jr. Boulevard) is 163,800 person trips in 2035. That market is made up of 6,700 park-and-riders, 55,700 walkers, and 101,400 feeder travelers. Similar information is provided in Table 4-2 but for the Enhanced Express Bus markets.

Table 4-1: Market Sizes for High Investment Corridors

Gateway Service-- High Investment Corridors	Estimated Market Size 2035*			
	PnR Market	Walk Market	Feeder Market	Total Market
C1--MLK	6,700	55,700	101,400	163,800
C2A--US15/501, Franklin	20,100	64,200	112,600	196,900
C2B--US15/501,Franklin, Estes	20,700	67,500	119,000	207,200
C3A--US15/501, Fordham	18,700	62,800	108,400	189,900
C3B--US 15/501, Fordham, Estes	21,800	71,600	117,100	210,500
C4A--NC54 to downtown	17,300	54,600	93,500	165,400
C4B--NC54, MLK Blvd.	14,100	63,700	101,200	179,000
C5A--North Rail (parallel MLK)	4,900	25,100	48,400	78,400
C5B--Fixed Guideway Corridor	9,700	76,200	98,200	184,100
C5C--5A + 5B	12,100	95,500	127,400	235,000
**Includes auto and transit trips, does not include walk and bike.*				

Table 4-2: Market Sizes for Enhanced Express Bus Corridors

Gateway Service-- Enhanced Express Bus Corridors	Estimated Market Size 2035*			
	PnR Market	Walk Market	Feeder Market	Total Market
C6A--US15/501 (South)	10,100	47,900	90,000	148,000
C6B--US15/501 (South), MLK	10,800	56,300	98,800	165,900
C7A--Hillsborough Road	6,800	55,900	98,300	161,000
C7B--Hillsborough Road, Estes Dr	6,800	55,100	99,100	161,000
C8A--Main Street (NC54)	7,100	56,000	95,500	158,600
C8B--Main Street (NC54), Estes	7,200	57,700	97,600	162,500
C9--Homestead Road	3,540	19,310	22,600	45,450
**Includes auto and transit trips, does not include walk and bike.*				

Analysis of Potential Transit Trips

Typically, for transit services the Walk market has greatest potential to achieve higher transit mode shares while Feeder and PnR markets have smaller potential to capture trips for transit, unless policies are implemented to restrict parking and encourage feeder modes (i.e. bike, Kiss & Ride, feeder bus routes). Since the focus of this effort is to intercept people at Gateway nodes, it was assumed that policies will be implemented to encourage PnR at the city boundaries. Thus, it is assumed that the PnR transit mode share and the Walk transit mode share are X%, the Feeder transit mode share = 0.25 X%. As a starting base assumption, we set X at 12%. A 12% mode share would be considered excellent for transit. These mode shares applied to the market segments yield the following total daily transit trips in each service corridor. See Table 4-3. These ridership levels will be used later to evaluate the cost effectiveness of different corridor technologies. Table 4-4 shows similar results for the Enhanced Express Bus corridors using the same assumptions regarding mode share.

As seen in Table 4-3, Corridor 1 (C1-MLK) would have 10,530 daily transit trips assuming a 12 percent mode share for park-and-ride and walk modes and 3 percent share (25 percent of 12 percent) for the feeder market.

Table 4-3: Estimated High Investment Corridor Transit Ridership

Gateway Service-- High Investment Corridors	Transit Trips
C1--MLK	10,530
C2A--US15/501, Franklin	13,494
C2B--US15/501,Franklin, Estes	14,154
C3A--US15/501, Fordham	13,032
C3B--US 15/501, Fordham, Estes	14,721
C4A--NC54 to downtown	11,433
C4B--NC54, MLK Blvd.	12,372
C5A--North Rail (parallel MLK)	5,052
C5B--Fixed Guideway Corridor	13,254
C5C--5A + 5B	16,734

Table 4-4: Estimated High Investment Corridor Transit Ridership

Gateway Service-- Enhanced Express Bus Corridors	Transit Trips
C6A--US15/501 (South)	9,660
C6B--US15/501 (South), MLK	11,016
C7A--Hillsborough Road	10,473
C7B--Hillsborugh Road, Estes Dr	10,401
C8A--Main Street (NC54)	10,437
C8B--Main Street (NC54), Estes	10,716
C9--Homestead Road	3,420

At the conclusion of this analysis, the Transit Study Committee decided that C2A and C2B should be combined with C3A and C3B. The decision was based on the extensive overlap of the services. C3 would become a service with three distinct branches—service via Franklin, via Fordham, and to Carolina North via Estes.

4.1.3 Evaluation of Technologies

In the evaluation of technologies for each Gateway service, the following questions were addressed:

- Is there likely to be sufficient demand to justify higher investment technologies?
- Would lower investment technologies be unable or ineffective if we are successful at achieving high rates of capture at gateway park-and-rides?

Several quantitative measures were used in this evaluation:

- Ridership and Productivity
- Capital and O&M Cost
    - Costs per mile and costs per hour that reflect industry norms
    - Costs vary greatly due to physical and operations factors in specific corridors
- Total Cost per Rider

Table 4-5 summarizes the technologies considered for the gateway services. Five basic technologies were examined—Light Rail Transit (LRT), Streetcar, BRT operating in a busway, BRT operating on an arterial street, and express bus. For HIC all of these technologies except the express bus were evaluated. For the EEB corridors, only bus modes were evaluated and did not include the two rail modes. Other technologies, such as commuter rail and heavy rail, were not initially considered because they were not considered practical by the Chapel Hill/Carrboro community because such services are intended for long distance, regional travel, while the travel distances within the community are short at about five miles in length. The purpose of the study, to remind the reader, is to develop transit strategies that are localized leaving regional service planning to other entities.

Table 4-5: Potential Technologies for Services

	High Investment Corridors		Enhanced Express Bus		
Characteristic	**LRT**	**Streetcar**	**BRT busway**	**BRT arterial**	**Express Bus**
Vehicle type and ROW	• Rail cars in exclusive ROW infrastructure	• Rail cars in arterial streets	• Buses in exclusive ROW facility	• Buses on exclusive lane in arterial street	• Limited-stop service in mixed traffic
Intersections with mixed traffic	• No	• Few	• Few	• Yes	• Yes
Infrastructure at stops	• Stations	• Enhanced shelters	• Stations	• Enhanced shelters	• Shelters
Payment and boarding	• Off-vehicle fare payment • At grade, multiple door boarding	• Off-vehicle fare payment • Multiple door boarding	• Off-vehicle fare payment • At grade multiple door boarding	• Off-vehicle fare payment • Multiple door boarding	• On-board payment • One-door boarding

Table 4-6 shows operating and cost assumptions for the technologies evaluated for both the High Investment and Enhanced Express Bus Corridors. The assumptions are based on industry standards as well as work done in the Raleigh-Durham area in developing similar technologies elsewhere in the region. The assumptions relate to service features such as stop spacing, number of signalized intersections as well as operating and capital cost assumptions.

Table 4-6: Basic Operational and Cost Assumptions for Technologies

Characteristics	**Light Rail**	**Streetcar**	**BRT busway**	**BRT arterial**	**Express Bus (Limited stop)**
Stop Spacing [mi/stop]	0.33	0.33	0.33	0.33	0.33
Signalized intersections [signals/mile]	0	2	1	2	3
Vehicle Cost [$ M/veh]	$3.5	$3.0	$0.8	$0.8	$0.5
Average Capital Cost [$ Millions/mile][2]	$40	$28	$22	$9	$0.5
O&M Cost [$ / rev veh-hr][3]	$230	$230	$80	$80	$80

[1] Includes inter-stop time time, traffic signal delays, dwell time, layover
[2] Includes track in both directions, stations, electrification, signals, public space, control center, maintenance facility
[3] Minimums, O&M cost increases marginally as rail options operate with more than one car and bus options operate with articulated buses

In addition to the basic characteristics in Table 4-6, further assumptions are established in the form of a conceptual operating plan.

Conceptual Operating Plan

To begin the process of evaluating transit technologies, a conceptual operating plan was developed in order to quantify the services. The conceptual plan was designed to be attractive to the prospective passengers by adopting the following service characteristics applied to all the services in all the gateway corridors:

- Weekday span of service: 6:00 am – 10:00 pm
- Three AM peak hours and three PM peak hours
- All other hours are off-peak
- Maximum service headway:
  - HIC Headway Peak: 10 minutes Off-peak: 15 minutes
  - EEB Headway Peak: 15 minutes Off-peak: 30 minutes

Also considered were these minimum feasible operational headway as follows:[9]

- Fixed guideway = 5 minutes
- BRT in busway or arterial exclusive lane = 3 minutes
- Express bus = 5 minutes

These also helped to select the train sizes for LRT and streetcar modes and bus sizes for BRT modes. Applying the above data, including Table 4-5 and Table 4-6 above, as well as potential ridership various service scenarios were analyzed for each gateway service corridor. Each technology, as well as variations in how each technology would be potential deployed, were evaluated in terms of cost as well as needed market share to make that technology cost equivalent to the lowest cost alternative. Table 4-7 on the next page illustrates the analysis as applied to gateway service Corridor 1, the Martin Luther King Jr. Blvd. corridor.

Table 4-7 contains the following column technology codes:

Code	Description	Comment
LR	Light Rail	Code followed by the numbers 1, 2, or 3 refer to number of cars in a train set.
SC	Streetcar	
BRT bw	Bus Rapid Transit in busway	Code followed by the number 1 refers to BRT operated by a standard forty-foot vehicle; the number 2 refers to an articulated (sixty-foot) vehicle
BRT art	Bus Rapid Transit in arterial street	

[9] In other words, what is the best frequency feasible for the given technology?

Table 4-7: Sample Technology Cost Evaluation

C1--Martin Luther King Jr. Corridor	LR3	LR2	LR1	SC2	SC1	BRT bw2	BRT bw1	BRT art2	BRT art1
Vehicle type/Number of cars in trains	3 cars	2 cars	1 car	2 cars	1 car	Articulated	40-foot	Articulated	40-foot
Peak Headway [min]	10	10	5	10	5	4	2	4	2
Capital Cost + Vehicles [$ millions]	$224	$213	$213	$165	$165	$138	$147	$86	$98
O&M Cost / Rider [$/pass]	$0.6	$0.6	$0.9	$1.0	$1.5	$0.5	$0.8	$0.6	$1.1
Total Cost / Rider [$/pass]	$4.2	$4.0	$4.3	$3.6	$4.1	$2.6	$3.1	$2.0	$2.6
Required Transit Mode Share to match lowest cost/rider alternative	13%	13%	14%	12%	13%	8%	10%	6%	8%

Table 4-7 shows for each technology the following information:

- *Vehicle type/Number of cars in trains*—number of cars or type of bus.
- *Peak Headway [min]*—service frequency in minutes.
- *Capital Cost + Vehicles [$ millions]*—capital cost of the service in millions of current (2008) dollars. The cost includes vehicles.
- *O&M Cost / Rider [$/pass]*—operating and maintenance cost per rider (current 2008 dollars per passenger).
- *Total Cost* / Rider [$/pass]—capital plus O&M costs per rider.
- *Required Transit Mode Share to match lowest cost/rider alternative*—what would a given technology's share of the travel market need to be in order for that technology to have a cost per rider equivalent to the lowest cost technology in that corridor.

Referring again to Table 4-7 and the column headed with "LR3." The "LR3" is Light Rail with three cars per train set (as indicated in the "*Vehicle type/Number of cars in trains*" line). The capital cost (including infrastructure and vehicles) would be $224 million (in 2008 dollars). The operating and maintenance cost would be $0.60 per rider and the total cost per rider (assuming a 20-year amortization of capital costs) would be $4.20 per rider. The lowest cost alternative in this corridor is BRT art2 (BRT with articulate vehicles operating in an arterial street) at a total cost of $2.00 per rider. For the LR3 option to be of equivalent cost per rider it would need to capture 13 percent of the travel market or just over twice the market share required of the BRT art2 option (at 6 percent of the market). The capital costs do not include the gateway park-and-ride facilities. Since all options would use the gateways that cost would initially be the same for each option. Thus including the gateway park-and-ride facility would obfuscate the relative cost of each technology.

The results of the analysis show in Table 4-7 and containing all HIC gateways that include Carolina North and the technologies found in Table 4-5 are shown in Table 4-8 on the next page. Only corridors that included a branch service to Carolina North were analyzed because of the importance of the new development and the desire to create a link with the main UNC campus. Thus, options without Carolina North were summarily dismissed at this point in the analysis. In addition, Gateway 2 was eliminated as an option because of its close similarities with Gateway 3. Both of these decisions were at the direction of the Transit Study Committee.

Table 4-9, after the next page, shows similar results for the Enhanced Express Bus corridors. Note that the column heading with "Exp B" represents Enhanced Express Bus.

