



**2012**

**CAMPUS MOBILITY PLAN**

**FINAL REPORT**

**July 2012**

**Prepared for**  
North Carolina State  
Transportation

**Prepared by**  
HDR Engineering, Inc. of the Carolinas



## Table of Contents

KEY RECOMMENDATIONS SUMMARY .....	ES-1
1 Background & Introduction.....	1
1.1 Study Overview .....	1
1.1.1 Relationship to Other Studies .....	1
1.1.2 Physical Master Plan – <i>A Campus of Neighborhoods and Paths</i> .....	2
1.1.3 Components of the 2012 <i>Campus Mobility Plan</i> .....	3
1.1.4 A “Living Document” .....	4
1.2 Study Team .....	4
1.2.1 Technical Team .....	4
1.2.2 Advisory Committee.....	5
2 Study Area and Service Characteristics.....	6
2.1 Campus Population .....	6
2.1.1 Current and Historic Levels .....	6
2.1.2 Projected Campus Growth .....	6
2.2 Wolfline Services.....	8
2.2.1 Daytime Services .....	9
2.2.2 Night and Weekend Services .....	11
2.2.3 Wolfline Fleet.....	13
2.2.4 Wolfline Costs and Funding .....	13
2.3 Other Transit Services .....	14
2.3.1 Public Transit Services.....	14
2.3.2 Private Apartment Shuttles.....	16
2.4 Ridership Levels .....	16
2.4.1 Ridership by Route .....	16
2.4.2 Ridership by Stop .....	17
2.4.3 Passenger Loads.....	19
2.4.4 Ridership by Time of Day .....	20
2.4.5 Park & Ride Facilities/Users .....	22
2.4.6 Night Security Escort.....	22
2.5 Rider On-board Surveys .....	23
2.5.1 Trip Characteristics .....	24
2.5.2 Rider System Use .....	25
2.5.3 Transit Dependency of Riders.....	26
2.6 Other Surveys.....	26
2.6.1 Customer Satisfaction Survey .....	26
2.6.2 Park & Ride Survey.....	27
2.7 Existing Traffic Levels .....	27
2.8 Travel Demand Management Strategies .....	28
3 Analysis and Potential Enhancements .....	32
3.1 Wolfline Goals.....	32
3.2 Routing, Scheduling, and Capital Alternatives.....	33
3.2.1 Local Services and Transit Centers.....	34

3.2.2	Park & Ride Lots and Commuter Services.....	43
3.2.3	Nighttime Services .....	48
3.3	Traffic Pattern and Roadway Modification Analyses.....	50
3.3.1	2022 Baseline Conditions Due to Growth.....	51
3.3.2	Alternative 1: Dan Allen Closure Only.....	51
3.3.3	Alternative 2: Dan Allen Closure with Prospective Pullen Road Extension and Western/Avent Ferry Tunnel .....	54
3.3.4	Other Road Network Changes .....	56
3.3.5	Dedicated Transit Guideway .....	56
3.4	Campus Involvement .....	58
3.4.1	Meetings .....	58
3.4.2	Major Feedback .....	58
4	Recommended Changes.....	61
4.1	2012-13 and 2013-14 Academic Years.....	61
4.1.1	Daytime Changes .....	61
4.1.2	Nighttime Changes.....	62
4.2	2014-15 through 2016-17 Academic Years.....	66
4.2.1	Service Changes .....	66
4.2.2	Capital Improvements.....	68
4.3	2017-18 through 2021-22 Academic Years.....	68
4.3.1	Service Changes .....	68
4.3.2	Capital Improvements.....	70
4.4	Recommendations by Route.....	70
4.4.1	Headway Adjustments .....	74
4.4.2	Fleet Impacts.....	75
4.5	Travel Demand Management Recommendations.....	77
4.6	Future Transit Guideway Corridors.....	77
4.6.1	Bus Priority Corridors.....	78
4.6.2	Fixed Guideway Corridors .....	83
5	Financial Summary.....	86
5.1	Operating Costs.....	86
5.2	Capital Costs.....	87
5.2.1	Bus Costs .....	87
5.2.2	Other Capital Costs .....	87
5.3	Potential Funding Sources .....	88

**Appendices**

- A1 Rider Survey Technical Memorandum
- A2 Traffic Technical Memorandum
- A3 Campus Involvement Technical Memorandum
- A4 Individual Route Maps

**Table of Exhibits**

Exhibit 1-1 Physical Master Plan & Study Area ..... 3

Exhibit 2-1 Historic NC State Population Levels ..... 6

Exhibit 2-2 Projected NC State Population Growth ..... 7

Exhibit 2-3 North/Central/South/West Precincts Population Growth..... 7

Exhibit 2-4 Centennial Campus Population Growth..... 8

Exhibit 2-5 Wolfline 2011-12 Daytime Route Parameters ..... 9

Exhibit 2-6 Wolfline 2011-12 Daytime Routes ..... 10

Exhibit 2-7 Wolfline 2011-12 Night Route Parameters..... 11

Exhibit 2-8 Wolfline 2011-12 Night Routes ..... 12

Exhibit 2-9 Wolfline Fleet ..... 13

Exhibit 2-10 Wolfline Costs and Fees 2002-2011 ..... 13

Exhibit 2-11 CAT/TTA Daytime Route Parameters..... 14

Exhibit 2-12 NC State Area Public Transit Service..... 15

Exhibit 2-13 Private Apartment Shuttle Routing..... 16

Exhibit 2-14 Spring 2011 Boardings by Route ..... 17

Exhibit 2-15 September 2011 Major Wolfline Stops (500+ trip ends) ..... 17

Exhibit 2-16 September 2011 Stop Level Activity & Land Use ..... 18

Exhibit 2-17 Percentage of Trips with Standees (Spring 2011) ..... 19

Exhibit 2-18 Total Wolfline Ridership by Half Hour (Spring 2011) ..... 20

Exhibit 2-19 Route Ridership by Half Hour (Spring 2011) ..... 21

Exhibit 2-20 Major Security Escort Locations..... 23

Exhibit 2-21 Budd Average Hourly Ridership ..... 23

Exhibit 2-22 Wolfline Trip Purpose ..... 24

Exhibit 2-23 Wolfline Access/Egress Modes ..... 25

Exhibit 2-24 Wolfline Riding Frequency ..... 25

Exhibit 2-25 Wolfline Rider Dependency ..... 26

Exhibit 2-26 2012 Intersections with Failing Approaches ..... 27

Exhibit 2-27 2012 AM Peak Intersection Delays ..... 29

Exhibit 2-28 2012 PM Peak Intersection Delays..... 30

Exhibit 3-1 Potential Transit Underpass of Western Boulevard ..... 41

Exhibit 3-2 Potential Centennial Campus Transit Center Location ..... 42

Exhibit 3-3 Estimated Parking Demand..... 45

Exhibit 3-4 Park & Ride Capture Areas..... 45

Exhibit 3-5 2007 Farmers Market Site Constraints ..... 46

Exhibit 3-6 Farmers Market Potential Shared Use Area ..... 47

Exhibit 3-7 2022 Alternative 1 Traffic Delay..... 53

Exhibit 3-8 2022 PM Peak Volumes for Pullen for Baseline, Alternative 1, and Alternative 2 ..... 55

Exhibit 3-9 Physical Master Plan Transit Corridors ..... 57

Exhibit 3-10 Route Change Scoring ..... 58

Exhibit 3-11 Schedule Change Scoring ..... 59

Exhibit 3-12 Capital Improvement Scoring ..... 59

Exhibit 4-1 AY 2012-13 to AY 2013-14 Daytime Routes..... 64

Exhibit 4-2 AY 2012-13 to AY 2013-14 Nighttime Routes ..... 65

Exhibit 4-3 AY 2014-15 to AY 2016-17 Daytime Routes..... 67  
Exhibit 4-4 AY 2017-18 to AY 2021-22 Daytime Routes..... 69  
Exhibit 4-5 Headway Changes by Route and Phasing ..... 75  
Exhibit 4-6 Changes in Fleet Composition..... 76  
Exhibit 4-7 Potential Bus Transit Emphasis Corridors ..... 79  
Exhibit 4-8 Bus Stop Types ..... 81  
Exhibit 4-9 Bus Stop Amenity Placement..... 82  
Exhibit 4-10 Bus Bay Dimensions ..... 83  
Exhibit 4-11 Potential Rapid Transit Corridors..... 84  
Exhibit 4-12 Corridor Design Envelope ..... 85  
Exhibit 5-1 Changes in Service Hours and Estimated Costs ..... 86

## CAMPUS MOBILITY PLAN

### KEY RECOMMENDATIONS SUMMARY

#### Overview

The 2012 *Campus Mobility Plan* calls for the development of an enhanced Wolfline bus system that serves the entire university community and accommodates future campus travel needs. It also complements other future local and regional transit investments including a potential rail system. It is designed to serve all campus sectors with particular emphasis on route and service changes in travel corridors to the south and transit demands associated with significant projected growth on Centennial Campus.

#### Wolfline Today

Wolfline is a fare-free public system on and around the NC State Campus. In Academic Year (AY) 2011-12 the network operated:

- 12 peak-hour weekday routes
- 3 late-night routes
- 2 weekend routes

The majority of day routes operate between roughly 7 AM and 10 PM. Three routes provide overnight service as late as 3:00 AM.

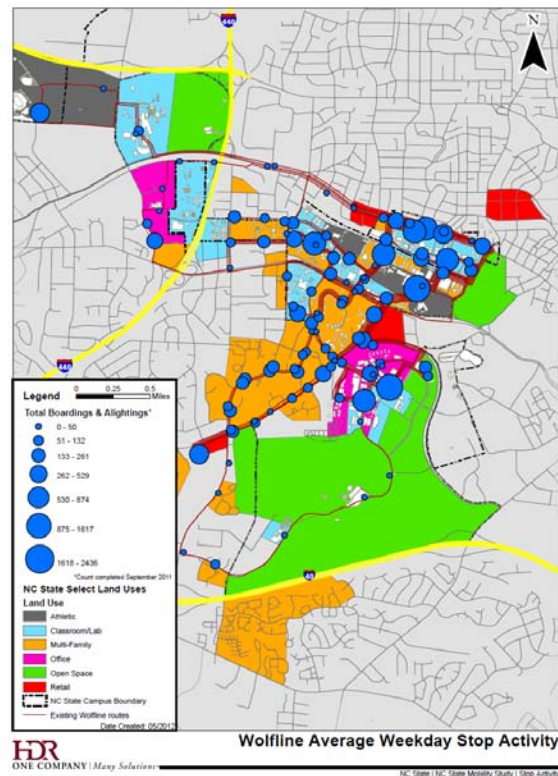
In the Spring 2011 semester, Wolfline carried in excess of 14,000 average weekday boardings.

**Exhibit ES-1** shows the daytime routes and ridership volumes by stop. Wolfline's system is robust; ridership is almost as high as Capital Area Transit (CAT) (18,900) and far exceeds the daily patrons on Triangle Transit (4,800) and Cary's CTran (600).

Wolfline total provides over 70,000 annual hours of service and costs \$5.5 million to operate. The majority (70-80%) of the funding coming from the \$135 per student transportation fee revenues.

A separate security escort service is provided by University Housing, and the WolfTrails program provides a variety of incentives for traveling other than in private vehicles.