Table 4-8: Results of Cost Analysis—Lowest Cost Technologies—High Investment Corridors

C1-Martin Luther King, Jr.	LR3	LR2	LR1	SC2	SC1	BRT bw2	BRT bw1	BRT art2	BRT art1
Vehicle type/Number of cars in trains	3 cars	2 cars	1 car	2 cars	1 car	Articulated	40-foot	Articulated	40-foot
Peak Headway [min]	10	10	5	10	5	4	2	4	2
Capital Cost + Vehicles [$ millions]	$224	$213	$213	$165	$165	$138	$147	$86	$98
O&M Cost / Rider [$/pass]	$0.6	$0.6	$0.9	$1.0	$1.5	$0.5	$0.8	$0.6	$1.1
Total Cost / Rider [$/pass]	$4.2	$4.0	$4.3	$3.6	$4.1	$2.6	$3.1	$2.0	$2.6
Required Transit Mode Share to match lowest cost/rider alternative	13%	13%	14%	12%	13%	8%	10%	6%	8%

C3B-US 15/501 Franklin, Fordham, Estes	LR3	LR2	LR1	SC2	SC1	BRT bw2	BRT bw1	BRT art2	BRT art1
Vehicle type/Number of cars in trains	3 cars	2 cars	1 car	2 cars	1 car	Articulated	40-foot	Articulated	40-foot
Peak Headway [min]	10	8	4	8	4	3	2	3	2
Capital Cost + Vehicles [$ millions]	$403	$389	$389	$307	$307	$270	$271	$195	$192
O&M Cost / Rider [$/pass]	$0.9	$1.1	$1.6	$1.7	$2.6	$0.8	$1.2	$1.2	$1.6
Total Cost / Rider [$/pass]	$5.5	$5.5	$6.0	$5.2	$6.1	$3.9	$4.2	$3.4	$3.8
Required Transit Mode Share to match lowest cost/rider alternative	11%	11%	12%	11%	13%	8%	9%	7%	8%

C4B--NC54 (East)--Raleigh Road	LR3	LR2	LR1	SC2	SC1	BRT bw2	BRT bw1	BRT art2	BRT art1
Vehicle type/Number of cars in trains	3 cars	2 cars	1 car	2 cars	1 car	Articulated	40-foot	Articulated	40-foot
Peak Headway [min]	10	9	4	9	4	3	2	3	2
Capital Cost + Vehicles [$ millions]	$240	$229	$236	$176	$179	$156	$156	$107	$106
O&M Cost / Rider [$/pass]	$0.6	$0.6	$1.0	$1.0	$1.6	$0.5	$0.7	$0.7	$1.0
Total Cost / Rider [$/pass]	$3.8	$3.7	$4.2	$3.4	$4.0	$2.6	$2.8	$2.2	$2.4
Required Transit Mode Share to match lowest cost/rider alternative	12%	12%	13%	11%	13%	8%	9%	7%	8%

C5B-Fixed Guideway Corridor	LR3	LR2	LR1	SC2	SC1	BRT bw2	BRT bw1	BRT art2	BRT art1
Vehicle type/Number of cars in trains	3 cars	2 cars	1 car	2 cars	1 car	Articulated	40-foot	Articulated	40-foot
Peak Headway [min]	10	10	5	10	5	4	2	4	2
Capital Cost + Vehicles [$ millions]	$370	$356	$356	$270	$270	$227	$244	$144	$163
O&M Cost / Rider [$/pass]	$1.1	$1.1	$1.6	$1.8	$2.7	$0.8	$1.4	$1.1	$1.9
Total Cost / Rider [$/pass]	$7.3	$7.0	$7.5	$6.3	$7.1	$4.6	$5.4	$3.5	$4.6
Required Transit Mode Share to match lowest cost/rider alternative	15%	14%	15%	13%	14%	9%	11%	7%	9%

Notes: LR= Light Rail; SC= Streetcar; BRT bw= Bus Rapid Transit in busway; BRT art= BRT in arterial street; Numbers following LR and SC are number of cars per train set; the number 2 following BRT options indicate use of articulated vehicles (60 foot) while the number 1 indicates a standard, 40-foot vehicle. Note that BRT art2 and art1 are not viable since the corridor does not have an existing arterial road. Capital costs do not include gateway park-and-ride facilities. Costs are expressed in 2008 dollars.

Table 4-9: Results of Cost Analysis—Lowest Cost Technologies—Enhanced Express Bus Corridors

C6B--US15/501 (South) & MLK	BRT bw2	BRT bw1	BRT art2	BRT art1	Exp B
Vehicle type	Articulated	40-foot	Articulated	40-foot	40-foot
Peak Headway [min]	4	3	4	3	3
Capital Cost + Vehicles [$ millions]	$192	$186	$124	$112	$45
O&M Cost / Rider [$/pass]	$0.6	$0.8	$0.9	$1.1	$1.5
Total Cost / Rider [$/pass]	$4.1	$4.2	$3.2	$3.2	$2.3
Required Transit Mode Share to match lowest cost/rider alternative	10.0%	10.2%	7.6%	7.7%	5.5%

C7B-Hillsborough Road, Estes	BRT bw2	BRT bw1	BRT art2	BRT art1	Exp B
Vehicle type	Articulated	40-foot	Articulated	40-foot	40-foot
Peak Headway [min]	5	3	5	3	3
Capital Cost + Vehicles [$ millions]	$196	$201	$128	$136	$63
O&M Cost / Rider [$/pass]	$0.8	$1.2	$1.1	$1.7	$2.2
Total Cost / Rider [$/pass]	$4.6	$5.1	$3.6	$4.3	$3.4
Required Transit Mode Share to match lowest cost/rider alternative	7.2%	8.1%	5.7%	6.8%	5.4%

C8B--Main Street (NC 54 West) via Estes	BRT bw2	BRT bw1	BRT art2	BRT art1	Exp B
Vehicle type	Articulated	40-foot	Articulated	40-foot	40-foot
Peak Headway [min]	5	3	5	3	3
Capital Cost + Vehicles [$ millions]	$196	$201	$128	$136	$65
O&M Cost / Rider [$/pass]	$0.8	$1.2	$1.1	$1.7	$2.1
Total Cost / Rider [$/pass]	$4.4	$4.9	$3.5	$4.2	$3.3
Required Transit Mode Share to match lowest cost/rider alternative	7.3%	8.1%	5.7%	6.9%	5.5%

C8B--Main Street (NC 54 West) via Greensboro	BRT bw2	BRT bw1	BRT art2	BRT art1	Exp B
Vehicle type	Articulated	40-foot	Articulated	40-foot	40-foot
Peak Headway [min]	5	3	5	3	3
Capital Cost + Vehicles [$ millions]	$230	$236	$152	$160	$77
O&M Cost / Rider [$/pass]	$1.1	$1.7	$1.5	$2.3	$3.0
Total Cost / Rider [$/pass]	$6.0	$6.7	$4.8	$5.7	$4.6
Required Transit Mode Share to match lowest cost/rider alternative	7.0%	7.8%	5.6%	6.7%	5.4%

C9-Homestead Road	BRT bw2	BRT bw1	BRT art2	BRT art1	Exp B
Vehicle type	Articulated	40-foot	Articulated	40-foot	40-foot
Peak Headway [min]	15	10	15	10	10
Capital Cost + Vehicles [$ millions]	$87	$86	$42	$41	$9
O&M Cost / Rider [$/pass]	$0.4	$0.6	$0.6	$0.8	$1.0
Total Cost / Rider [$/pass]	$5.5	$5.6	$3.1	$3.2	$1.5
Required Transit Mode Share to match lowest cost/rider alternative	22.7%	22.9%	12.6%	13.0%	6.3%

Notes: BRT bw= Bus Rapid Transit in busway; BRT art= BRT in arterial street; Numbers following LR and SC are number of cars per train set; the number 2 following BRT options indicates use if articulated vehicles (60-foot) while the number 1 indicates a standard, 40-foot vehicle; Exp B = Enhanced Express Bus. Capital costs do not include Gateway park-and-ride facilities. Costs are expressed in 2008 dollars.

Table 4-10: Summary of Cost Analysis—Lowest Cost Technologies

Gateway Services	Lowest Cost/Rider Technology	Riders/day	Cost / Rider [$/pass]	Capital Cost [$ millions]
1 – MLK Blvd	BRT art2	10,530	$2.0	$86.5
3B – US15/501, Fordham Blvd, Estes Dr	BRT art2	14,721	$3.4	$195.3
4B – NC 54, MLK Blvd	BRT art2	12,372	$2.2	$107.3
5B – E-W rail	BRT bw2*	10,011	$3.5	$144.2
6B – US 15/501, Columbia Rd, MLK Blvd	Exp B	9,180	$2.3	$45.3
7B – Hillsborough Rd and Estes Dr	Exp B	8,668	$3.4	$63.3
8B – NC 54 to downtown + Estes Dr	Exp B	8,930	$3.3	$64.8
Alt 8B via So. Greensboro	Exp B	7,840	$4.6	$77.3
9 – Homestead Rd	Exp B	2,850	$1.5	$9.2

**arterial BRT though less costly is not truly an option since the corridor is not currently an arterial rather a largely undeveloped corridor with not current transportation infrastructure.*

As seen in Table 4-10, the BRT technology operating in an arterial street is the least costly for the HIC gateways. The only exception is Gateway 5B where a busway is least costly. It is least costly because there currently is no arterial in the corridor. By default, the busway option would be least expensive in that corridor. In the Enhanced Express Bus (EEB) corridors, the least costly alternatives are the express bus options. While LRT has proven to be too costly for the gateway services, the overall Raleigh-Durham region was considering LRT connection Chapel Hill with the rest of the region. Should those plans progress, they would impact Gateway services 3B and 4B. As LRT plans advance, assumptions about the type of services associated with those gateways should be re-evaluated.

The services listed in Table 4-10 comprise the gateway services to be further evaluated in this study. As previously mentioned in section 4.1.2, Gateway service 2 was combined with Gateway service 3.

4.2 Enhanced Local Bus

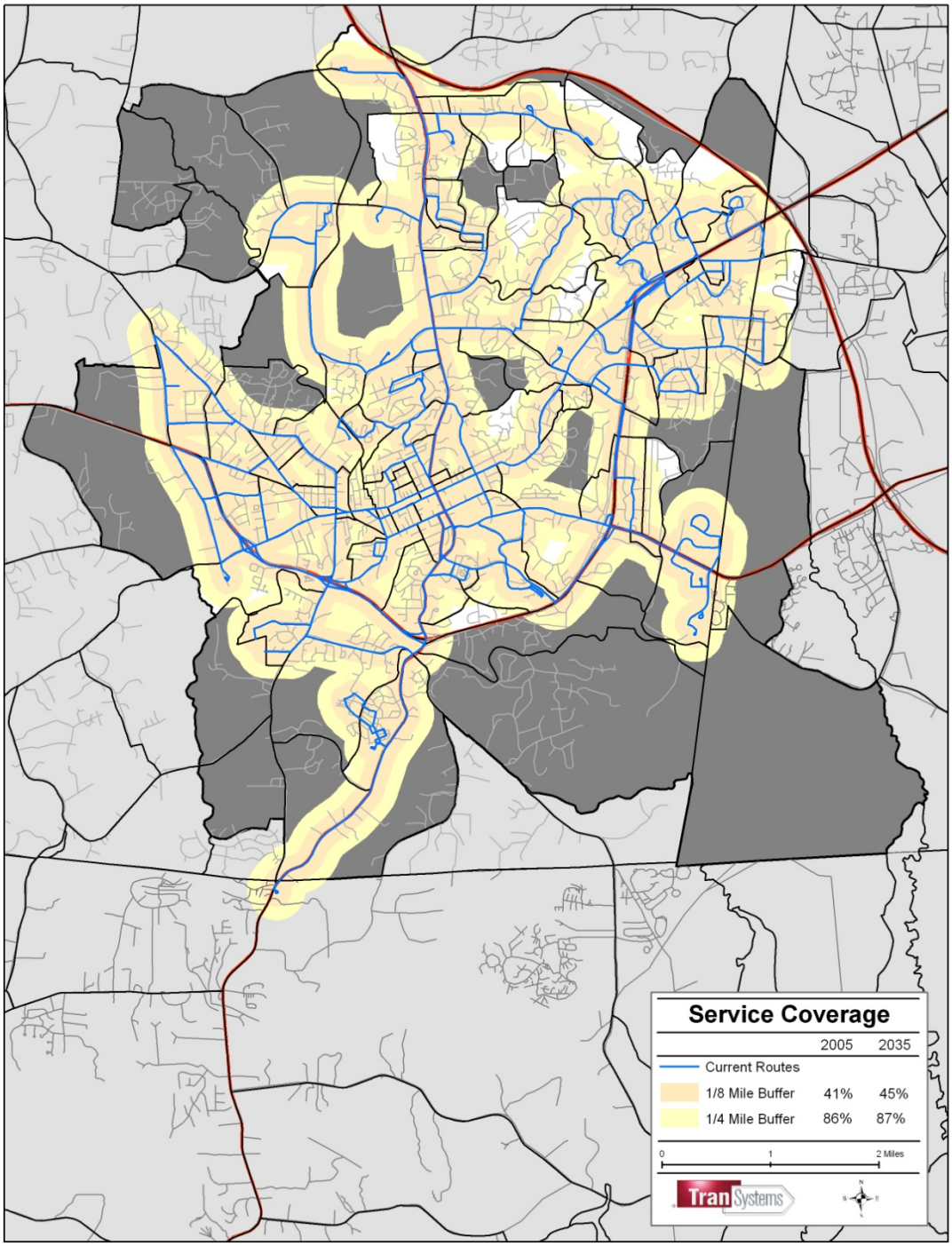
While the goal of the Gateway services is to intercept travelers entering the Carrboro/Chapel Hill community, the goal of the enhanced local bus is to provide mobility *within* the community. The enhanced local bus would not only provide such mobility, it would also offer a choice of travel superior to the automobile. In general, this means frequent service and service that is widely available throughout the community, throughout the day, and every day during the week.