#### Exhibit ES-1 September 2011 Campus Stop Level Activity



#### Future NC State Growth

Projections indicate that the combined university-related population will increase from 43,000 students, faculty, staff, and corporate partners in 2011 to 51,000 by 2022, a 20% jump.

Virtually all of this activity growth is projected to occur on or impact the Centennial Campus.

This precinct is projected to more than double in population by 2025, which equates to nearly 12,000 more people.

**Wolfline Goals**

The following goals for Wolfline are central to the work done in this study.

- Provide mobility for students, faculty, staff & visitors around campus
- Focus on internal circulation, inter-campus connections and peripheral park & rides
- Provide connections to CAT, CTran, and TTA
- Operate in a cost-effective manner

**Traffic Congestion and Roadways**

Existing and future traffic conditions on and around the University were evaluated. Intersection congestion and delay problems, especially during busy PM travel periods, are already bad and will continue to deteriorate in the future as traffic around campus increases. By 2022, eight intersections are projected to be failing, although virtually all of them are on the campus periphery. Nevertheless, Wolfline (and other transit systems) will continue to experience delay through these problem areas for some time to come.

The proposed daytime closure of Dan Allen Drive should aid north-south transit performance crossing Main Campus, but will divert trips and alter traffic levels both on campus roadways and along peripheral arterials and collectors.

Generally, while several new internal roadways will be constructed on Centennial Campus, no physical capacity increases are anticipated elsewhere. Should a new public Pullen Road extension be completed between Western Avenue and Centennial Parkway, travel patterns surrounding campus would change and Wolfline routes would benefit.

**RECOMMENDED WOLFLINE CHANGES**

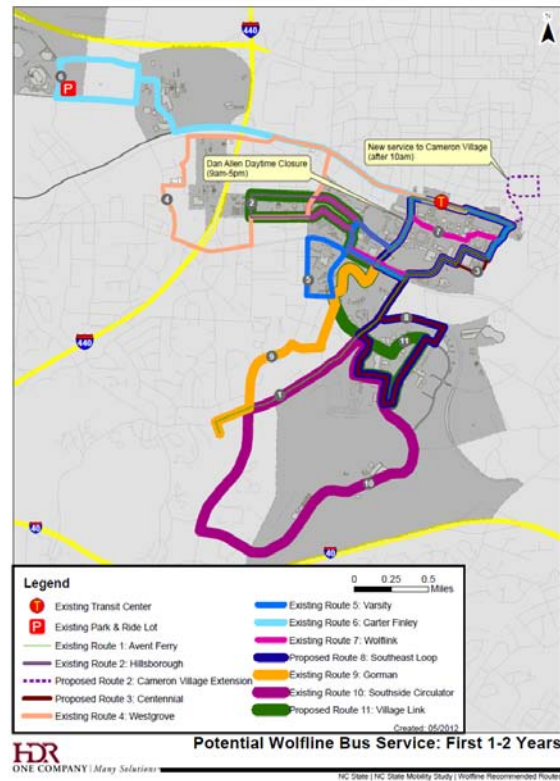
Proposed Wolfline system enhancements and refinements were divided into three implementation phases between 2012 and 2022 – short-term (years 1-2); mid-term (years 3-5); and long-term (years 6-10).

**Short-Term (Years 1-2) Changes**

During the short-term, daytime route changes are shown in **Exhibit ES-2** and consist of:

- Reorienting routes to serve the new Hunt Library located on Centennial
- Combining current routes Engineering and Centennial Express routes (3, 3A) to provide more frequent service connecting Centennial and main campuses
- Extending service to Cameron Village

**Exhibit ES-2  
AY 2012-13 to AY 2013-14 Daytime Routes**

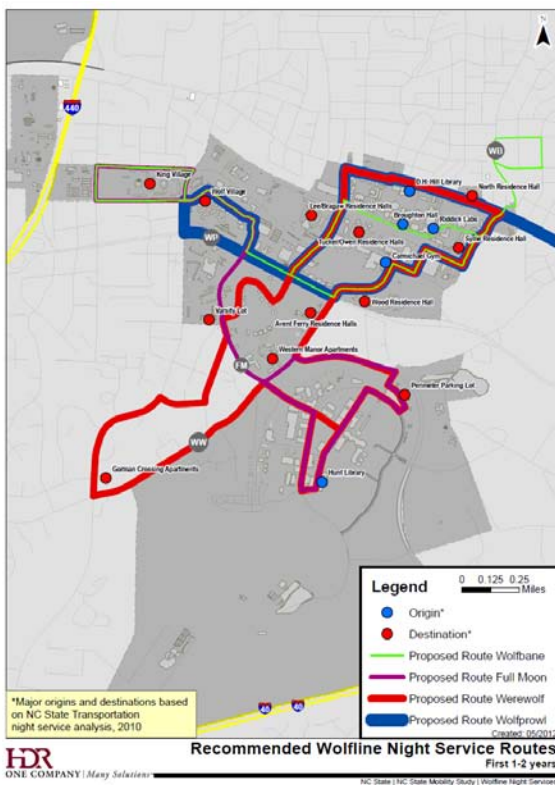




Nighttime changes are shown in **Exhibit ES-3** and include:

- Adding new nighttime services – the Wolfbane and Full Moon routes join the Werewolf and WolfProwl routes
- Continuing operation of the University Housing security escort while exploring new Wolfline service designs to provide point to point travel relief.

**Exhibit ES-3  
AY 2012-13 to AY 2013-14 Nighttime Routes**



Schedule changes focus on accommodating existing overloads, and adjustments to the daily span of service:

- All routes operate from roughly 7:00 AM to 6:30 PM at a minimum
- Major daytime routes continue until 10:00 PM when nighttime routes begin
- Increase frequency on the 1 Avent Ferry
- Increase frequency on the 9 Gorman St. Local

Capital items during the short-term are:

- With bus assignment changes, one less 30-foot bus and two more 40-foot buses are required for peak operating periods

Traffic changes recommended are:

- Closing Dan Allen Dr at railroad from 9:00 AM to 5:00 PM to all but buses and authorized university and emergency vehicles

Transportation Demand Management (TDM) improvements recommended for the short-term and continuing over the 10 years are:

- Intensify alternative transportation program marketing efforts aimed at reducing commuter and mid-day vehicle trips on campus
- Increase charges for parking sufficient to increase transit’s travel mode share
- Expand the Zipcar and bicycle rental stations to all campus precincts
- Add bicycle racks to buses wherever possible on routes serving park and ride lots, beginning with the 6 Carter Finley
- Encourage carpooling and vanpooling through employee matching and priority parking locations

**Mid-Term (Years 3-5) Changes**

During the mid-term, the ongoing growth at Centennial requires more frequent service on some routes and the addition of new routes to serve new developments and provide more choices.

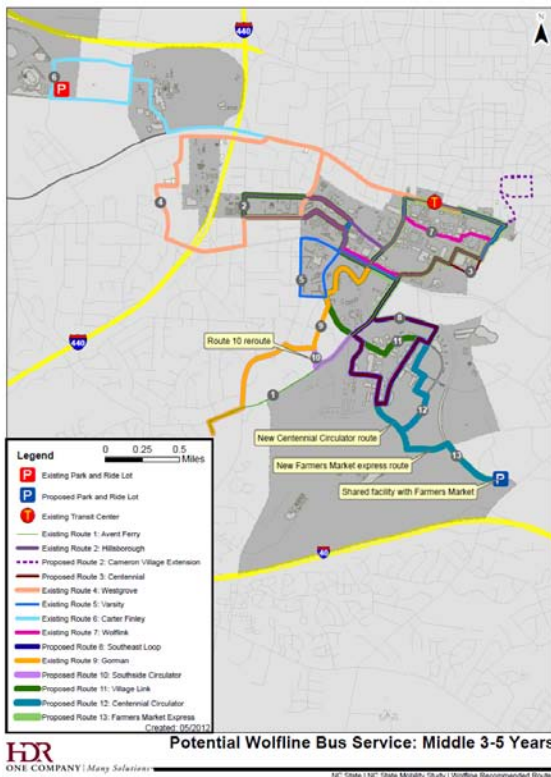
Route changes are shown in **Exhibit ES-4** and consist of:

- Rerouting the existing 10 Southside Circulator to provide direct service to Avent Ferry apartments
- New 12 Centennial Circulator providing internal mobility for the Centennial Campus



- New 13 Farmers Market Express providing peripheral P&R service from a new southern site to Centennial Campus and the main campus.

**Exhibit ES-4**  
**AY 2014-15 to AY 2016-17 Daytime Routes**



**Long-Term (Years 6-10) Changes**

In August, 2017, the existing bus operation contract expires, and will likely be opened to competitive bidding. This should allow some increased flexibility to adjust service levels and fleet requirements that will meet transit needs in the second five years of the plan period. The ongoing development in Centennial Campus continues to require more frequent service and service to more locations on campus.

Route changes are shown in **Exhibit ES-5** and consist of:

- Combining the 2 Hillsborough St Shuttle with the 4 Westgrove and rerouting through a new Ligon St Tunnel under I-440
- Rerouting the new 3 Engineering to use the Pullen Road extension to Centennial Parkway
- Extensions to the 12 Centennial Circulator to serve new developments
- New 14 Southwest Express from a new P&R near Gorman & Avent Ferry
- New 15 Commuter Rail Shuttle during peak times between Dan Allen commuter rail station and Centennial

Schedule changes during the long-term are designed to match service supply and demand. With a new operating contract, articulated (60-foot buses) can be used. On high frequency routes, the frequency of service can be reduced when the larger buses go into service without hurting service quality.

- Decrease frequency on the new 3 Engineering, 8 Southeast Loop, and 9 Gorman Street Local with the use of articulated buses
- Increase frequency due to demand on 12 Centennial Circulator and 13 Farmers Market Express

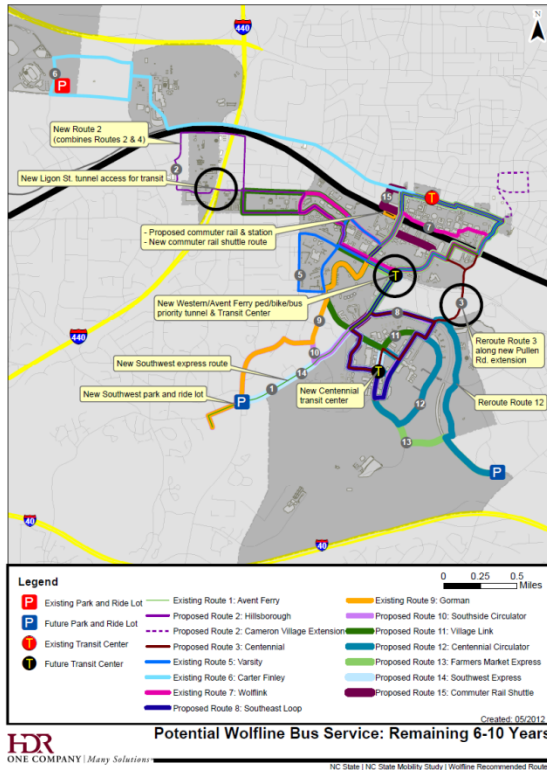
Schedules are adjusted to match the projected growth on Centennial Campus

- Increase frequency to match demand on routes [new] 3 Engineering, 8 Southeast Loop, 10 Southside Circulator, and 11 Village Link

Capital items needed during the midterm are:

- Bus fleet growth requires purchase of eight more 40-foot buses and four more 30-foot buses
- Construction of a new expanded/shared P&R lot with Farmers Market (250 total spaces)

**Exhibit ES-5**  
**AY 2017-18 to AY 2021-22 Daytime Routes**



Several capital items come on line during the long-term:

- 17 new articulated buses added to fleet, including spares; 13 full sized buses are retired; and 3 30-foot buses are retired
- Centennial Transit Center – a new Centennial Transit Center near Hunt Library and the Engineering buildings
- New eastbound stop at Wolf Village
- Southwest Park & Ride – a new park & ride adjacent to the planned CAT transit center in the vicinity of Avent Ferry & Gorman (550-650 spaces)
- New Western Blvd/Avent Ferry underpass and transfer point

**CONCLUSIONS**

The Wolfline bus system is providing mobility to the University population today, with ridership levels close to the ridership on the City of Raleigh’s CAT system. Without the mobility provided by Wolfline, students, faculty, and staff would have increased difficulties traveling around campus; more parking spaces would be required; and traffic levels would be higher.