4.2.1 Current Chapel Hill Transit Service

In fall 2006 (at the outset of this study) operating schedules and routes, CHT operated up to 24 different routes during times of the year when the University of North Carolina is in session. Including tripper service, the fixed route service operated 61 vehicles during peak hours. About 26,000 daily boardings occurred on an average weekday in October 2006. In addition to a fixed-route service, CHT also operates demand response service in compliance with the Americans with Disabilities Act (ADA) as well as to provide feeder service in low-density areas and certain kinds of evening trips. Service frequencies range from five and 10 minutes for express routes to 40-to 60-minute service

for linehaul routes. Off-peak services typically operate from 15 to 60 minutes with 40-minute headways common. CHT had a 2006 operating budget of about $14 million. CHT is a "fare free" system in that no fares are collected from riders.

Figure 4-15: Geographic Coverage of Chapel Hill Transit's Fixed-Route System 2005 and 2035



As shown in Figure 4-15, about 86 percent of the community population is within a quarter-mile of the 2005 fixed-route system. Assuming no changes in the route structure, about 87 percent of the population will be within a quarter miles of a bus route in the year 2035.

4.2.2 Expanded Local Bus Network

While the current system does a good job in providing geographic coverage, a local system that can truly compete with the spontaneity of the automobile would need not only greater coverage than the current service but also more frequent service (that is, headways that are shorter). The 2030 adopted long range plan developed by the Durham-Chapel Hill-Carrboro (DCHC) Metropolitan Planning Organization contained an extensive bus network for Chapel Hill Transit. That network included services with, respectively, 10-minute and 20-minute peak and off-peak service frequencies. It also contained services in support of a regional commuter rail service as well as bus services supplied by the Triangle Transit Authority (TTA). Further, services similar to some of the gateway services described above were included in the 2030 plan.

As preliminary ridership forecasting prepared by North Carolina State University's Institute for Transportation Research and Education (ITRE) using 2035 population and social economic data showed good ridership levels versus the base condition (current routes using 2035 data), the DCHC bus plan, with modifications, was used to support the above gateway services.

The modifications included eliminating routes from the 2030 plan. The plan called for 53 routes as a part of 2030 CHT system including the commuter rail service. Of those, 12 (including the commuter rail line) were considered to significantly duplicate the gateway services. Thus, they were eliminated for the purposes of the Chapel Hill/Carrboro 2035 Long Range Transit Plan (2035 LRTP). That left 41 routes as part of the 2035 LRTP.

4.3 Conclusion

The purpose of this section was to define in more specific terms the conceptual service design developed in Section 3. This section reviewed a variety of transit technologies to be used for the gateway services. In addition, the nature of the underlying local bus network was determined. For the gateway services, a network of BRT routes and enhanced express bus services were recommended to intercept travelers at the city boundaries and bring them into the heart of the community. To further provide mobility within the community, the gateway services would be supported by a modified version of the DCHC 2030 route plan for Chapel Hill Transit.

Section 5: Forecasting Ridership for the Concept Service Plan

The purpose of this section is to discuss the testing of the service plan developed in Sections 3 and 4 of this study. In Section 3, a concept service plan was developed that had two broad components: a set of "gateway" services intending to intercept travelers at the community boundaries and transferring those travelers to a robust transit system. The second component involves a high level of localized transit services to provide mobility within the community. Thus, travelers should be able to park their automobiles at the city boundaries and use transit to meet virtually all of their mobility needs. Section 4 further defined these services in terms of transit technologies to be used as well as basic service assumptions. In general, the gateway services would use buses for both types of services, that is, the high investment corridors (HIC) and the Enhanced Express Bus corridors (EEB). The HICs (mainly on the east side of the community) would use BRT technologies. The EEB would use standard transit vehicles in an express bus service configuration.

This section will model those services to predict patronage level. These patronage levels will form the basis of more detailed operating and capital plans and help further shape the services. Two groups of services are contemplated to be modeled: high investment and low investment packages of services.

5.1 High and Low Investment Scenarios

The service plan discussed in Sections 3 and 4 was divided into two groups of services, which are contemplated to be modeled: high investment and low investment packages of services. The main distinguishing characteristic that separates these two levels is the use of the fixed guideway corridor (gateway service 5).

In general, the high investment scenario uses the Gateway 5 but not Gateway 4. The low investment would be the opposite—using Gateway 4 and not Gateway 5. See Figure 5-1 for the high investment scenario and Figure 5-2 for the low investment scenario. Note that in both figures a Gateway 4 node is present. However, a close look at Figure 5-1 shows gateway service 5(b) originating at Gateway 3, following the fixed guideway corridor to gateway 4 before proceeding to the core of the Chapel Hill/Carrboro community. In Figure 5-2 the fixed guideway corridor is not used and service begins at gateway node 4 (in this scenario gateway nodes 3 and 4 are not connected by service as in the high investment scenario).

Figure 5-1: High Investment Scenario

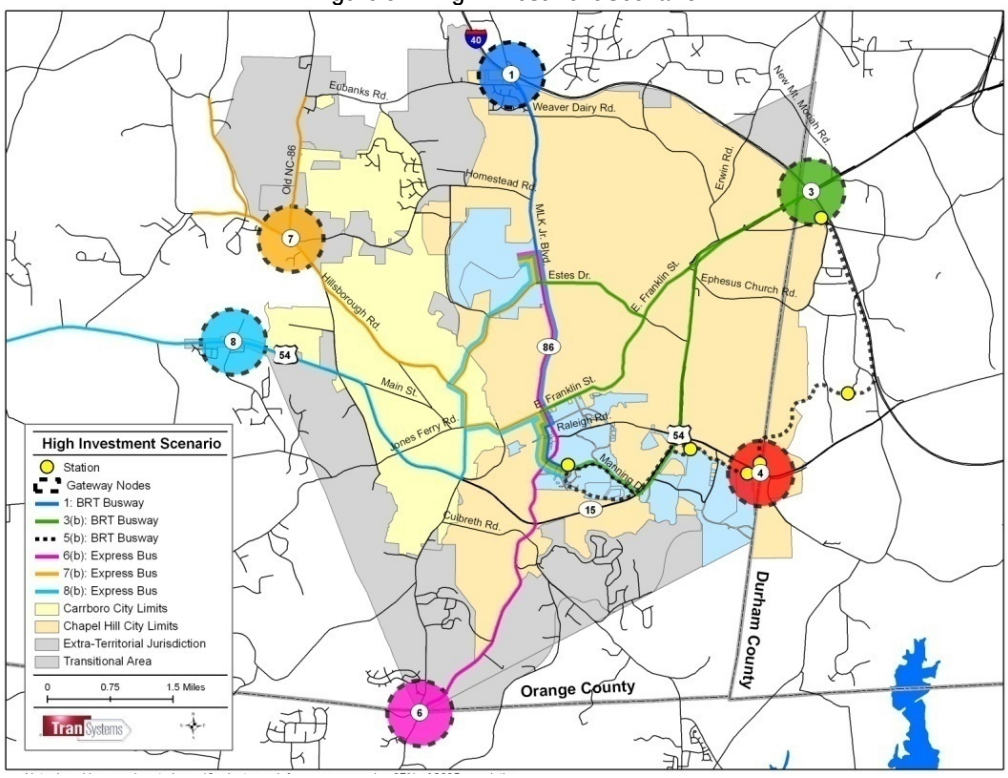
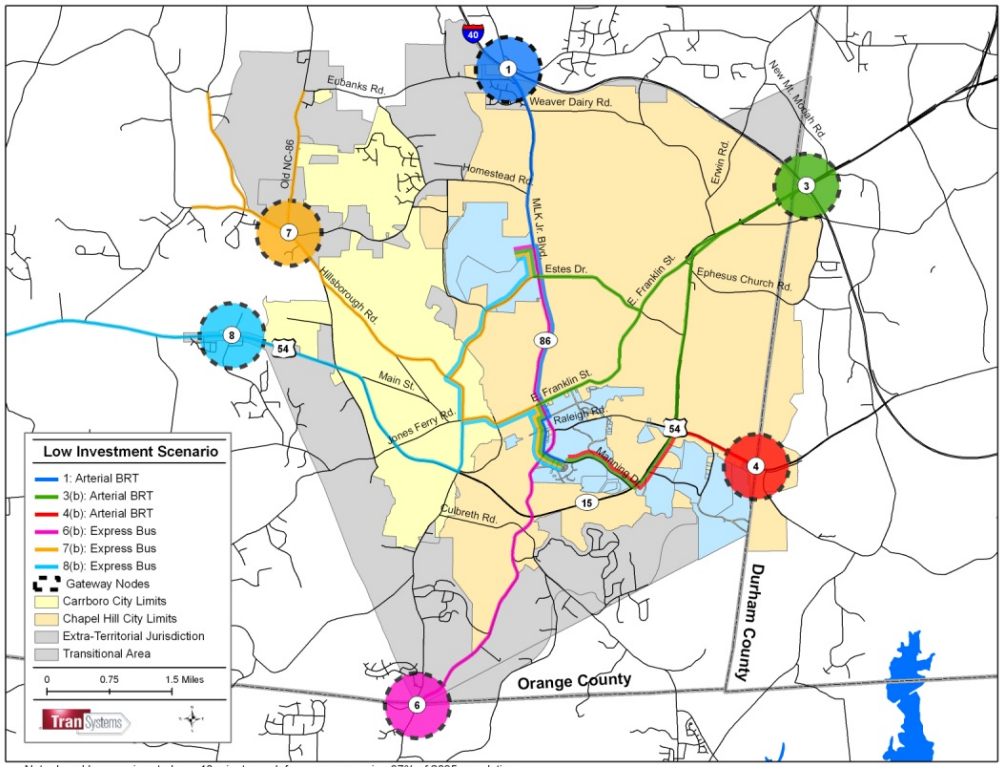


Figure 5-2: Low Investment Scenario



5.2 Model Runs[10]

This section documents the procedures, input assumptions, and model results used to examine the impacts of two alternative transit investment scenarios on regional travel behavior in the Chapel Hill-Carrboro study area. In conducting the analysis, the most recent version available of the TRM was used. The TRM was developed and maintained by the Institute for Transportation Research and Education (ITRE) as the official travel demand forecasting model (pending adoption) for both the Capital Area and the Durham-Chapel Hill-Carrboro metropolitan planning organizations (MPO). The model was described in detail in Section 2 of this report.

5.2.1 Base Network Configuration

The TRM was first run against a base "no-build" regional transportation network and sociodemographic forecasts of population and employment for the year 2035. This represents the planning horizon year for Durham-Chapel Hill-Carrboro MPO (DCHC MPO), and both the sociodemographic forecasts and network were already developed by ITRE for use in the TRM.

The 2035 transportation network provided with the TRM included all existing plus committed (E+C) highway and transit improvements found in the DCHC MPO's current transportation improvement program (TIP), as well as major transportation projects included in the constrained long-range transportation plan. One such long-range project that could potentially impact the findings from this study is the proposed Triangle Transit Authority (TTA) regional rail service between Durham and Chapel Hill. This proposed rail service competes directly with at least one BRT route (Gateway 5) between I-40 and downtown Chapel Hill.

The 2035 TRM transportation network was modified to eliminate the proposed TTA rail service between Durham and Chapel Hill, as well as any bus route that did not originate *and* end within the Chapel Hill-Carrboro study area. In addition, routes that generally duplicated the gateway services were either eliminated or modified as well as services that originated outside of the study area and ended in Chapel Hill-Carrboro.[11] These later routes consisted mainly of TTA regional bus services.