Over the next 10 years, Wolfline service needs to expand to meet the demands of the growing Centennial Campus, and to provide increased choices to the University. Through a combination of increased frequency on existing routes; the judicious addition of new routes; and the conversion of selected routes to larger, more efficient buses, Centennial Campus can be served in a cost-efficient manner.

The introduction of two new peripheral park & ride lots gives riders a choice of travel options, and will reduce the need to provide parking spaces in the heart of the campuses. A new commuter rail shuttle bus will integrate the Centennial Campus in with the greater transit system for Wake County.



For more details, see the project website:  
[www2.acs.ncsu.edu/trans/planning/campusmobilityplan.html](http://www2.acs.ncsu.edu/trans/planning/campusmobilityplan.html)

## 1 Background & Introduction

The 2012 North Carolina State University (NC State) *Campus Mobility Plan* presents recommendations for service and capital improvements to the Wolfline service and related transportation infrastructure over the next 10-year period.

In September 2011, NC State engaged HDR Engineering, Inc. of the Carolinas (HDR) to prepare the 2012-2022 *Campus Mobility Plan* for Wolfline in part to complement several other longer term bus and rail studies being undertaken in the Triangle region.

### 1.1 Study Overview

This study involved the preparation of a phased bus transit plan for NC State in anticipation of significant enrollment and employment growth, principally in the Centennial Campus. The total university-related population is projected to increase from 43,000 students, faculty, staff, and corporate partners in 2011 to 51,000 by 2022. While this 20 percent growth is substantial, the growth rate was reduced during the course of this study. NC State has significantly reduced its projected higher education enrollment to balance enrollment with projected resources. At NC State, the growth is projected to occur entirely on the Centennial Campus south of Western Avenue, with the historic North and Central Campuses showing a modest decline.

The 2012 *Campus Mobility Plan* calls for the development of an enhanced bus system that complements a near term expansion of local (Capital Area Transit-CAT) and regional (Triangle Transit-TTA) bus service as well as the potential construction of a rail system late in the plan period. Besides expanding bus service to match the projected increases in population and to serve new developments on the Centennial Campus, the Wolfline service must anticipate the impacts of commuter rail service and light-rail service proposed by Triangle Transit. If and when fully funded, both of these systems would travel through the heart of the campus along the existing North Carolina Railroad (NCRR) right-of-way, and will serve one or more stations on campus.

The planning horizon used for the 2012 *Campus Mobility Plan* is a ten-year horizon, with phases developed for the first two years, three-to-five years, and six-to-ten years. This planning horizon provides a mid-term view for NC State related to the planned investments required for the Wolfline service.

#### 1.1.1 Relationship to Other Studies

TTA is conducting an Alternatives Analysis (AA) for future rail investment in the entire Triangle region, encompassing Wake, Durham, and Orange Counties. The AA is examining multiple rail corridors both within individual counties and across county borders. Both commuter rail (using existing/expanded freight tracks) and light rail transit (LRT) technologies are being considered.

The AA is focused on specific rail corridors, including the NCRR corridor through the NC State campus. Each transit operator in Wake County is developing its own bus service plans that consider transit

connections to the rail corridors and service beyond the corridors throughout the county. The separate rail plans and bus plans have been merged into a comprehensive transit plan for the region. This comprehensive plan will be taken to the voters in each county to solicit their approval on implementing a half-cent sales tax dedicated to funding the transit program within each county. Each county must conduct its own referendum; Durham County voters approved the sales tax in 2011, and Wake County voters may be asked to vote on a similar tax in November 2012.

The ten-year planning horizon used for the 2012 *Campus Mobility Plan* is sufficient to match the planned implementation of the commuter rail service, but any light-rail service will occur further in the future. Both of these services are uncertain since their implementation is dependent upon the passage of a half-cent sales tax dedicated to transit. Should the referendum fail or be delayed, some of the recommended Wolfline service may be delayed as well.

Technical Memorandum #1 prepared as part of the long-range plan, presents the results of a rider survey conducted on the CAT, CTran, Triangle Transit, and Wolfline system. This Memorandum is summarized later in this report and the full Memorandum, which includes a comparison among Wolfline and the other transit providers, is included in the Appendix.

### 1.1.2 Physical Master Plan – *A Campus of Neighborhoods and Paths*

The growth of the university is shaped by the NC State University Physical Master Plan – *A Campus of Neighborhoods and Paths* (the Physical Master Plan). This plan shows the locations of existing and proposed buildings; the roadway network internal to the campus; areas protected from growth; and the overall standards that will be used for future development. The current master plan dates from October 2007 and has received minor modifications since that time. **Exhibit 1-1** shows the Physical Master Plan as it existed in June 2011. The University property shown in the Physical Master Plan and the surrounding environs is the study area for the 2012 *Campus Mobility Plan*.

Note that the Physical Master Plan divides the university into five “precincts” – North (north of the NCRR); Central (between NCRR and Western); South (south of Western); West (Carter Finley Stadium and the Centennial Biomedical Campus (Vet School)); and Centennial Campus. In the sections following, the precincts are grouped into the main campus (North, Central, and South) Centennial Campus, and the West Campus.

A key objective of the 2012 *Campus Mobility Plan* is to provide input to the update of the Physical Master Plan now being undertaken by the University Architects Office. This input will focus on the physical elements necessary to support transit service, such as major stops, transit centers, and park & ride lots. Also included will be recommendations regarding the location of a potential transit guideway, should the university decide to pursue such a technology in the future.



Exhibit 1-1  
Physical Master Plan & Study Area



Source: NC State Physical Master Plan as updated June 2011

**1.1.3 Components of the 2012 Campus Mobility Plan**

The 2012 *Campus Mobility Plan* is intended to serve as a guide in developing a transit vision, outlining existing findings, and implementing recommendations. The plan presents a series of transit service and capital improvement recommendations aimed at accomplishing these objectives. The main components of the transit development plan include:

- An evaluation of existing routes, service levels, and plans for today and the future
- Considerations of existing and future demographics, land use, and travel patterns on and around the university
- Input from students and stakeholders on existing and proposed future service expansions
- Recommendations for new services, enhancements to existing services, and capital facility improvements
- A phased financial forecasting plan identifying for Years 1-2, 3-5, and 6-10 the operating and capital costs associated with implementing the recommendations of the transit plan

**1.1.4 A “Living Document”**

The 2012 *Campus Mobility Plan* described here will inevitably be subject to some changes over time. Other than the initial phase, elements of which may be implemented as early as Fall 2012, the changes proposed for later years may be modified as they near implementation. Today’s growth projections may not materialize as anticipated, since they are dependent upon somewhat unpredictable factors such as State and University budgets and students’ willingness to impose higher transportation fees on themselves.

Additionally, the new Hunt Library’s opening in early 2013, followed later in the year by new housing on Centennial Campus are anticipated to have substantial effects on the travel patterns of the university. Further refinement of the transit route and service plans will be required as these patterns emerge and establish themselves.

**1.2 Study Team**

To ensure the goals and recommendations of the 2012 *Campus Mobility Plan* reflect the interests and considerations of all parties at the university, considerable effort was made to incorporate the input of administration and staff from multiple departments and the student body. An assembled technical team consisting of NC State Transportation staff and HDR consultants guided and monitored study progress. The broader community was represented by the Advisory Committee.

**1.2.1 Technical Team**

The core study technical team consisted of NC State Transportation staff and the consultant team. Members of this group met throughout the study to review the findings and develop the recommendations.

Brian O’Sullivan	Asst. Director, Transp.	Tyler Risdon	Grad. Intern
Baird Bream	Grad. Intern	Robert Bush	HDR Project Manager
Alison Carpenter	Transportation	Michael Ousdahl	HDR
David Hammerman	Transportation	Suraj Pamulapati	HDR
Tom Kendig	Director, Transportation	Kirk Stull	HDR
Anne Marie Measmer	Transportation	Mike Surasky	HDR
Kim Paylor	Transportation		



**1.2.2 Advisory Committee**

The Advisory Committee met three times over the course of the study –in December 2011 to discuss the findings; in February 2012 to review the recommendations prior to the campus-wide meeting; and in June 2012 to review the study report

Kristine Alpi	Library of Veterinary Medicine	Lisa Johnson Brian Jones	University Architects Office Centennial Campus Development
Lauren Ball	Office of International Services	Janie Jones	First Transit
John Barnwell	Campus Police	Chris Kingston	Athletics
Dick Bernhard	Phys Env. Transp. Subcommittee	Eric Lamb	City of Raleigh – Transportation Planning
Demar Bonnemere	Athletics	Erik Landfried	Triangle Transit
Gregory Cain	Parking Services	Amy Lubas	Centennial Campus Partnership
Bob Campbell	University Recreation	John Mountz	Greek Life
Carson Cook	Office for Institutional Equity and Diversity	Josh Privette	Student Government
Mike Davidson	College of Veterinary Medicine	David Rainer	Environmental Health & Public Safety
David Eatman	Raleigh CAT	John Royal	College of Engineering
Ryan Givens	Parking/Facility Planner	Tom Skolnicki	University Architects Office
David Goldsmith	NCSU Libraries	Cameron Smith	Capital Project Management
Susan Grant	University Housing	Trey Standish	University Planning & Analysis
Mike Harwood	Centennial Campus Development	John Stone	College of Engineering
Kristy Jackson	Institute for Transportation Research and Education	Andy Walsh	Student Government
		Shannon Yates	Athletics

## 2 Study Area and Service Characteristics

Detailed existing demographic, land use, and travel pattern analyses were prepared to describe the market for transit in the study area. Included is an assessment of the campus population levels, an evaluation of Wolfline’s services, a review of other area transit service, an evaluation of ridership levels, rider travel patterns and service review, and documentation of existing traffic levels around the campus.

### 2.1 Campus Population

NC State has several population groups of interest. Students represent the largest population group and make up the majority of the Wolfline riders. Other groups include faculty and staff, which have similar, but distinct travel needs. A fourth group at NC State, not found at most universities, is the Corporate Partners – private employers located within the Centennial Campus.

#### 2.1.1 Current and Historic Levels

The population of the NC State campus has grown nearly 30 percent since the early 1990’s. The historic population totals along with the current population are provided in **Exhibit 2-1**. Corporate Partners are not included in the historical information.

**Exhibit 2-1  
Historic NC State Population Levels**

	1992	1997	2002	2007	2011	1992-2011 % diff.
Total Undergraduates	18,651	19,105	20,146	22,133	23,515	26%
Graduate Students	4,636	5,346	5,838	6,668	8,691	87%
Non-Degree Students	3,869	3,078	3,652	3,230	2,558	-34%
<b>ENROLLMENT</b>	<b>27,156</b>	<b>27,529</b>	<b>29,636</b>	<b>32,031</b>	<b>34,764</b>	<b>28%</b>
Faculty	1,676	1,669	1,748	1,876	2,073	24%
Staff	4,312	4,668	5,137	5,907	5,896	37%
<b>TOTAL POPULATION</b>	<b>33,144</b>	<b>33,866</b>	<b>36,521</b>	<b>39,814</b>	<b>42,733</b>	<b>29%</b>

Source: 2007 Physical Master Plan plus current population

The largest percentage growth since 1992 has been in the graduate student population, which nearly doubled over the time. The number of non-degree students actually fell over the period. Total enrollment showed a growth of 28 percent, an increase of more than 7,500 students. Total faculty and staff grew by one-third, an increase of 2,000 employees.

#### 2.1.2 Projected Campus Growth

During the course of this study, NC State conducted a routine review of its long-range enrollment projections. To ensure optimal alignment between enrollment and resources, the University decided to slow enrollment growth. Instead of an ambitious goal of 40,000 in 2017, the University is now aiming at

37,000 students in 2020 (including both online and off-site enrollment). **Exhibit 2-2** shows the projected population growth for NC State as a whole. Population estimates for 2017 and 2022 have been interpolated from adjacent years for use in projected future traffic levels and to correspond to the planning horizons for the 2012 *Campus Mobility Plan*. “Residents” as used in the next exhibits are students living on campus.

**Exhibit 2-2  
Projected NC State Population Growth**

	2011	2015	2017	2020	2022	2025	2011-17 % diff.	2017-22 % diff.
Undergraduate Residents	8,500	9,700	9,819	10,000	10,389	11,000	15.5%	5.8%
Undergraduate Non-Residents	15,015	14,300	14,300	14,300	14,179	14,000	-4.8%	-0.8%
Graduate Students	8,691	9,500	9,850	10,400	10,558	10,800	13.3%	7.2%
Non-Degree Students	2,558	2,500	2,418	2,300	2,259	2,200	-5.5%	-6.6%
<b>ENROLLMENT</b>	<b>34,764</b>	<b>36,000</b>	<b>36,397</b>	<b>37,000</b>	<b>37,397</b>	<b>38,000</b>	<b>4.7%</b>	<b>2.7%</b>
Faculty	2,073	2,150	2,228	2,350	2,409	2,500	7.5%	8.1%
Staff	5,896	6,200	6,357	6,600	6,679	6,800	7.8%	5.1%
Corporate Partners	NA	3,000	3,366	4,000	4,704	6,000		39.8%
<b>TOTAL POPULATION</b>	<b>42,733</b>	<b>47,350</b>	<b>48,373</b>	<b>49,950</b>	<b>51,264</b>	<b>53,300</b>	<b>13.2%</b>	<b>6.0%</b>

Source: NC State University Planning and Analysis  
NA = Not Available

Over the next 14 years, the population is projected to increase by nearly 11,000, which includes almost 5,000 more corporate partners. This amounts to a 25 percent increase in the total population, or 11 percent when the effect of the corporate partner growth is removed. More growth is anticipated in the first five years, with a 13 percent increase in the total population, followed by a further 6 percent increase in the last five years.

The population growth is almost exclusively occurring on Centennial Campus. **Exhibit 2-3** shows the growth (or decline) on the northern precincts (north, central, south, west) and **Exhibit 2-4** shows the growth on Centennial Campus. The population of the northern precincts is projected to decline by 3 percent total, indicating essentially a flat population level. In contrast, Centennial Campus is projected to more than double in population, with a 155 percent increase by 2025, resulting in nearly 12,000 more people on campus. Even when controlling for the corporate partners, the population is projected to grow by 74 percent.

**Exhibit 2-3  
North/Central/South/West Precincts Population Growth**

<b>North/Central/South/ West Precincts</b>	2011	2015	2017	2020	2022	2025	2011-17 % diff.	2017-22 % diff.
Undergraduate Residents	8,500	8,500	8,619	8,800	9,187	9,800	1.4%	6.6%
Undergraduate Non-Residents	10,115	10,300	9,561	8,550	8,408	8,200	-5.5%	-12.1%
Graduate Students	6,461	7,000	6,821	6,560	6,655	6,800	5.6%	-2.4%
Non-Degree Students	2,558	2,500	2,418	2,300	2,259	2,200	-5.5%	-6.6%

North/Central/South/ West Precincts	2011	2015	2017	2020	2022	2025	2011-17 % diff.	2017-22 % diff.
ENROLLMENT	27,634	28,300	27,445	26,210	26,523	27,000	-0.7%	-3.4%
Faculty	1,723	1,750	1,780	1,825	1,874	1,950	3.3%	5.3%
Staff	5,896	5,200	5,279	5,400	5,360	5,300	-10.5%	1.5%
Corporate Partners								
<b>TOTAL POPULATION</b>	<b>35,253</b>	<b>35,250</b>	<b>34,512</b>	<b>33,435</b>	<b>33,759</b>	<b>34,250</b>	<b>-2.1%</b>	<b>-2.2%</b>

Source: NC State University Planning and Analysis

**Exhibit 2-4  
Centennial Campus Population Growth**

Centennial Campus	2011	2015	2017	2020	2022	2025	2011-17 % diff.	2017-22 % diff.
Undergraduate Residents		1,200	1,200	1,200	1,200	1,200		0.0%
Undergraduate Non-Residents	4,900	4,000	4,625	5,750	5,770	5,800	-5.6%	24.8%
Graduate Students	2,230	2,500	2,968	3,840	3,903	4,000	33.1%	31.5%
Non-Degree Students								
ENROLLMENT	7,130	7,700	8,813	10,790	10,874	11,000	23.6%	23.4%
Faculty	350	400	446	525	535	550	27.4%	19.9%
Staff	NA	1,000	1,076	1,200	1,312	1,500		22.0%
Corporate Partners	NA	3,000	3,366	4,000	4,704	6,000		39.8%
<b>TOTAL POPULATION</b>	<b>7,480</b>	<b>12,100</b>	<b>13,703</b>	<b>16,515</b>	<b>17,486</b>	<b>19,050</b>	<b>83.2%</b>	<b>27.6%</b>

Source: NC State University Planning and Analysis  
NA = Not Available

This skew of the growth patterns towards Centennial Campus has significant implications for the transit system and for general traffic levels in the area.

## 2.2 Wolfline Services

Wolfline service is considered fare-free general-public service open to all. Wolfline data is reported to the National Transit Database and is eligible to receive federal funds. Wolfline offers a variety of different transit services. The Academic Year (AY) 2011-12 routes can be divided into:

- 12 peak-hour weekday routes
- 3 late-night routes
- 2 weekend routes

The Red Terror, is a game-day special event route connecting campuses and off-site athletic arenas, and is not being evaluated in this study.

Wolfline service is operated by a private contractor, First Transit. The contract was originally signed for the 2007-12 period; it was renewed for another five years for 2012-17. Two additional one-year extension options are available after 2017.

**2.2.1 Daytime Services**

A total of 12 daytime routes are in operation. **Exhibit 2-5** lists key operating characteristics of the Spring 2012 semester’s offerings.

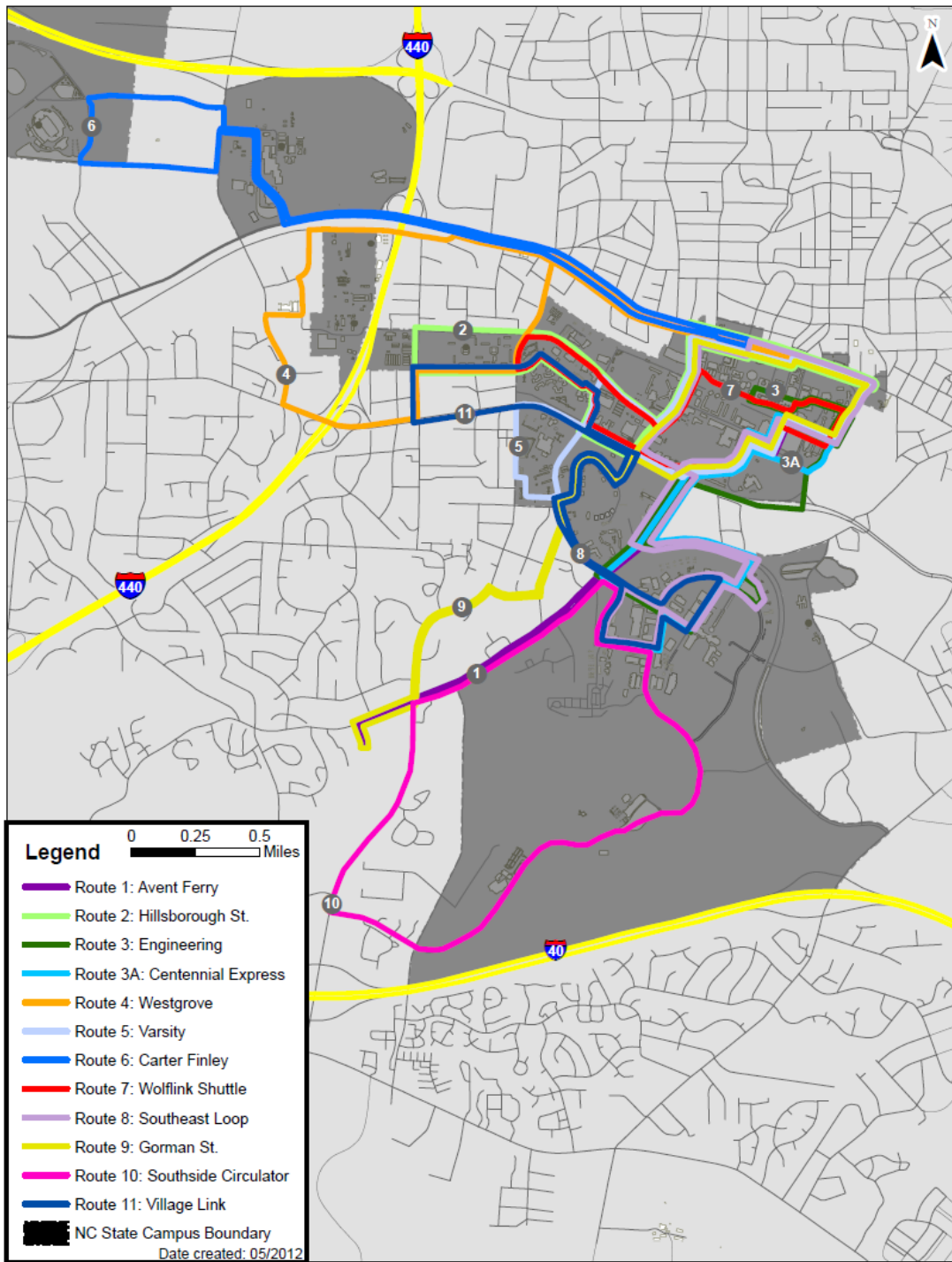
**Exhibit 2-5  
Wolfline 2011-12 Daytime Route Parameters**