Other transportation projects included in the base network represent highway improvements (e.g., road widening, interchange reconfigurations, sidewalk, and bikeway construction). While these projects may impact overall traffic flow in the region, they do not directly favor one transit investment scenario over another, or over the base no-build configuration.

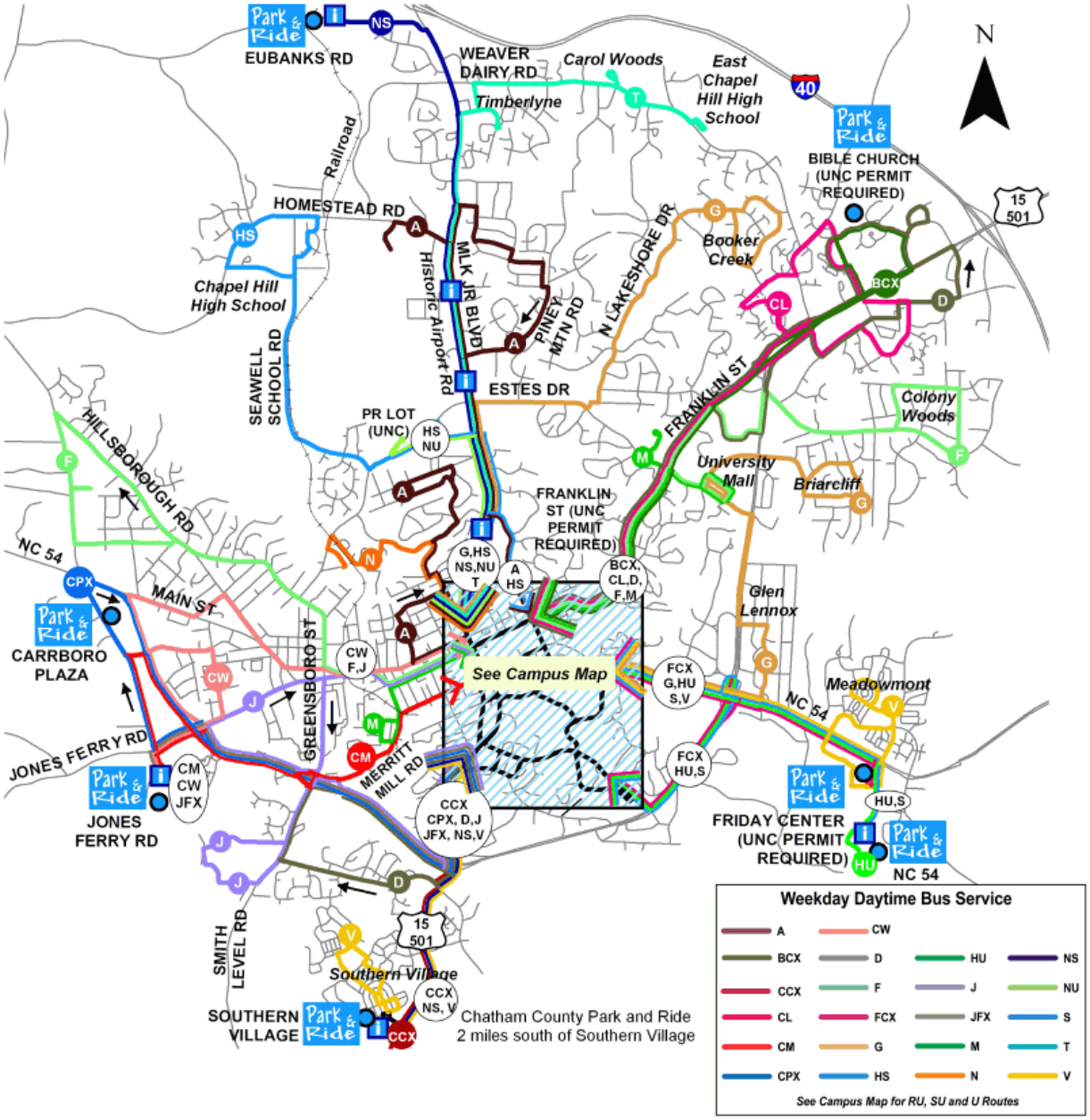
5.2.2 Transit Investment Scenarios

As described above, two alternative transit investment scenarios were tested. Both scenarios included service level improvements to selected existing local and express bus routes, reconfiguration of certain local bus routes to serve as feeder routes to new express bus and BRT routes, and creation of new, high-level service BRT routes connecting outlying park-and-ride facilities (i.e., "gateways") within downtown Chapel Hill and the proposed high density mixed-unit development known as Carolina North. Figure 5-3 shows the current local and express bus routes serving the Chapel Hill-Carrboro study area, differentiating routes by transit operator.

[10] This section was largely prepared by Cambridge Systematics of the TranSystems Team.

[11] Routes HUX and NUX while overlapping to some degree the gateway services were retained as they served the UNC hospital market. As targeted services with a narrowly defined purpose, they were retained to supplement their respective gateway services.

Figure 5-3: Current Chapel Hill Transit Service



Source: Chapel Hill Transit (Fall 2006)

The principal difference between the low investment transit scenario (identified hereafter as "Low Investment") and the high transit investment scenario (identified hereafter as "High Investment"), is that the High Investment scenario includes a high speed BRT service (gateway 5), operating on a physically separated right-of-way, which connects the P&R facility at the I-40/US 5-US 501 interchange with downtown Chapel Hill, along an alignment that roughly follows the railroad right-of-way proposed for the TTA Durham to Chapel Hill rail service. The High Investment scenario also had Gateway 1 operating in an exclusive, grade separated busway. The Low Investment scenario does not include gateway 5; instead, it includes an express bus route (Gateway 4), beginning at NC 54 near the Durham-Orange County line, and terminating near downtown Chapel Hill on the University of North Carolina (UNC) campus. The transit service changes for both the High Investment and Low Investment scenarios were illustrated earlier in Figure 5-1 and Figure 5-2, respectively. Table 5-1 lists the changes made to current CHT routes under both the Low Investment and High Investment scenarios. Figure 5-4 shows the CHT routes included model run. It will be noted in the Figure that two CHT routes (one north of I-40 and Eubanks) and south toward Jordan Lake go outside the city. Both are designated as "local routes" were included as part of the underlying network because they could potentially feed the gateway nodes.

5.2.3 Forecasting Methodology

Three separate model runs were conducted, for the Base No-Build, Low Investment, and High Investment scenarios, using the TRM and 2035 forecasts of population and employment distribution. The difference between these three model runs was in the configuration and headways of the transit network, as described above.

Each model run included all four submodels – trip generation, destination choice, mode choice, and traffic assignment, using default closure criteria for the number of iterations in the user-equilibrium traffic assignment model. A feedback loop took the final network travel times from the assignment submodel and used them to revise the zone-to-zone impedances in the destination choice model, thereby making trip length and destination choice somewhat sensitive to congested travel times. Each model run was recycled through five feedback iterations.

In examining the TRM, we found that the formula used for computing destination choice impedances did not include any variable for out-of-pocket cost. Consequently, the current model is not able to account for the effects of a major parking cost increase on the diversion of trips from zones with high parking costs to alternative zones with lower or no parking costs. In order to investigate this potential policy, the destination choice model would need to be revised and recalibrated. Later in this section, the potential impact of restrictive parking policies is estimated using an off-model technique.

The TRM mode choice submodel outputs zone-to-zone trip tables for total auto trips and (linked[12]) transit trips by two time periods (peak and off-peak) in production/attraction (P/A) format. P/A format means that for all home-based trip purposes, the "from" location is always the residence zone, while the "to" location is always the zone where the non-home activity takes place. In other words, a simple home-based work trip (from home to work and then back to home) expressed in P/A format will appear as two trip productions at the home zone and two trip attractions at the workplace zone. For non-home-based trips, the "from" location is always the origin zone, while the "to" location is always the destination zone.

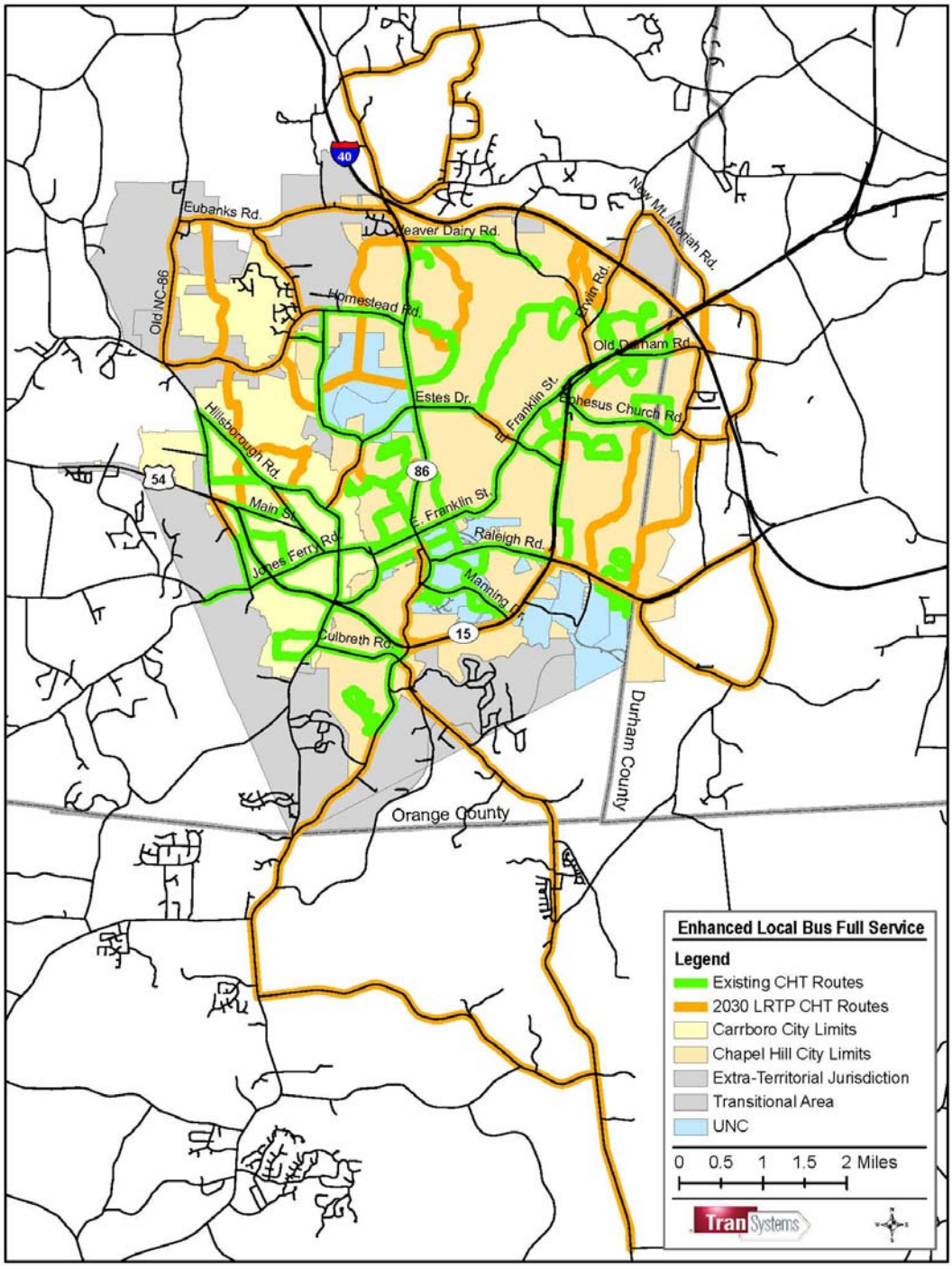
[12]A "linked" transit trip refers to a trip made for a specific purpose (e.g., home-based work) from production zone to attraction zone, based on the primary mode taken. "Unlinked" trips count each change of mode (e.g., a transfer from one bus to another or from auto to bus) as a separate trip segment. Consequently, one linked transit trip may consist to two or more unlinked trip segments.