Route	Span	Headway (min)	Buses
1 Avent Ferry	6:57 AM – 10:05 PM	12 day; 18 evening; 36 night	40-foot
2 Hillsborough Street Shuttle	7:21 AM – 6:36 PM	15 minute	40-foot
3 Engineering	7:16 AM – 8:24 PM	10 day; 30 evening	30-foot
3A Centennial Express	7:00 AM – 6:30 PM	15 minute	40-foot
4 Westgrove	7:15 AM – 8:12 PM	30 minute	40-foot
5 Varsity	7:11 AM – 10:05 PM	15 day; 30 night/evening	40-foot
6 Carter Finley	7:08 AM – 10:07 PM	15 day; 30 night/evening	40-foot
7 Wolflink Shuttle	7:18 AM – 10:03 PM	10 day; 30 night/evening	30-foot
8 Southeast Loop	6:58 AM – 9:54 PM	12 day; 36 night/evening	40-foot
9 Gorman Street Local	7:00 AM – 10:30 PM	9 morning; 12 afternoon; 16 evening; 48 night	40-foot
10 Southside Circulator	7:00 AM – 12:06 PM 3:00 PM – 7:02 PM	16 minutes	40-foot
11 Village Link	7:26 AM – 6:29 PM	30 minutes	40-foot

Source: Wolfline Routes and Schedules

The majority of routes operate between roughly 7 AM and 10 PM, but several routes end service around 6:30 PM. The 10 Southside Circulator, a relatively new route, is the only route that does not operate during the midday. Routes 3 Engineering and 7 Wolflink Shuttle use smaller buses because they operate internally on the north campus on streets with tighter turns and narrower roadways. **Exhibit 2-6** shows the Spring 2012 route structure

Exhibit 2-6  
Wolfline 2011-12 Daytime Routes



Existing Wolfline Routes



**2.2.2 Night and Weekend Services**

As noted above, several routes operate during the evening and night hours until 10 PM. Wolfline operates three routes in the late night hours. **Exhibit 2-7** provides the details on these services.

**Exhibit 2-7  
Wolfline 2011-12 Night Route Parameters**

Route	Span	Headway (min)	Buses
2 Hillsborough Street Night Shuttle	6:19 PM – 2:51 AM (M-F)	30 minute	40-foot
Werewolf	9:55 PM – 2:57 AM (M-F) 5:53 PM – 2:57 AM (S,S)	22 minute	40-foot
Wolfprowl	9:00 PM – 3:00 AM (Th, F, S)	30 minute	40-foot

Source: Wolfline Routes and Schedules

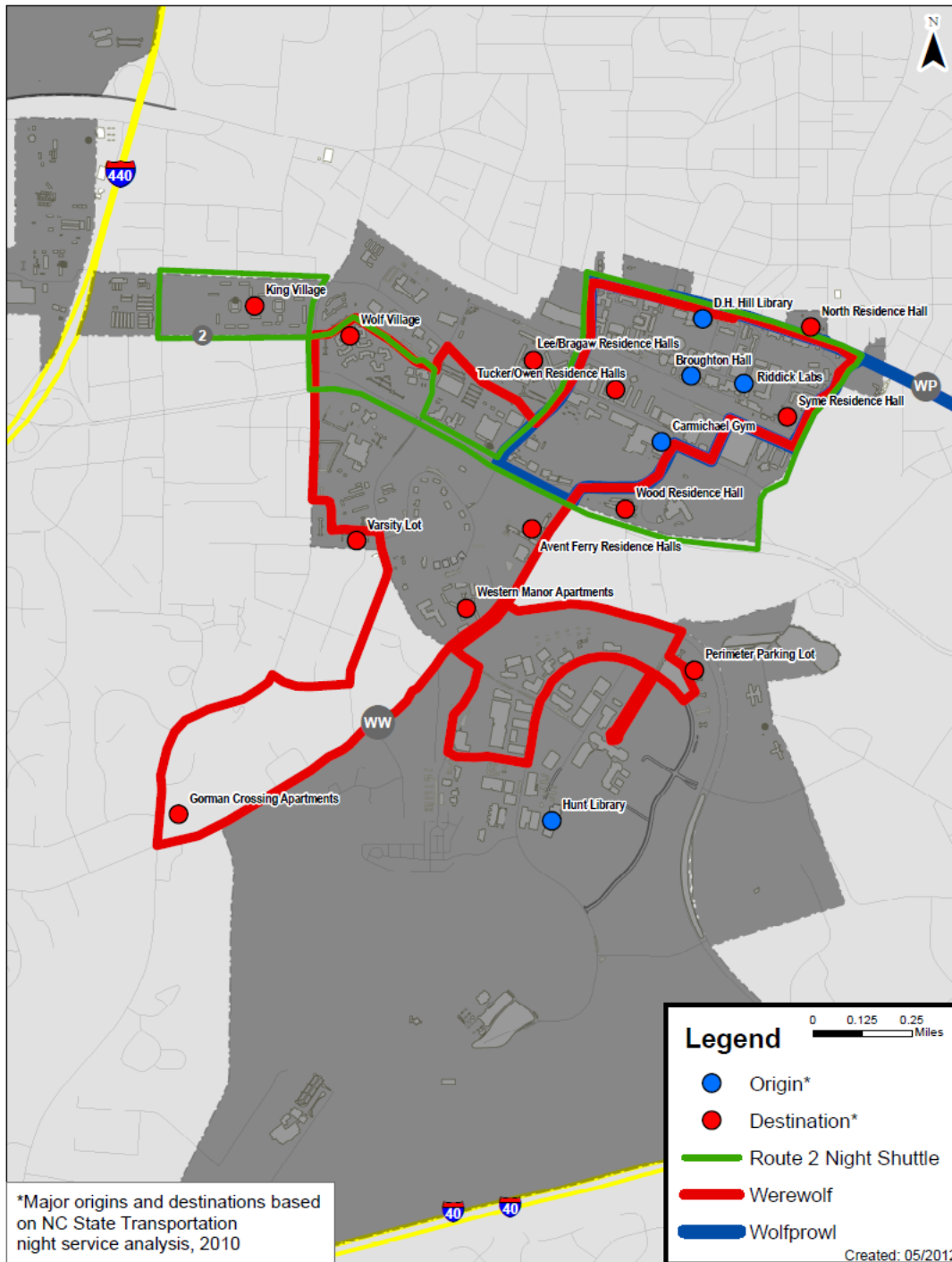
The 2 Hillsborough Street Night Shuttle does not follow the same route as the daytime 2 Hillsborough Street Shuttle. The Werewolf is the only route in the Wolfline system that operates on the weekend, and then only in the evening and nighttime. The Wolfprowl only operates on Thursday, Friday, and Saturday nights and serves a specific purpose rather than a normal night circulator. **Exhibit 2-8** shows the nighttime Wolfline routes.

Separate from the Wolfline routes, the Budd Security Group provides a demand-response<sup>1</sup> night security escort service that escorts students, faculty, and staff between campus locations. The service operates between the hours of 6:00 PM and 3:00 AM and is under the authority of University Housing. One van is used to provide the service. After 3:00 AM until the start of bus service, the Campus Police provide an escort service. Major locations shown on the map are reflective of the travel patterns from this Budd escort and the Hunt Library, which is anticipated to be another active nighttime location. More information on the Budd escort service ridership patterns is provided in Section 2.4.6.

<sup>1</sup> Demand-response refers to services that do not follow a set route. Vehicles connect specific origins and destinations based upon the travel needs of the riders. It is similar to a taxi service except that riders share the vehicle among multiple origin/destination pairs.



Exhibit 2-8  
Wolfline 2011-12 Night Routes



Existing Wolfline Night Routes

### 2.2.3 Wolfline Fleet

Exhibit 2-9 lists the Wolfline 34-vehicle fleet, all owned by the private contractor, First Transit. They also have two standby buses available at their facility that are occasionally used on Wolfline service.

**Exhibit 2-9  
Wolfline Fleet**

Vehicle	Model	Year	Number	Length	Seats
New Flyer	DLF40	2007	21	40-foot	34
Blue Bird	C4RE	2002	5	40-foot	45
El Dorado	XHF-32	2007	8	32-foot	30

Source: First Transit



The five Blue Bird buses were included as used buses in the contract. They are scheduled to be replaced with new buses in 2013.

### 2.2.4 Wolfline Costs and Funding

The Wolfline system, free and open to the public, is primarily funded by a dedicated Transit Fee assessed on all registered students as part of their educational expenses. In 2011, the annual fee was \$135, which covered 71 percent of the \$5.5 million transit contract, the Transit Visualization System<sup>2</sup> (real time bus locator), and charges associated with the GoPass trips. This pass system enables students/ faculty/staff to ride for free on local CAT and regional TTA systems. Exhibit 2-10 shows the 10 years of costs and student fees.

**Exhibit 2-10  
Wolfline Costs and Fees 2002-2011**

Description	Actual 2002	Actual 2003	Actual 2004	Actual 2005	Actual 2006	Actual 2007	Actual 2008	Actual 2009	Actual 2010	Actual 2011
Transit Payments	\$2,241,588	\$2,332,562	\$2,634,108	\$3,088,172	\$3,207,394	\$3,722,771	\$4,147,810	\$4,006,047	\$4,207,330	\$5,463,473
Student Fee Revenue	\$1,887,846	\$2,006,001	\$2,035,657	\$2,057,193	\$2,252,335	\$2,728,357	\$3,053,893	\$3,562,516	\$3,632,129	\$3,852,928
Annual Deficit	\$353,742	\$326,561	\$598,451	\$1,030,979	\$955,059	\$994,413	\$1,093,917	\$443,531	\$575,201	\$1,610,545
Fees as a % of Expense	84%	86%	77%	67%	70%	73%	74%	89%	86%	71%
Ann. Student Transit Fee	\$74.00	\$78.00	\$80.00	\$80.00	\$88.00	\$104.00	\$114.00	\$130.00	\$130.00	\$135.00
From Fiscal Year ending June 30										

Source: NC State Accounting System

No fares are collected on Wolfline service, the university does not receive any operating money directly from federal or State transit sources. NC State Transportation parking revenues subsidize approximately 20-30 percent of transit-related costs, variable year to year.

<sup>2</sup> See <http://NCState.transloc.com/> for real-time bus location information.

## 2.3 Other Transit Services

Besides Wolfline, other transit services are provided to and around the campus. These include public transit services and private apartment shuttles, discussed below.

### 2.3.1 Public Transit Services

The City of Raleigh’s transit service, CAT, offers five routes to or around the campus, including one route that only operates nights and Sundays. Connections are provided to downtown Raleigh and to apartment complexes and businesses. Triangle Transit, the regional transit provider in Wake, Orange, and Durham Counties, has seven routes with stops adjacent to the campus. **Exhibit 2-11** provides the service parameters for these routes. All routes use 40-foot buses, with most of the fleet using low-floor buses. **Exhibit 2-12** shows the Wolfline, CAT, and TTA routes.