Table 5-1: Chapel Hill Transit Service Changes and Assumptions

Route Name	Route Change	Peak Headways (min)			Off-Peak Headways (min)		
		Base	Low	High	Base	Low	High
Gateway Services							
BRT 1 I40-Rosemary-UNC	*New Service*		4.0	4.0		10.0	10.0
BRT 3A I40 to UNC via US 15	*New Service*		10.0	10.0		20.0	20.0
BRT 3B I40-Elizabeth-UNC	*New Service*		10.0	10.0		20.0	20.0
BRT 3C I40 to Carolina N	*New Service*		5.0	5.0		10.0	10.0
BRT 4	*New Service*		3.0			10.0	
BRT 5 I40 to UNC	*New Service*			3.0			10.0
BRT 6	*New Service*		3.0	3.0		20.0	20.0
BRT 7 Carolina North	*New Service*		3.0	3.0		20.0	20.0
BRT 7 UNC	*New Service*		3.0	3.0		20.0	20.0
BRT 8 Carolina North	*New Service*		3.0	3.0		20.0	20.0
BRT 8 UNC	*New Service*		3.0	3.0		20.0	20.0
Local Services							
CHT A :Weiner-MLKBlvd		16.5	10.0	10.0	43.9	20.0	20.0
CHT Base 1 Carr N			10.0	10.0		20.0	20.0
CHT Base 3 Estes-Carrboro			10.0	10.0		20.0	20.0
CHT Base 4 Laurel Hills			10.0	10.0		20.0	20.0
CHT Base 8 UNC Exp			10.0	10.0		20.0	20.0
CHT Carr 1A Feeder			10.0	10.0		20.0	20.0
CHT Carr 1B Feeder			10.0	10.0		20.0	20.0
CHT CARR 2 Feeder			10.0	10.0		20.0	20.0
CHT CH MODY			10.0	10.0		20.0	20.0
CHT CL :WaldenGrnflds-UNCHosp		60.0	10.0	10.0		20.0	20.0
CHT CM :FamPrac-JonesFerry		46.3	10.0	10.0	49.3	20.0	20.0
CHT CW :Pittsboro-JonesFerry		15.0	10.0	10.0	44.5	20.0	20.0
CHT D :Providence-SmithLevel	*Extend on northeast end to cover existing route and stops.*	20.0	10.0	10.0	32.7	20.0	20.0
CHT Eubanks Station 1A Feeder			10.0	10.0		20.0	20.0
CHT Eubanks Station 1B Feeder			10.0	10.0		20.0	20.0
CHT F :ColonyWoods-McDougle			10.0	10.0		20.0	20.0
CHT G :Briarcliff-BookerCreek			10.0	10.0		20.0	20.0
CHT Gateway Feeder 1	*Extend to connect to Gateway 3*		10.0	10.0		20.0	20.0
CHT Gateway Feeder 2	*Extend to connect to Gateway 3*		10.0	10.0		20.0	20.0
CHT Gateway Feeder 3	*Extend to connect to Gateway 3*		10.0	10.0		20.0	20.0
CHT HS :VarsityTheater-Hghsch		30.0	10.0	10.0	-	20.0	20.0
CHT HUX :UNCHosp-HedrickBldg		10.0	10.0	10.0	28.8	20.0	20.0
CHT HW 1A Feeder			10.0	10.0		20.0	20.0
CHT HW 1B Feeder			10.0	10.0		20.0	20.0
CHT HW 2A Feeder			10.0	10.0		20.0	20.0
CHT HW 2B Feeder			10.0	10.0		20.0	20.0
CHT HW 3A Feeder			10.0	10.0		20.0	20.0
CHT HW 3B Feeder			10.0	10.0		20.0	20.0
CHT J :SGreensboro-RockCrkApt	*Extend on southwest end to cover existing route and stops.*	15.0	10.0	10.0	20.0	20.0	20.0
CHT Meadowmont Feeder			10.0	10.0		20.0	20.0
CHT MOD 1			10.0	10.0		20.0	20.0
CHT MOD 10 XPS			10.0	10.0		20.0	20.0
CHT MOD 21			10.0	10.0		20.0	20.0
CHT MOD 8 -1			10.0	10.0		20.0	20.0
CHT MOD 8 -2			10.0	10.0		20.0	20.0
CHT MODV			10.0	10.0		20.0	20.0
CHT N :EstsParkApt-FamilyPract		23.6	10.0	10.0	44.4	20.0	20.0
CHT NUX :UNCHosp-PR Lot		20.0	10.0	10.0	40.0	20.0	20.0
CHT RU :Columbia-FamilyPract		15.0	10.0	10.0	15.0	20.0	20.0
CHT S :UNCHosp-HedricBldg		11.5	10.0	10.0	15.7	20.0	20.0
CHT SU		20.0	20.0	20.0	20.0	20.0	20.0
CHT T :UNCHosp-ECHHghSch		32.0	10.0	10.0	38.7	20.0	20.0
CHT U :BowlesDr-FranklinSt		15.0	10.0	10.0	15.0	20.0	20.0
CHT V :Meadowmont-SVillage	*Extend on south end and east end to cover existing route and stops.*	37.0	10.0	10.0	57.1	20.0	20.0
Other Services							
CHT Base 11 S Orange	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT Base 13 Hills. Exp	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT Base 2 New Hope Commons	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT Base 9 Mason Farm Exp	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT CPX IB:UNC-CarborroP&R	*Eliminate Route*	15.0	10.0	10.0		20.0	20.0
CHT EW Crosstown	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT FCX IB:Pittsboro-FridayCntr	*Eliminate Route*	8.0	10.0	10.0		20.0	20.0
CHT JFX IB:Pittsboro-JonesFerry	*Eliminate Route*	15.0	10.0	10.0		20.0	20.0
CHT M:UnivMall-CrestCole	*Eliminate Route*	-	10.0	10.0	45.0	20.0	20.0
CHT MOD 20 Pitt. Exp	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT MOD 22 Exp	*Eliminate Route*		10.0	10.0		20.0	20.0
CHT NS IB:SVillage-Eubanks	*Eliminate Route*	15	10.0	10.0	35.5	20.0	20.0
TTA Rail: Dur-CH	*Eliminate Fixed Guideway*		10.0	10.0		20.0	20.0

Source: TranSystems

Figure 5-4: Enhanced Local Bus Full Service



Trip tables in P/A format must be converted to origin/destination (O/D) format in order to compute the directionality of travel for traffic assignment. If this is not done, then the return home portion of a simple home-based work trip will appear to begin at home and end at work, thereby overestimating the traffic flow in one direction and underestimating it in the other direction. Correct conversion of trip tables from P/A to O/D format must be done separately for each trip purpose to reflect differences in the percentage of trips that are simple round trips versus multi-stop trip chains.

The TRM converts auto trip tables from P/A format to O/D format prior to the traffic assignment submodel, but leaves transit trips in P/A format, even when they are assigned to specific transit routes. Inbound versus outbound directions on a transit route therefore show substantial differences in ridership, even though one would expect that inbound transit trips during the morning peak would become outbound trips during the afternoon peak. Consequently, while total daily transit ridership by route can be calculated with a reasonable measure of confidence, the directional split by route and time period is, at best, a rough indication of the directional bias for the morning peak period.

5.2.4 Forecast Results and Comparisons between Scenarios

The TRM results include system-wide summaries of total auto and (linked) transit trips, as well as vehicle volumes by highway segment and transit ridership by route. Both system-wide summaries and volumes by segment and/or route are further categorized by at least three time periods – peak, off-peak, and total daily. The TRM defines a four-hour morning peak between 6:00 a.m. to 10:00 a.m. and a four-hour afternoon peak between 3:30 p.m. to 7:30 p.m. Off-peak represents all other time periods during the day.

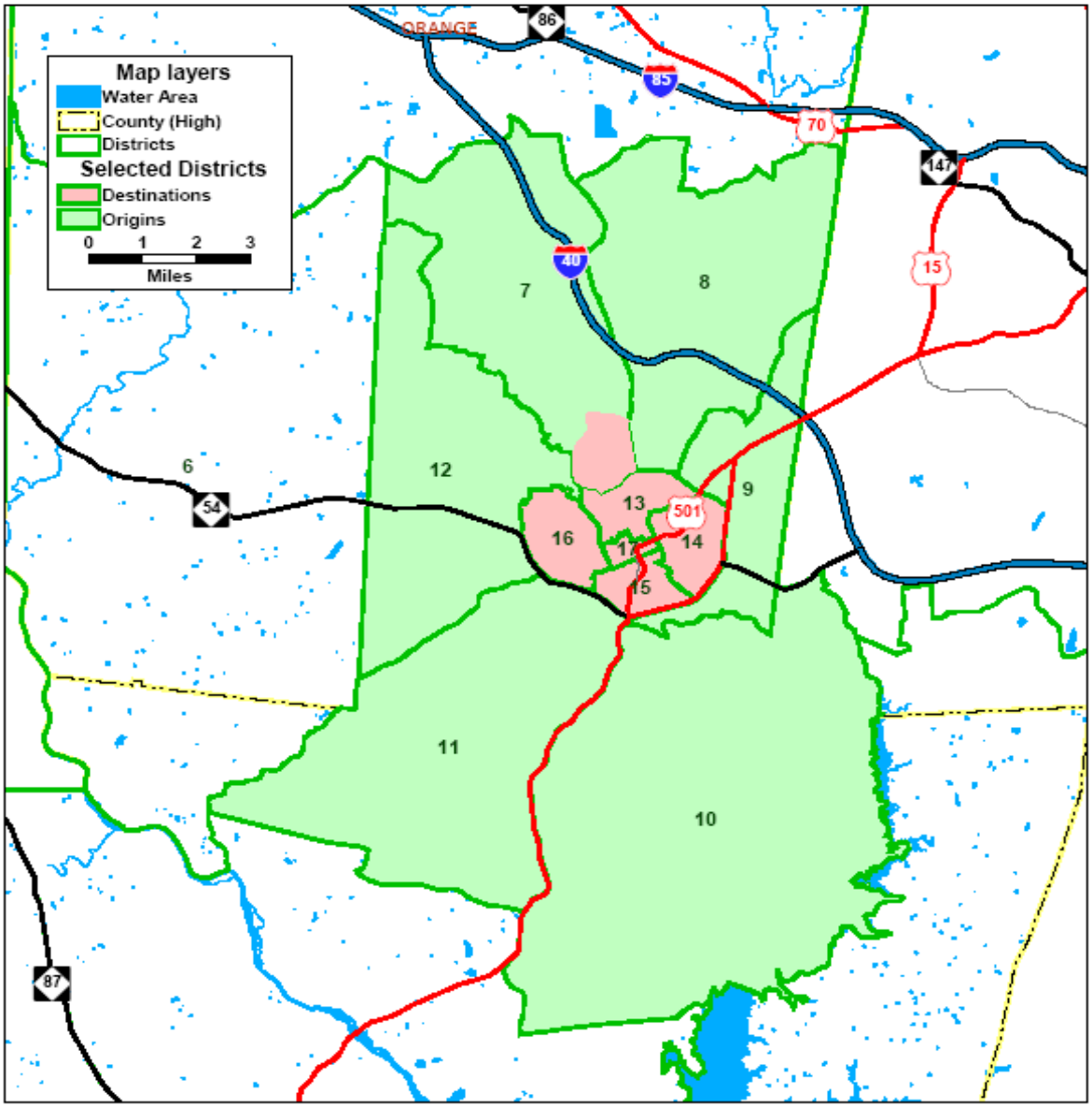
The TRM produces travel forecasts for the entire Triangle Region, which includes all of the CAMPO and DCHC MPO MPOs, plus some additional areas beyond the planning area boundaries. However, for the purpose of this study, we want to focus on that portion of the study area around the towns of Chapel Hill and Carrboro that would be directly impacted by the proposed transit investments. Consequently, we defined the study area for reporting system-wide summaries including all trips attracted to districts 13 to 17 (representing downtown Chapel Hill, Carrboro, and the UNC campus), plus traffic analysis zone (TAZ) 2023 (representing the Carolina North development), regardless of where they came from. Likewise, we included all trips produced in districts seven to 17 (roughly the southeastern quadrant of Orange County), regardless of where they went to. Figure 5-5 shows the study area for reporting system-wide summaries.

System-wide Impacts

Table 5-2 presents the study area summaries for total transit trips, total auto trips, and transit mode share under the base no-build and each transit investment scenario. Separate sub tables are presented for all trips attracted to the specified destination zones (the pink area in Figure 5-5), for all trips produced throughout the study area (the green and pink areas in Figure 5-5), and for the combination of all trips produced in and/or attracted to the study area. Separate totals are presented by peak, off-peak, and total daily transit trips and transit mode share. Auto trips are further divided into morning and afternoon peak trip totals.

Under the Low Investment scenario, total daily transit ridership within the study area increases by over 31 percent, from 42,700 to over 55,800 riders per day. Daily transit mode share also increases, from 5.3 percent in the base scenario to 7.0 percent under Low Investment scenario. Total daily auto person trips show a corresponding decrease, going from 761,300 trips in the base scenario to about 743,600 in the Low Investment scenario. The total increase in daily transit trips does not quite offset the total decrease in daily auto trips, resulting in a small decrease in total daily trips of about 0.6 percent within the study area.