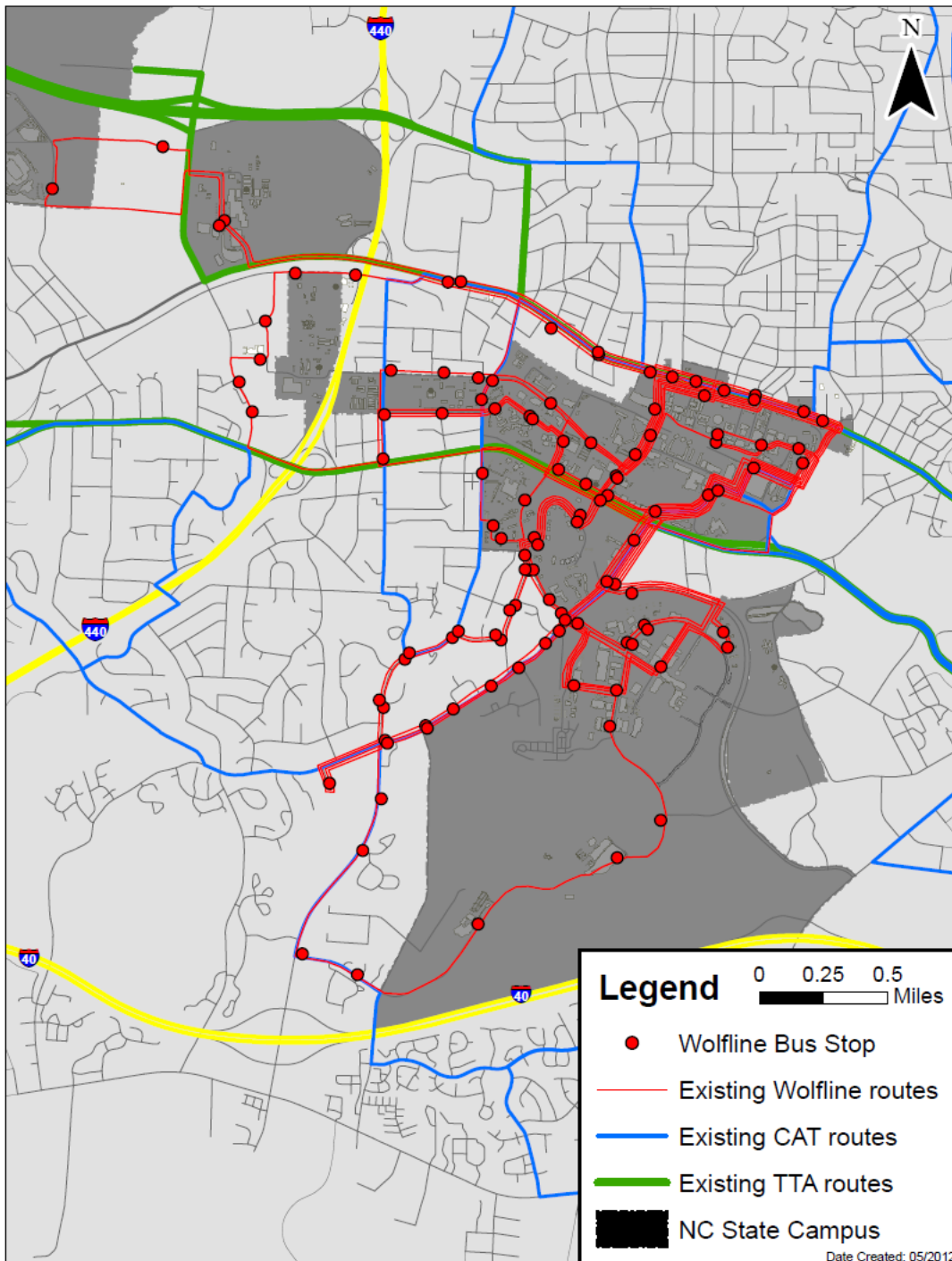
**Exhibit 2-11**  
**CAT/TTA Daytime Route Parameters**

Route	Operator	Span	Headway (min)
4 Rex Hospital	CAT	4:30 AM – 8:30 PM (M-F) 5:00 AM – 8:00 PM (Sat)	30 minutes (M-F) 60 minutes (Sat)
11 Avent Ferry	CAT	5:45 AM – 11:00 PM (M-Sat) 8:00 AM – 8:00 PM (Sun)	30 peak; 60 other times
11C Buck Jones Connector	CAT	5:55 AM – 11:00 PM (M-Sat)	60 minutes
12 Method	CAT	5:45 AM – 11:00 PM (M-F) 6:45 AM – 11:00 PM (Sat) 8:00 AM – 8:00 PM (Sun)	30 peak; 60 other times
38 Blue Ridge (night & Sundays)	CAT	7:00 PM – 12:00 AM (M-Sat) 8:00 AM – 8:00 PM (Sun)	60 minutes
100 Raleigh-Airport-RTC	TTA	6:05 AM – 11:15 PM (M-F) 6:30 AM – 7:15 PM (Sat)	30 peak; 60 midday, nights 60 minutes (Sat)
105 Raleigh-RTC	TTA	5:45 AM – 9:35 AM (M-F) 3:20 PM – 7:15 PM (M-F)	30 minutes
301 Raleigh-Cary-RTC	TTA	5:50 AM – 9:37 AM (M-F) 3:30 PM – 7:30 PM (M-F)	30 minutes
303 Cary-Raleigh	TTA	9:00 AM – 2:55 PM (M-F) 7:00 AM – 6:55 PM (Sat)	60 minutes
305 Lake Pine-Cary-Raleigh	TTA	6:10 AM – 9:53 AM (M-F) 4:05 PM – 7:43 PM (M-F)	35-60 minutes
CRX Chapel Hill-Raleigh Express	TTA	6:00 AM – 9:55 AM (M-F) 4:00 PM – 7:21 PM (M-F)	15-35 minutes
DRX Durham-Raleigh Express	TTA	6:02 AM – 9:25 AM (M-F) 3:32 PM – 7:20 PM (M-F)	25-30 minutes

Source: Individual systems



Exhibit 2-12  
NC State Area Public Transit Service

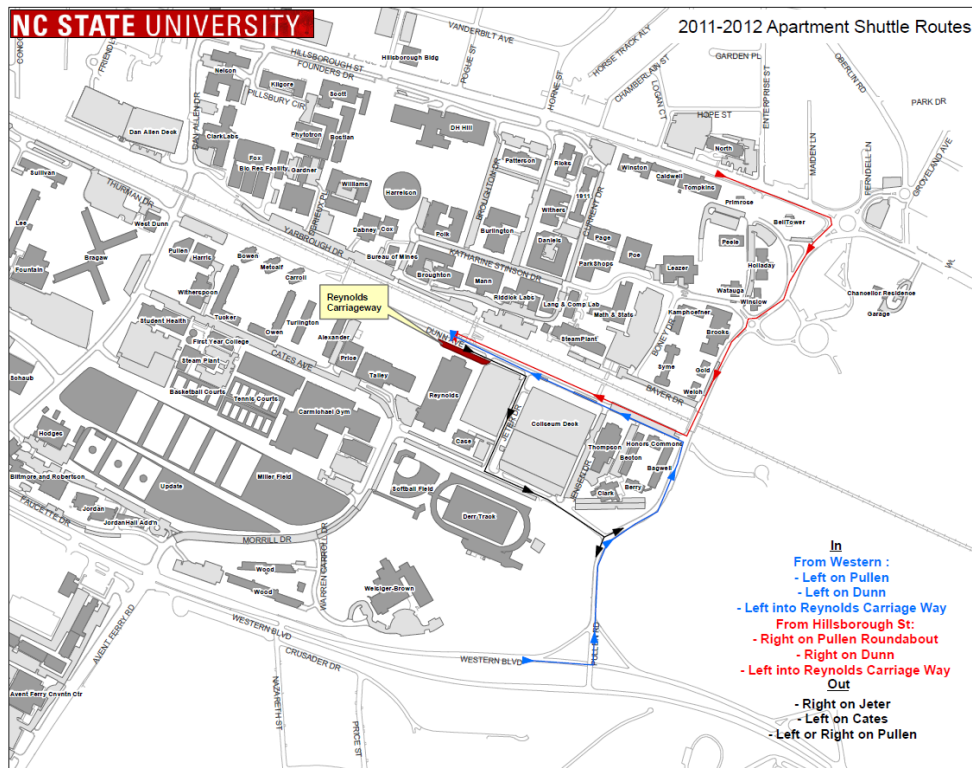


NC State Area Existing Transit Service

### 2.3.2 Private Apartment Shuttles

Several apartment complexes provide their own shuttle bus service to and from campus on routes and at stops specified by Transportation. **Exhibit 2-13** shows the current shuttle routing.

**Exhibit 2-13**  
**Private Apartment Shuttle Routing**



## 2.4 Ridership Levels

In the Spring 2011 semester, Wolfline carried in excess of 14,000 average weekday boardings. This ridership level is almost as high as the 18,900 riders on CAT and far exceeds the 4,800 riders on Triangle Transit and the 600 riders on Cary's CTran.

### 2.4.1 Ridership by Route

Ridership on the individual routes ranges from 300 or fewer average weekday boardings on the peak-only 10 Southside Circulator and weekend-night-only Wolfprowl to more than 2,000 average weekday boardings on the 1 Avent Ferry and 9 Gorman Street Local. The 1 Avent Ferry, with 2,590 average weekday riders, is the busiest route in Wake County. **Exhibit 2-14** provides the average weekday boardings for the Spring 2011 semester. Ridership for the 3A Centennial Express and 10 Southside Circulator is from Fall 2011 since these routes did not exist in Spring 2011.



**Exhibit 2-14**  
**Spring 2011 Boardings by Route**

Route	Average Weekday Boardings
1 Avent Ferry	2,590
2 Hillsborough Street Shuttle (1)	779
3 Engineering	1,482
3A Centennial Express (2)	907
4 Westgrove	345
5 Varsity	1,036
6 Carter Finley	694
7 Wolfink Shuttle	1,650
8 Southeast Loop	1,765
9 Gorman Street Local	2,044
10 Southside Circulator (2)	311
11 Village Link	526
Werewolf	180
Wolfprowl	133
<b>TOTAL</b>	<b>14,443</b>

Source: APC Count Data

Notes: (1) includes nighttime ridership  
(2) from Fall 2011

### 2.4.2 Ridership by Stop

Stop level ridership information was examined to identify major activity locations. **Exhibit 2-15** lists all stops with more than 500 average daily trip ends (boardings plus alightings). These 12 stops encompass 58 percent of the total Wolfline activity. **Exhibit 2-16** shows the stop level activity on top of the land use for September 2011. Stops served by more than one route show the consolidated ridership totals.