Figure 5-5: Study Area for Reporting System wide Summary Results



Source: Cambridge Systematics

Table 5-2: System wide Summary for Chapel Hill/Carrboro Study Area

Systemwide Transit Trips				Systemwide Auto Trips					Systemwide Transit Share			
[Trips Attracted to Districts 13-17 & TAZ 2023]				[Trips Attracted to Districts 13-17 & TAZ 2023]					[Trips Attracted to Districts 13-17 & TAZ 2023]			
	Peak	Off-peak	Daily		AM Peak	Off-Peak	PM Peak	Daily		Peak	Off-peak	Daily
Base no-build	20,757	14,695	35,452	Base no-build	83,398	169,494	87,079	339,971	Base no-build	10.9%	8.0%	9.4%
Low investment	26,038	18,373	44,411	Low investment	80,934	165,588	85,122	331,644	Low investment	13.6%	10.0%	11.8%
High investment	26,134	18,620	44,754	High investment	81,945	165,796	85,215	332,956	High investment	13.5%	10.1%	11.8%
[Trips Produced in Districts 7-17]				[Trips Produced in Districts 7-17]					[Trips Produced in Districts 7-17]			
	Peak	Off-peak	Daily		AM Peak	Off-Peak	PM Peak	Daily		Peak	Off-peak	Daily
Base no-build	18,242	15,019	33,261	Base no-build	120,749	301,225	192,787	614,761	Base no-build	5.5%	4.7%	5.1%
Low investment	22,494	19,121	41,615	Low investment	118,432	296,961	190,112	605,505	Low investment	6.8%	6.0%	6.4%
High investment	22,607	19,392	41,999	High investment	118,404	297,095	190,133	605,632	High investment	6.8%	6.1%	6.5%
[Combined Trip Productions and Attractions]				[Combined Trip Productions and Attractions]					[Combined Trip Productions and Attractions]			
	Peak	Off-peak	Daily		AM Peak	Off-Peak	PM Peak	Daily		Peak	Off-peak	Daily
Base no-build	24,738	17,963	42,701	Base no-build	155,918	372,163	233,213	761,294	Base no-build	6.0%	4.6%	5.3%
Low investment	32,127	23,678	55,805	Low investment	152,009	363,601	228,003	743,613	Low investment	7.8%	6.1%	7.0%
High investment	32,305	23,997	56,302	High investment	152,930	363,494	227,888	744,312	High investment	7.8%	6.2%	7.0%

Source: Cambridge Systematics

Under the High Investment scenario, total daily transit ridership within the study area increases by nearly 32 percent, from 42,700 to 56,300 riders per day. Daily transit mode share also increases, from 5.3 percent in the base scenario to 7 percent under High Investment scenario. Total daily auto person trips show a corresponding decrease, going from 761,300 trips in the base scenario to about 744,300 in the High Investment scenario. As with the Low Investment scenario, the total increase in daily transit trips does not quite offset the total decrease in daily auto trips, resulting in a small decrease in total daily trips of about 0.4 percent within the study area.

The majority of the increase in transit trips under both the Low and High Investment scenarios can be attributed to trips attracted to the Chapel Hill CBD, the UNC campus, and the Carolina North development. Daily transit mode share for trips going to these areas rises from 9.4 percent in the base scenario to 11.8 percent for both the Low and High Investment scenarios. Peak period transit mode share to these areas is even higher – 13.6 and 13.5 percent under the two investment scenarios, compared to 10.9 percent in the base scenario.

Figure 5-6 compares the level of AM peak traffic congestion under the no build scenario against the High Investment scenario. Traffic congestion is measured in terms of highway volume-to-capacity (V/C) ratio. At a V/C ratio of less than 0.6, traffic is operating at free flow speeds. As the V/C ratio approaches 1.0, speeds begin to decrease rapidly, traffic flow becomes unstable, and any traffic incident (e.g., a vehicle breakdown or minor crash) can cause traffic flows to break down into stop-and-go patterns. At V/C ratios above 1.2, traffic volumes exceed the capacity of the roadway link, traffic flow is highly unstable, and stop-and-go traffic becomes the norm rather than the exception.

Neither the Low nor High Investment scenarios have a significant impact on peak hour traffic congestion in the Chapel Hill-Carrboro study area. At best (under the Low Investment scenario) peak period auto trips within the study area are reduced by only 4,400 vehicles, or less than 3 percent of total peak hour traffic volumes. Some small improvements in peak period traffic flow seem to occur along US 15-501 near I-40, and along the US 15-501 bypass southeast of the UNC Campus. However, traffic congestion near downtown Chapel Hill remains largely unaffected by the transit improvements alone.

5.2.5 Route Level Impacts

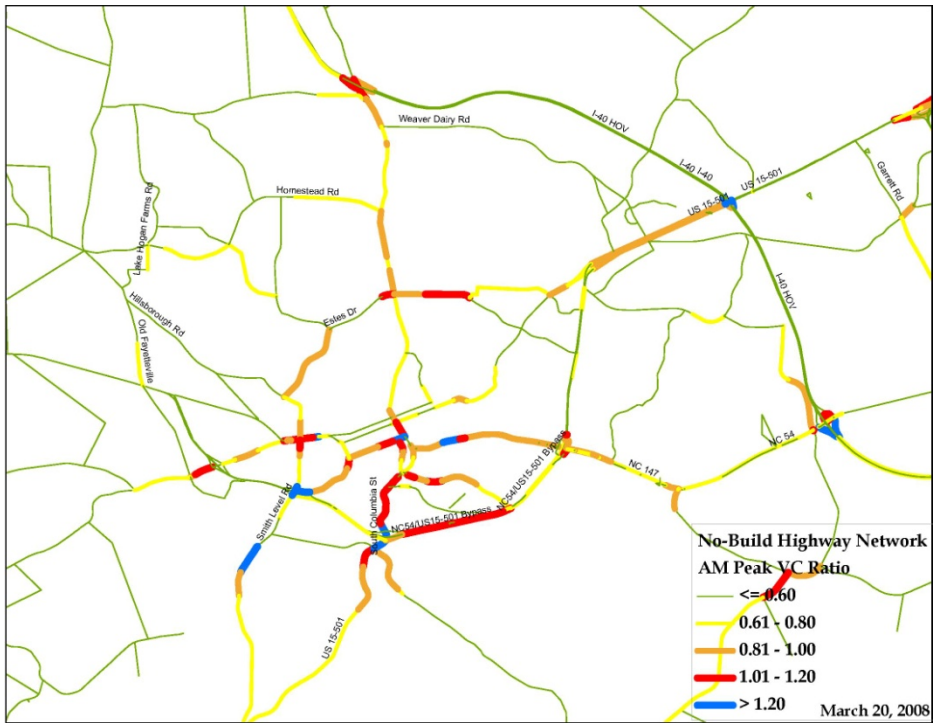
Table 5-3 summarizes the transit boardings (peak, off-peak, and total daily) by route for: 1) gateway services for low and high investment scenarios; 2) local routes to be operated in conjunction with gateway routes; and (3) compares these with base condition services.

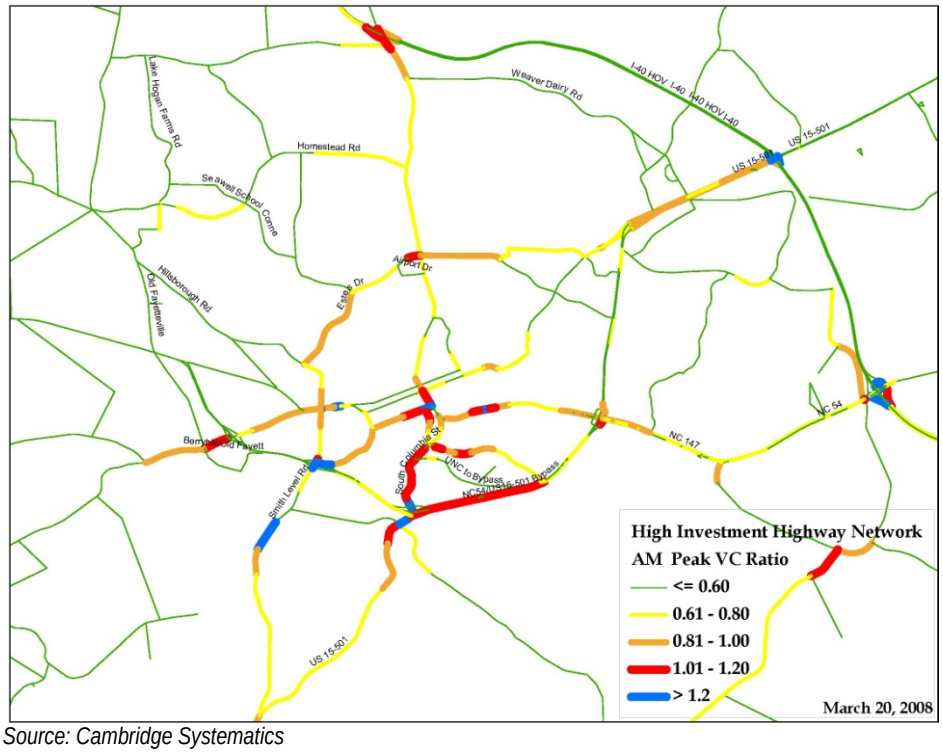
Total daily transit boardings on all transit routes serving the study area increase from about 37,600 in the base scenario to 56,290 under the Low Investment scenario and to 57,556 under the High Investment scenario.[13] These correspond to percentage increases of 49.8 percent and 53.2 percent, respectively.

The proposed BRT routes attract between 13,100 and 13,550 daily transit riders (9,300 to 9,500 peak riders). The ridership attracted to the new BRT service augmented with increases in ridership on the revised CHT routes (increasing from 37,600 daily boardings in the base scenario to about 43,200 under the Low Investment and around 44,000 under the High Investment scenario).

[13]Total boardings, as reported in this section, are higher than the total study area transit ridership reported in the previous section in Table 5-2. This difference is primarily because system-wide ridership is reported as "linked" transit trips, while boardings are reported as "unlinked" transit trips.

Figure 5-6: AM Peak Traffic Congestion under No Build and Low Investment Scenarios





Source: Cambridge Systematics

Table 5-3: Projected 2035 Transit Boardings by Route

Route Name	Peak Ridership			Off-Peak Ridership			Daily Ridership		
	Base	Low	High	Base	Low	High	Base	Low	High
BRT 1 I40-Rosemary-UNC		1,868	1,879		976	986		2,844	2,864
BRT 3A I40 to UNC via US 15		1,313	1,307		275	320		1,588	1,627
BRT 3B I40-Elizabeth-UNC		633	643		271	249		904	891
BRT 3C I40 to Carolina N		1,375	1,365		675	681		2,050	2,046
BRT 4		1,315			640			1,955	
BRT 5 I40 to UNC			1,808			862			2,670
BRT 6		1,477	1,189		269	261		1,747	1,450
BRT 7 Carolina North		358	363		59	55		417	417
BRT 7 UNC		173	176		129	133		302	309
BRT 8 Carolina North		463	459		227	217		690	676
BRT 8 UNC		341	334		268	271		609	605
Total Gateway Routes		**9,316**	**9,522**		**3,790**	**4,034**		**13,106**	**13,556**
CHT A :Weiner-MLKBlvd	2,299	2,227	2,270	1,252	1,956	2,041	3,551	4,183	4,311
CHT Base 1 Carr N		979	1,067		957	968		1,936	2,036
CHT Base 3 Estes-Carrboro		545	543		568	569		1,113	1,113
CHT Base 4 Laurel Hills		293	340		360	427		652	766
CHT Base 8 UNC Exp		399	410		322	334		721	743
CHT Carr 1A Feeder		47	48		47	48		95	95
CHT Carr 1B Feeder		48	44		56	56		104	101
CHT CARR 2 Feeder		53	53		32	32		85	85
CHT CH MODY		144	228		302	437		446	666
CHT CL :WaldenGrnflds-UNCHosp	443	967	979	-	1,103	1,121	443	2,070	2,100
CHT CM :FamPrac-JonesFerry	234	611	609	576	596	627	809	1,207	1,236
CHT CW :Pittsboro-JonesFerry	497	439	442	462	619	624	959	1,058	1,066
CHT D :Providence-SmithLevel	2,007	2,053	1,975	1,653	1,739	1,632	3,660	3,792	3,607
CHT Eubanks Station 1A Feeder		77	77		65	64		142	141
CHT Eubanks Station 1B Feeder		86	86		75	75		161	161
CHT F :ColonyWoods-McDougle	811	781	781	866	829	839	1,677	1,610	1,619
CHT G :Briarcliff-BookerCreek	1,050	1,230	1,111	948	1,223	1,090	1,998	2,453	2,201
CHT Gateway Feeder 1		6	10		10	11		16	21
CHT Gateway Feeder 2		162	182		199	222		361	404
CHT Gateway Feeder 3		85	103		96	115		180	218
CHT HS :VarsityTheater-Hghsch	304	190	190	-	113	115	304	302	305
CHT HUX :UNCHosp-HedrickBldg	1,157	457	141	74	18	5	1,231	475	147
CHT HW 1A Feeder		87	88		73	73		160	161
CHT HW 1B Feeder		67	67		117	116		184	183
CHT HW 2A Feeder		50	50		40	40		90	90
CHT HW 2B Feeder		61	61		86	85		146	146
CHT HW 3A Feeder		86	87		92	93		178	179
CHT HW 3B Feeder		319	313		232	232		551	545
CHT J :SGreensboro-RockCrkApt	1,449	699	697	1,601	693	700	3,050	1,391	1,397
CHT Meadowmont Feeder		56	100		59	112		115	211
CHT MOD 1		572	639		655	757		1,227	1,396
CHT MOD 10 XPS		155	146		54	47		209	193
CHT MOD 21		1,005	1,008		1,077	1,083		2,082	2,091
CHT MOD 8 -1		230	232		487	488		717	720
CHT MOD 8 -2		751	1,021		166	168		916	1,189
CHT MODV		1,110	1,113		829	832		1,939	1,944
CHT N :EstsParkApt-FamilyPract	464	436	534	676	637	772	1,140	1,073	1,306
CHT NUX :UNCHosp-PR Lot	384	168	218	474	140	171	858	308	389
CHT RU :Columbia-FamilyPract	571	297	221	946	366	308	1,517	664	529
CHT S :UNCHosp-HedricBldg	1,001	888	768	1,222	565	482	2,224	1,452	1,250
CHT SU	425	394	434	351	626	665	776	1,020	1,099
CHT T :UNCHosp-ECHHghSch	1,340	1,341	1,396	1,490	1,460	1,419	2,830	2,801	2,815
CHT U :BowlesDr-FranklinSt	855	459	556	1,862	598	736	2,717	1,057	1,293
CHT V :Meadowmont-SVillage	653	1,017	1,041	331	724	695	984	1,741	1,736
Total Local Routes	**15,945**	**22,125**	**22,475**	**14,784**	**21,058**	**21,526**	**30,730**	**43,184**	**44,001**
CHT CPX :UNC-CarborroP&R	399			-			399		
CHT FCX :Pittsboro-FridayCntr	736			-			736		
CHT JFX :Pittsboro-JonesFerry	433			-			433		
CHT NS :SVillage-Eubanks	3,397			1,882			5,279		
Total Other Routes	**4,965**			**1,882**			**6,847**		
Total Chapel Hill Boardings	**20,911**	**31,441**	**31,997**	**16,666**	**24,848**	**25,560**	**37,577**	**56,290**	**57,556**