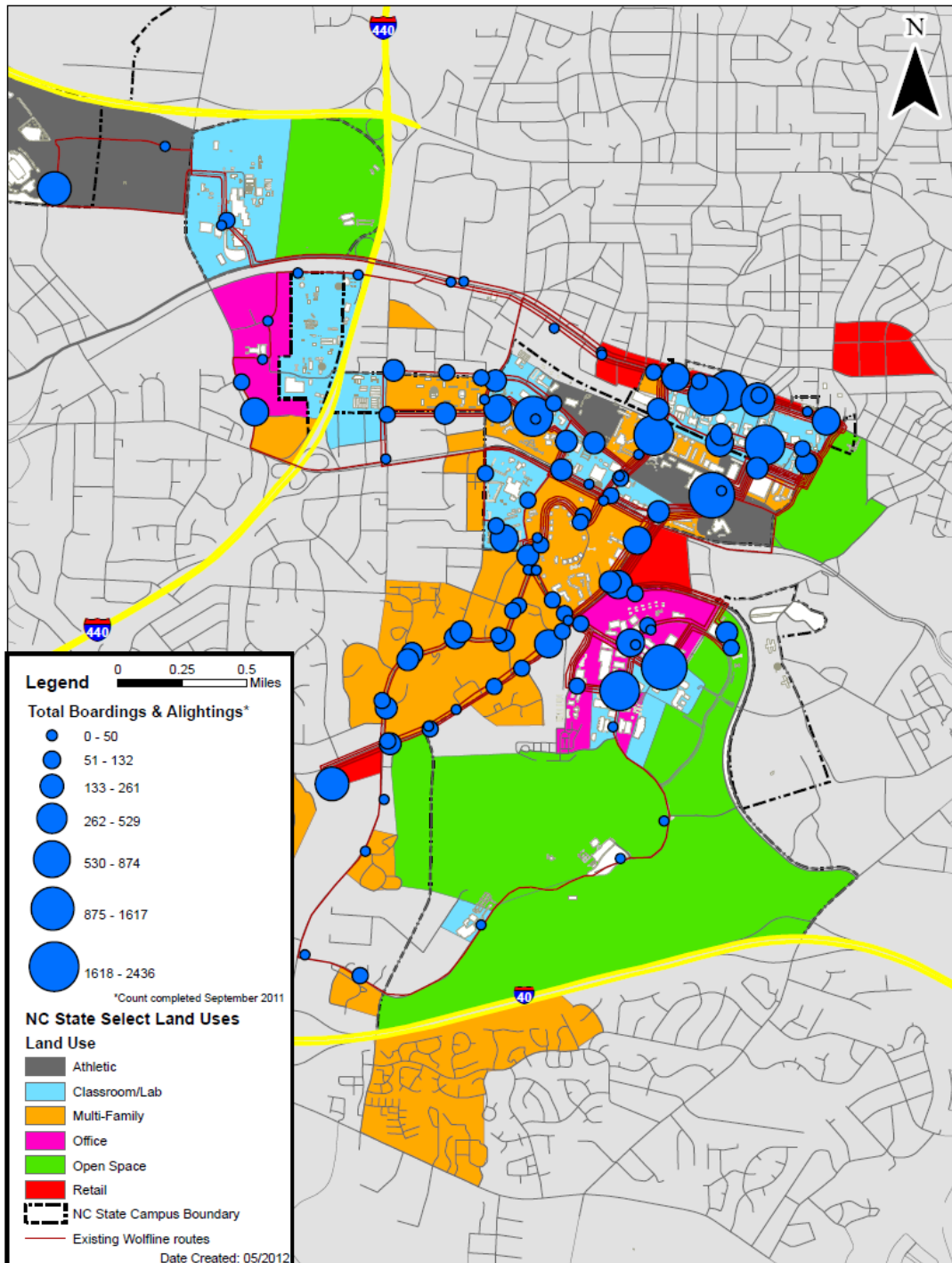
**Exhibit 2-15**  
**September 2011 Major Wolfline Stops (500+ trip ends)**

Location	Boardings	Alightings	Total
Morrill Dr at Carmichael Gym	1,697	738	2,436
Varsity Dr at Partners Way (COE)	1,258	1,157	2,414
Wolf Village Shelter	849	768	1,617
Main Campus Dr at College of Textiles	739	705	1,437
Current Dr at Stinson Dr (Lang & Comp Lab)	663	595	1,258
Dan Allen Dr at Witherspoon	422	795	1,217
Founders Dr at DH Hill	603	544	1,147
Founders Dr at Scott Hall	546	512	1,058
Founders Dr at Patterson	473	401	874
Greek Way at Avent Ferry Rd	380	333	713
Carter Finley Park & Ride	341	341	682
Yarborough Dr at Stinson Dr (Broughton)	222	307	529

Source: APC Count Data



Exhibit 2-16  
September 2011 Stop Level Activity & Land Use



Wolfline Average Weekday Stop Activity

### 2.4.3 Passenger Loads

As a university campus service, Wolfline’s ridership is closely tied to class schedules. Trip fluctuations can result in crowded conditions on some trips. While some degree of standees is acceptable given the short duration of the trip, some trips exceed a 150 percent seated load, considered a level-of-service<sup>3</sup> (LOS) F condition by the *Transit Capacity and Quality of Service Manual*. With an average of 36 seats on a 40-foot bus, a 150 percent load would be in excess of 54 riders on board at any one time. **Exhibit 2-17** shows the percentage of total trips that exceed the LOS for F, E, and D conditions during the Spring 2011 semester, based upon the reported max load onboard the vehicle on any given trip.

**Exhibit 2-17**  
**Percentage of Trips with Standees (Spring 2011)**

Route	LOS F 150% Load “Crush Load”	LOS E 125% Load “Full Bus”	LOS D 100% Load “Some Standees”	Total with Standees
1 Avent Ferry	3%	3%	4%	10%
2 Hillsborough Street Shuttle (1)	0%	1%	1%	2%
3 Engineering	1%	2%	6%	9%
3A Centennial Express (2)	0%	1%	3%	5%
4 Westgrove	0%	0%	1%	1%
5 Varsity	1%	1%	2%	4%
6 Carter Finley	0%	0%	1%	1%
7 Wolfink Shuttle	1%	2%	5%	8%
8 Southeast Loop	2%	3%	6%	12%
9 Gorman Street Local	5%	4%	7%	15%
10 Southside Circulator (2)	0%	0%	0%	0%
11 Village Link	0%	0%	2%	2%
Werewolf	0%	0%	0%	0%
Wolfprowl	0%	0%	0%	0%

Source: APC Count Data

Notes: (1) includes nighttime trips  
(2) from Fall 2011

The two routes with the heaviest ridership, 1 Avent Ferry and 9 Gorman Street Local, are also the two routes with the most overloaded trips. While no standards exist on the number of trips that can exceed a certain LOS standard and still be acceptable, a level where more than 2 percent of the trips exceeded LOS F was viewed as undesirable and an indication that more frequent service was needed. A 2 percent level is about one overloaded trip per day. Route 8 Southeast Loop should be closely monitored; while no more than 2 percent of the trips exceeded the crush loads, 12 percent of the trips did have standees.

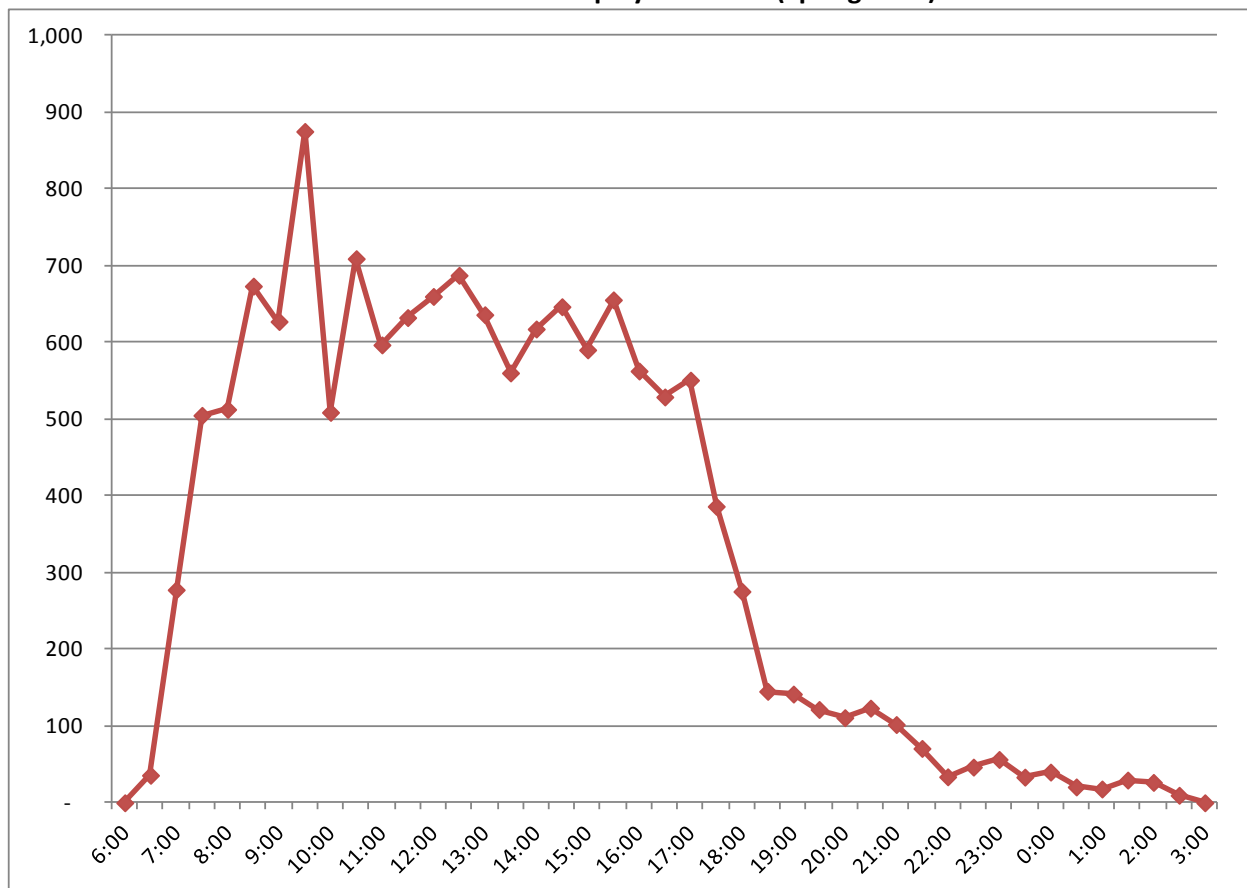
**Suggested Passenger Load Standard**  
For Wolfline, a reasonable target is for no more than 2% of the trips on a route to exceed LOS “F”, or 150% of a seated load, considered to be a “crush load.”

<sup>3</sup> LOS is a standard approach used for traffic and transit evaluations; it is similar to the grade system used in school, and indicates when conditions are acceptable and when they are nearing or have surpassed the desired capacity constraints. For planning purposes, a LOS D or E is considered a reasonable target for most measures. At this level, a balance is achieved between providing a high quality service and the costs of the service.

### 2.4.4 Ridership by Time of Day

Ridership fluctuates over the course of the day at Wolfline. To identify travel patterns and habits, ridership was analyzed by half-hour time period for each route. The results for the system are shown in **Exhibit 2-18**; **Exhibit 2-19** provides a table by route. The graph clearly shows the peak half hour is from 9:30 to 10:00 AM as students take Wolfline to reach their 10:00 AM classes. During that half hour, 875 riders were on Wolfline, or 6 percent of the total daily ridership.