Sources: Data by Cambridge Systematics as compiled by TranSystems

5.3 Off-Model Ridership Forecasting

It was recognized as part of this study that even with exceptional transit service within the Chapel Hill/Carrboro community, other policies would be needed to truly make transit a preferred mode of choice for residents, employees and visitors. Policies such as land use patterns that encourage more dense development and the use of bicycles and walking are discussed later in Section 7 of this study. Other policies include controlling the availability of parking on the UNC main campus, Carolina North, and the downtowns of Chapel Hill and Carrboro. Consequently, the parking policy was subjected to off-model techniques. These embellishments addressed parking policy impacts which also included the shifting of travel patterns associated with some of the gateway nodes.

5.3.1 Transit Supportive Parking Policies

The version of the TRM) used in this study had limitations in modeling the impact of changing parking policies. In essence, modeling restrictive parking policies requires increasing the price of parking assumed in the model. Truly restrictive policies are beyond the TRM's ability to reliably predict. For this reason, restrictive policies were not modeled and do not appear in the discussion in section 5.2 nor in Figure 5-6. The TRM does not account for out-of-pocket costs in the destination choice model. As a result, the model will tend to overestimate the mode shift from auto to transit resulting from parking cost increases, but will not account for the likely decrease in total trips going to the affected downtown zones. The trips that are most likely to be diverted from the zones with the high parking costs would be discretionary trips (i.e., shopping, personal business), because trip makers would be able to satisfy their needs at other locations without having to pay the parking fees. In order to address this problem, the TRM would have to be revised to include out-of-pocket costs in the destination choice model. This is certainly doable, but was beyond the scope of this study.

A second issue in using the TRM for evaluating changes in parking policies is that the proposed restrictive parking cost increases are well beyond the range of trip maker experiences used to calibrate the TRM. Travel models are typically calibrated using observations of travel behavior obtained from local household travel surveys. These surveys reflect local existing conditions and traveler experiences. In the case of the Triangle Region, local conditions include relatively low area wide parking costs and relatively low traffic congestion, compared to places like New York City or Washington, D.C. where high parking charges are more common. The problem is that when the model is applied well outside the range of experience on which it was calibrated, we cannot be confident that the model parameters will hold. For example, if the model predicts a -0.15 cost elasticity, it assumes that elasticity will remain constant regardless of the price increase. In fact, at significantly higher prices, the elasticity may indeed change — people could become more sensitive to higher costs or less sensitive, we just don't know.

Given these limitations, an off model approach was used to provide an estimate as the potential ridership impact of implementing Draconian parking policies. Below describes the process used to reallocate auto trips to transit based on limited availability of parking on the main campus. The same basic methodology was used to analyze restrictive parking at Carolina North.

Two basic methodologies were used. The first was a "proportional" method that established a ratio between auto trips and available parking. The second utilized an elasticity factor.

Proportional Method
TAZs in the main campus area were identified and included: 1946, 1959-1960, 1962-1967, 1969, 1973-1974, 2045 and 2056. Auto and transit trips to these TAZs were compiled for the 2005, 2035 No Build, 2035 Low Investment and 2035 High Investment scenarios. The trips include both peak and off-peak trips. (See Table 5-4)

Table 5-4: Trips Attracted to UNC Main Campus Area

Trips Attracted to UNC Area*

2005

	AM	PM	Peak	Offpeak	DAILY
Transit			8,037	5,079	13,116
Auto	22,845	20,367	43,212	43,239	86,451
Auto Share			84.3%	89.5%	86.8%
Transit Share			15.7%	10.5%	13.2%

No-Build

	AM	PM	Peak	Offpeak	DAILY
Transit			16,833	11,410	28,243
Auto	53,315	34,833	88,148	86,685	174,833
Auto Share			84.0%	88.4%	86.1%
Transit Share			16.0%	11.6%	13.9%

Low Investment

	AM	PM	Peak	Offpeak	DAILY
Transit			19,044	13,369	32,413
Auto	51,811	34,216	86,027	84,930	170,957
Auto Share			81.9%	86.4%	84.1%
Transit Share			18.1%	13.6%	15.9%

High Investment

	AM	PM	Peak	Offpeak	DAILY
Transit			19,129	13,611	32,740
Auto	51,826	34,332	86,158	85,161	171,319
Auto Share			81.8%	86.2%	84.0%
Transit Share			18.2%	13.8%	16.0%

*Includes TAZs 1946, 1959-1960, 1962-1967, 1969, 1973-1974, 2045 and 2056

Next, the current and future number of parking spaces was identified. There were 13,500 parking spaces in 2007 and are 19,000 spaces projected for 2035. A ratio was calculated that compares the current number of spaces with the 2005 daily auto trips that are accommodated by the existing number of parking spaces. This calculation is:

86,451 auto trips / 13,500 parking spaces = 6.4038

That ratio was then applied to the future number of spaces to determine how many daily auto trips would be accommodated in the future.

The future number of auto trips for each of the 2035 scenarios was compared to the number of daily auto trips that would be accommodated with the future number of parking spaces. The difference was calculated. Since these trips would not be able to drive to campus, these trips were reassigned to other modes including park-and-ride (or Gateway services), local bus or other. Of these trips, it was assumed that 75 percent would use transit and 25 percent would get to campus by some other means. Of the 75 percent that use transit, 75 percent would use the park-and-ride and 25 percent would use local buses[14]. The results are shown in Table 5-5.

[14] UNC Commuter surveys show a different proportion of travel modes to the campus. Some of those other modes include vanpool and carpool travel. The town of Chapel Hill advised that since parking would likely not accommodate van or carpooling that the trips unable to be accommodated on campus would all be transferred to transit with 75 percent to gateway or park and ride services and the balance to local bus.

Table 5-5: Impact of Parking Deficit on Transit Trips

53,161	DAILY trips not accomodated in No-Build
29,903	park and ride
9,968	bus
13,290	other
49,285	DAILY trips not accomodated in Low Investment
27,723	park and ride
9,241	bus
12,321	other
49,647	DAILY trips not accomodated in High Investment
27,927	park and ride
9,309	bus
12,412	other

Park-and-ride trips were then broken out further based on where they enter the community. Auto trips from the model were used to determine the proportion of transit trips that should be assigned to each Gateway. The transit trips were then calculated based on the proportions.

The trips reassigned from auto to transit were then added to the original transit trips produced by the model. See Table 5-6. The table shows "original" ridership by gateway resulting from TRM model runs. "Allocation of parking" is the estimate of transit ridership due to the projected deficit in parking at the main campus of UNC.

A similar analysis for the new Carolina North development was conducted. Using the same auto to parking ratio established above shows that the projected parking at Carolina North would not accommodate all future auto trips. In addition, it was reasoned by the town of Chapel Hill that travelers destined to Carolina North would most likely not use Gateway 4. Rather they would use Gateways 1 and 3. Table 5-7 shows the results of the Carolina North analysis with and without reallocating Gateway 4 ridership.

Elasticity Method

Another approach used was based on elasticity relating parking cost with parking demand. According to Cambridge Systematics of the TranSystems' Team, the standard elasticity is for every 100 percent increase in parking fees, auto trips change by 25 to 33 percent. Based on the model inputs in the regional travel demand model for the Durham-Chapel Hill-Carrboro area, UNC main campus area parking costs are $6 per day. In order to simulate "Draconian" parking policies[15], a 200 percent increase of that rate to $18 per day was modeled. Understanding that the established elasticity was not intended to predict such extremes in parking cost changes, the results in Table 5-8 were obtained for the main campus.

[15] "Draconian" policies are defined here as extreme policies intended to discourage parking.

Table 5-6: Transit Ridership Due to Deficit of Parking at UNC Main Campus

	Low Investment Allocation			High Investment Allocation		
	Original Ridership	from Parking	TOTAL	Original Ridership	from Parking	TOTAL
Gateway 1	2,844	5,037	7,881	2,864	5,083	7,947
Gateway 3A	1,588	3,276	4,863	1,627	3,362	4,989
Gateway 3B	904	1,865	2,769	891	1,842	2,733
Gateway 3C	2,050	4,230	6,280	2,046	4,227	6,273
Gateway 4	1,955	7,621	9,576			
Gateway 5				2,670	7,675	10,345
Gateway 6	1,747	2,764	4,510	1,450	2,786	4,236
Gateway 7-UNC	302	378	680	309	385	694
Gateway 7-Carolina North	417	521	939	417	520	937
Gateway 8-UNC	609	952	1,561	605	967	1,572
Gateway 8-Carolina North	690	1,080	1,770	676	1,080	1,756

Table 5-7: Transit Ridership Due to Deficit of Parking at Carolina North

	Low Investment		
	No Allocation of Gateway 4	Allocation of Gateway 4	High Investment
Gateway 1	1,066	1,872	1,065
Gateway 3A	693	693	704
Gateway 3B	395	395	386
Gateway 3C	895	1,701	886
Gateway 4	1,612	-	-
Gateway 5	-	-	1,608
Gateway 6	585	585	584
Gateway 7-UNC	80	80	81
Gateway 7-Carolina North	110	110	109
Gateway 8-UNC	201	201	203
Gateway 8-Carolina North	228	228	226

Table 5-9 shows the ridership from both the increase in the parking fee by 200 percent and compares with the results obtained from the allocation of trips derived from the proportional method. The variance in ridership between the elasticity and proportion methods is about 14 percent for both the low and high investment scenarios. The results are for the main campus.

Conclusion

For purposes of the LRTP, the proportional method will be used as it relates to the physical limitations in parking, which may be a more accurate indicator of parking induced transit ridership. Further, the elasticity method is not intended to predict outcomes involving large increases in parking fees. While the elasticity is a kind of check on the proportional method, a more rigorous analysis is needed to better determine the impact that parking supply and pricing would actually have on transit ridership. In fact, the above analysis is not intended to be the final word on the affects of reduced parking availability on transit ridership.

Table 5-8: Transit Trips Due to Increasing Parking Fees at UNC Main Campus

43,343	DAILY trips not accomodated in No-Build
24,380	park and ride
8,127	bus
10,836	other

42,465	DAILY trips not accomodated in Low Investment
23,887	park and ride
7,962	bus
10,616	other

42,581	DAILY trips not accomodated in High Investment
23,952	park and ride
7,984	bus
10,645	other

Table 5-9: Comparison of Elasticity and Proportional Methods for Main Campus

	Low Investment		High Investment	
Gateway	Allocation from Parking	200% Parking Increase	Allocation from Parking	200% Parking Increase
Gateway 1	5,037	4,340	5,083	4,359
Gateway 3A	3,276	2,822	3,362	2,884
Gateway 3B	1,865	1,607	1,842	1,580
Gateway 3C	4,230	3,644	4,227	3,625
Gateway 4	7,621	6,566		
Gateway 5			7,675	6,583
Gateway 6	2,764	2,381	2,786	2,389
Gateway 7-UNC	378	325	385	330
Gateway 7-Carolina North	521	449	520	446
Gateway 8-UNC	952	821	967	829
Gateway 8-Carolina North	1,080	930	1,080	926
Totals	27,723	23,887	27,927	23,952

5.4 Forecasted Ridership

Combining the forecasting work in Sections 5.2 (model run) and 5.3 (off-model restrictive parking policies at the main campus of UNC and at Carolina North), ridership for each gateway and the local service is shown in Table 5-10. Ridership forecasts are shown for each investment level, gateway service, as well as daily ridership and annualized. In addition, “new riders” is shown indicating the number of riders being added in the corridor above the current (2006) ridership levels.

As can be seen in Table 5-10, the gateway service ridership is substantially influenced by restrictive parking. Out of 46,700 total gateway riders, 33,600 daily riders would be attributed to the parking restrictions. This represents over 70 percent of the gateway riders or a 356 percent increase over the model results in which no restrictive parking policies were assumed. Reviewing the modal share data in Table 5-2, if the parking numbers were to be borne out, transit modal share in the community would rise by a similar percentage.

5.5 Target Corridors and Combined Investment Scenarios

Another end product for this ridership forecasting effort was to identify two gateway corridors for more detailed analysis. These "prototype" corridors would form the basis in developing cost information for the remaining services. The Transit Study Committee identified Gateway 1 (Martin Luther King Jr. Boulevard) and Gateway 3B/3C (US 15/501 via Franklin and via Estes to Carolina North) corridors to be developed further. Gateways 4 and 5 under the Low and High Investments were not targeted because the committee believed that those corridors would be studied through a regional transit planning process that was occurring at the time of this study.

In addition to identifying two corridors for further analysis, the High and Low Investment scenarios were combined to produce an overall service concept called the "Modified High Investment Service Concept." This concept retains all of the Low Investment gateway services as well as the enhanced local bus network. However, the concept adds in a light rail transit (LRT) corridor[16]. While the LRT option proved too costly as a strict gateway service (operating wholly within the study area), it may be a viable *regional* option. As a regional option it would serve the functions intended for either or both Gateway 3 and Gateway 4. For this reason, it is included in the service concept. See Figure 5-7.

Since the gateway and local bus services in the Modified High Investment concept are the same as under the Low Investment scenario, ridership projections and operating assumptions associated with the Low Investment are carried under the new, combined service concept. From this point forward, ridership and other information associated with this LRTP will be identified, as appropriate, as "Modified High Investment Service Concept."

[16] The corridor is Gateway 5 which, under the High Investment scenario, was to be an exclusive busway for Bus Rapid Transit (BRT)

Figure 5-7: Modified High Investment Service Concept

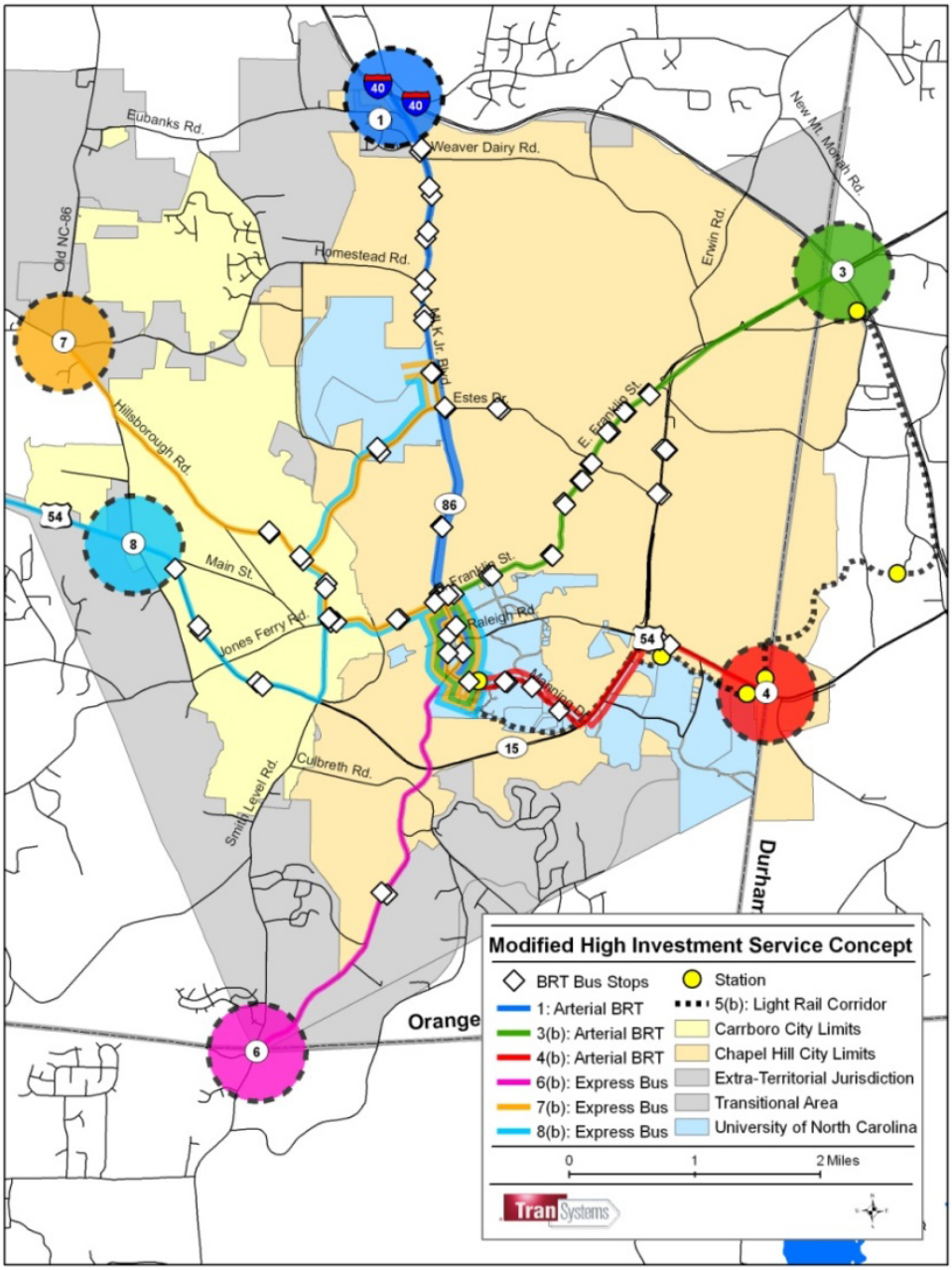


Table 5-10: Summary of 2035 Ridership Levels By Service and Investment Level

Daily Ridership

	Gateway Services												Local Bus	Grand Total
LOW INVESTMENT	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**	**Total GW**		
Model Run	2,832	1,253	714	1,618	1,699		1,666	302	417	606	690	11,798	43,184	54,981
Due to Parking Deficit at UNC Main	5,037	3,276	1,865	4,230	7,621		2,764	378	521	952	1,080	27,723	9,241	36,964
Due to Parking Deficit at Carolina N	1,872	693	395	1,701	0		585	80	110	201	228	5,865	1,955	7,820
Totals	9,741	5,222	2,973	7,549	9,319		5,014	760	1,049	1,760	1,998	45,386	54,379	99,765
Gateway P&R Parking Spaces	4,067	3,226	1,385	3,648	5,457		1,436	70	671	162	565	20,688		
New Riders	7,931	4,723	2,243	7,502	4,137	N/A	887	0	0	0	0	28,513		
HIGH INVESTMENT	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**			
Model Run	2,864	1,627	891	2,046		2,670	1,450	309	417	605	676	13,556	44,001	57,556
Due to Parking Deficit at UNC Main	5,083	3,362	1,842	4,227		7,675	2,786	385	520	967	1,080	27,926	9,309	37,235
Due to Parking Deficit at Carolina N	1,065	704	386	886		1,608	584	81	109	203	226	5,851	1,950	7,801
Totals	9,012	5,694	3,119	7,158		11,953	4,820	775	1,046	1,775	1,982	47,333	55,260	102,592
Gateway P&R Parking Spaces	3,710	3,111	1,416	3,393		6,118	1,655	70	670	162	565	20,870		

Annualized Ridership

LOW INVESTMENT	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**	**Total GW**		
Model Run	829,700	367,200	209,100	474,200	497,800		488,100	88,500	122,200	177,700	202,300	3,456,800	12,652,800	16,109,600
Due to Parking Deficit at UNC Main	1,475,900	959,800	546,400	1,239,300	2,232,800		809,700	110,700	152,800	279,000	316,300	8,122,700	2,707,600	10,830,300
Due to Parking Deficit at Carolina N	548,500	203,000	115,600	498,400	0		171,300	23,400	32,300	59,000	66,900	1,718,400	572,800	2,291,200
Totals	2,854,100	1,530,000	871,100	2,211,900	2,730,600		1,469,100	222,600	307,300	515,700	585,500	13,297,900	15,933,200	29,231,100
New Riders	2,323,700	1,383,700	657,200	2,198,200	1,212,100		259,800	0	0	0	0	8,034,700		
HIGH INVESTMENT	**GW 1**	**GW 3A**	**GW 3B**	**GW 3C**	**GW 4**	**GW 5**	**GW 6**	**GW 7-UNC**	**GW 7-CN**	**GW 8-UNC**	**GW 8-CN**	**Total GW**		
Model Run	839,200	476,700	261,200	599,300		782,300	424,900	90,500	122,300	177,300	198,000	3,971,700	12,892,200	16,863,900
Due to Parking Deficit at UNC Main	1,489,300	985,100	539,700	1,238,500		2,248,800	816,200	112,800	152,300	283,300	316,300	8,182,300	2,727,500	10,909,800
Due to Parking Deficit at Carolina N	312,000	206,400	113,100	259,500		471,100	171,000	23,600	31,900	59,400	66,300	1,714,300		
Totals	2,640,500	1,668,200	914,000	2,097,300		3,502,200	1,412,100	226,900	306,500	520,000	580,600	13,868,300	15,619,700	29,488,000

Notes: *GW= gateway; CN= Carolina North; UNC=University of North Carolina main campus*

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Section 6: Conceptual Operating Plans

As discussed at the end of Section 5, an end product for the ridership forecasting effort was to identify two gateway corridors for more detailed analysis. These "prototype" corridors would form the basis in developing costs information for the remaining services. The Transit Study Committee identified Gateway 1 (Martin Luther King Jr. Boulevard) and Gateway 3B/3C (US 15/501 via Franklin and via Estes to Carolina North) corridors to be developed further. Gateways 4 and 5 under the Low and High Investments were not targeted because the committee believed that those corridors would be studied through a regional transit planning process that was occurring at the time of this study.

This section presents a conceptual operating plan for enhanced transit service in the two selected corridors in the Chapel Hill/Carrboro area. The scope of the operating plan is limited to a conceptual level. It includes a running way definition, ridership estimate, station and vehicle description, and operating parameters (i.e. span of service, fleet size, headway, running time). Based on this operating plan, generalized service parameters for the remaining gateway routes as well as for the enhanced local bus service are also presented. Finally, ridership and gateway park and ride information is presented for the "low investment" scenario discussed earlier in Sections 4 and 5.

6.1 Martin Luther King Jr. Blvd., Gateway 1

The Martin Luther King Jr. Boulevard is served by a BRT route 1 (also referred to as Gateway 1).

6.1.1 BRT Gateway 1

BRT Route 1 extends from a park-and-ride station near the intersection with I-40 to Manning Drive at the University of North Carolina (UNC) in downtown Chapel Hill. The entire alignment for this BRT route is presented in the Figure 6-1.

Key trip generators for this corridor are the park-and-ride lot near I-40, which will generate trips from commuters that live in the outer areas of Chapel Hill, and the Carolina North mixed-use development. Key trip attractors for this corridor are employment, school, and shopping developments in downtown Chapel Hill and Carolina North. This route is expected to carry approximately 9,800 trips per day in the low investment build scenario. About 70 percent of this ridership is projected to be generated by park-and-ride activity primarily at the Gateway at I-40 and Martin Luther King Jr. Boulevard. This level of demand will require about 4,100 parking spaces at this gateway. While regional ridership impacts were not modeled, the number of parking spaces, nonetheless, reflects demand net of regional riders.

Figure 6-2 (on page 6-3) shows a conceptual site plan for Gateway 1. The illustration shows the park-and-ride facility along with ancillary development that would be encouraged to occur at the gateway independent of the BRT project itself. This concept site plan is later evaluated for potential land development in Section 7 of this study. See Figure 7-2 on page 7-2.