**Exhibit 2-18**  
**Total Wolfline Ridership by Half Hour (Spring 2011)**



Source: APC Count Data

**Exhibit 2-19**  
**Route Ridership by Half Hour (Spring 2011)**

Time	1	2	3	3A	4	5	6	7	8	9	10	11	Were	Prowl	Total	Daily %
6:00															-	0%
6:30	16								20						36	0%
7:00	43	5	15	17	9	40	25	12	33	53	13	11			278	2%
7:30	105	25	30	26	15	37	34	74	53	63	17	26			505	3%
8:00	74	27	60	23	12	34	31	63	41	93	30	24			513	4%
8:30	111	51	44	34	22	46	44	64	109	90	19	39			673	5%
9:00	84	20	86	48	11	41	25	71	57	112	30	45			627	4%
9:30	145	67	78	40	30	65	53	113	128	116	18	21			875	6%
10:00	71	22	80	38	11	26	18	51	56	79	26	32			509	4%
10:30	123	32	79	59	16	45	30	79	122	79	25	20			709	5%
11:00	83	38	74	42	16	47	34	89	34	120		19			597	4%
11:30	123	30	80	46	14	49	27	80	85	80		19			632	4%
12:00	86	31	96	69	14	37	28	75	81	106		38			660	5%
12:30	159	31	86	55	17	58	33	99	44	93		13			688	5%
13:00	83	41	65	42	20	44	37	82	72	134		16			636	4%
13:30	125	21	83	40	10	36	19	56	83	55		33			560	4%
14:00	102	30	91	58	17	52	32	89	47	87		12			618	4%
14:30	138	37	66	37	24	43	38	77	73	106		8			647	4%
15:00	77	23	74	46	13	34	23	58	106	64	30	42			590	4%
15:30	142	27	75	47	14	46	24	78	75	92	17	20			656	5%
16:00	83	32	46	32	20	43	33	70	88	77	21	18			563	4%
16:30	124	20	53	34	13	33	24	49	60	65	17	36			529	4%
17:00	86	20	58	41	13	39	21	57	87	78	32	19			551	4%
17:30	111	21	22	23	15	29	20	52	36	29	17	13			386	3%
18:00	67	16	9	10		22	11	31	57	49		3			275	2%
18:30	50	14	-			22	5	17	38	-					145	1%
19:00	-	11	27			17	7	15	27	38					142	1%
19:30	48	10	-			14	5	12	-	32					122	1%
20:00	47	8	6			14	4	12	20	-					111	1%
20:30	36	8				11	4	10	21	34					123	1%
21:00	29	9				9	3	11	12	17			12		102	1%
21:30	20	7				3	3	5	3				21	9	71	0%
22:00		7											21	6	34	0%
22:30		7											25	15	46	0%
23:00		5											33	18	56	0%
23:30		6											14	13	33	0%
0:00		6											22	13	40	0%
0:30		3											9	9	21	0%
1:00		4											8	6	18	0%
1:30		3											18	8	30	0%
2:00		3											9	15	27	0%
2:30														10	10	0%
3:00															-	0%
TOTAL	2,590	779	1,482	907	345	1,036	694	1,650	1,765	2,044	311	526	180	133	14,443	

Source: APC Count Data

Notes: Routes 3A and 10 from Fall 2011; Wolfprowl only operates on Thursday and Friday nights

Two-thirds of the ridership occurred between 8:30 AM and 4:00 PM, shown enclosed in the lighter lines. For routes that need additional trips for overloads, this 7.5 hour time period encompasses the key hours. The heavier-weight lines enclose the hours when most routes have service – 7:00 AM to 6:30

PM. Ninety-two percent of all ridership occurs during this time period. Ninety-five percent occurs before 8:00 PM, indicated by the dashed line.

Most routes in the Wolfline system keep their peak headways until 6-6:30 PM, when demand drops off. The exception is the 9 Gorman Street Local, which offers its peak headway beginning at 7:00 AM and dropping at 1:30 PM. Based upon the half-hour analysis, it would appear that the peak headway of 9 minutes could begin 1.5 hours later than currently scheduled; to after 8:30 AM (at least a 1 hour delay until 8:00 AM), but should continue in the afternoon to 4:00 PM, another 2.5 hours.

#### 2.4.5 Park & Ride Facilities/Users

For those commuters driving but without parking permits, NC State provides or maintains access to several free off-campus Park & Ride commuter lots, all served by Wolfline buses. These perimeter lots are:

- Carter Finley - Location: Within Carter Finley Stadium grounds off Trinity Road one half-mile west of the Centennial Biomedical Campus. Served by the Route 6 Carter Finley. 250+ spaces
- Westgrove -Location: Blue Ridge Road north of Western Boulevard, and one half-mile west of Central Campus. Served by the Route 4 Westgrove. 126 spaces
- Food Lion at Avent Ferry Shopping Center - Location: Avent Ferry Road near Gorman Street and 1.6 miles south of Western Avenue. Served by the 1 Avent Ferry and 9 Gorman Street Local. 25-70 spaces

During September 2011, counts were taken of the number of cars at the Carter Finley and Westgrove lots. Four days of counts were taken at Carter Finley, which had an average of 206 cars (80 percent occupancy). Westgrove was checked over three days and had an average of 44 cars parked (35 percent occupancy).

#### 2.4.6 Night Security Escort

Not included in the Wolfline analysis is the escort trips provided by the Budd Security Group for University Housing. From August 2009 to June 2010, NC State Transportation worked with University Housing to gather data and analyze the results. The report, *Analysis of Budd Group Mobile Escort Log*, provides insight into the usage during the late night hours between 6:00 PM and 3:00 AM. This analysis does not include the separate Campus Police escort that begins at 3:00 AM.

This report found that the average day over the year had 33.5 riders on 28 vehicle trips. During the key months of September through April, the service averaged about 10 more riders per day, or about 44 riders each day.

**Exhibit 2-20** shows the major locations for either origins or destinations. The Avent Ferry Complex and DH Hill Library were the two largest locations accounting for 25 percent of the trips.



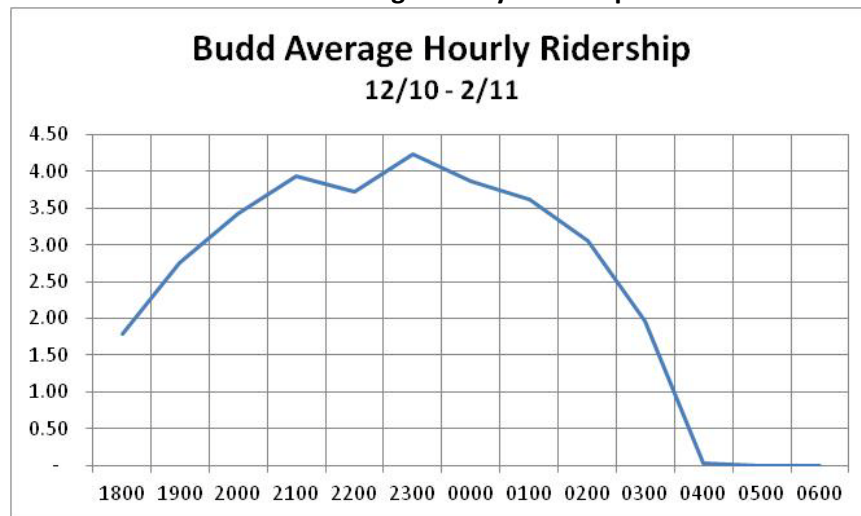
**Exhibit 2-20  
Major Security Escort Locations**

Travel Location	Trip Ends
Avent Ferry Complex	2,256
D.H. Hill Library	1,816
Bowen, Metcalf, Carroll, Tucker, & Owen cluster	1,554
North Hall	996
Wolf Village Apartments	995
Wood Hall	919
Sullivan Hall	817
Lee Hall	636
Syme Hall	626
College Inn	620
Bragaw Hall	618

Source: Analysis of Budd Group Mobile Escort Log from 08/09 through 06/10 by NC State Transportation

**Exhibit 2-21** shows the results of special counts taken from December 2010 through February 2011 for hourly usage. Approximately 70 percent of the ridership occurred between 8:00 PM and 2:00 AM. Over one-third (37 percent) of the ridership occurred between 6:00 PM and 10:00 PM, during which time the Wolfline daytime routes were in operation.

**Exhibit 2-21  
Budd Average Hourly Ridership**



Source: Budd Group Escort Time-of-Day Log analyzed by NC State Transportation

## 2.5 Rider On-board Surveys

To gain a better understanding of current transit users within the region, HDR administered an on-board ridership survey in October 2010. The survey asked questions regarding riders’ trip characteristics,

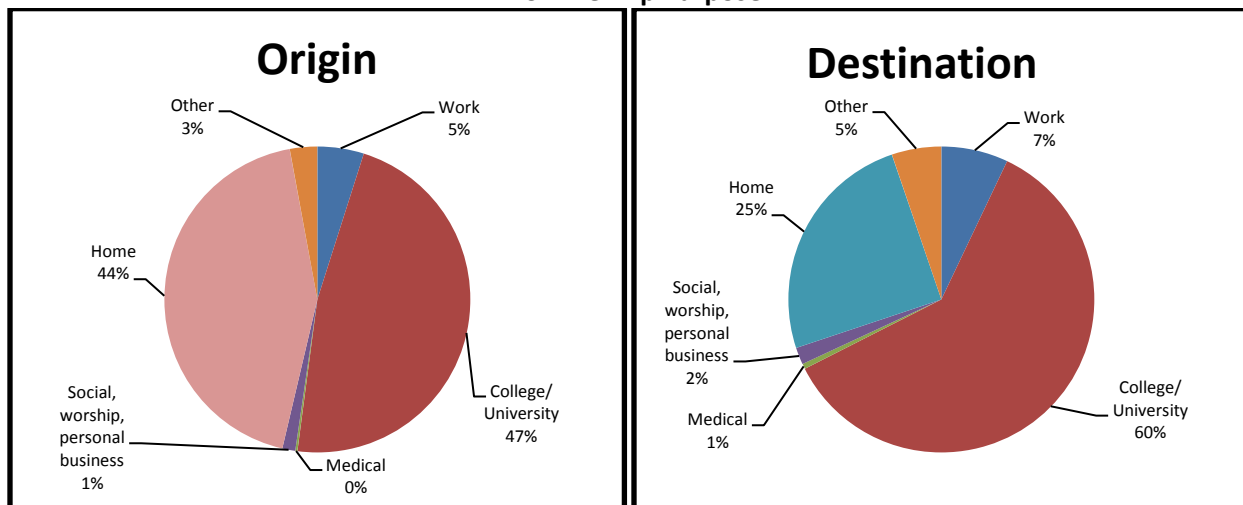
ridership habits, demographic information, and recommendations for improvements. The rider surveys are described in detail in a separate Technical Memorandum prepared as part of the overall study. Highlights are given below.

The Wolfline rider survey sampled routes over an average weekday period using an abbreviated postcard-sized form. A total of 1,960 responses were received. This sample size is accurate at the 90 percent confidence level, plus or minus 1.6 percent for system-wide statistics. The results presented below reflect the weighting of responses by route.

### 2.5.1 Trip Characteristics

When asked about the purpose of their trip, phrased as “Where did you come from before you got on this bus?” and “Where are you going now?” a plurality of riders (47 percent) said their origin was from college/university, while another 44 percent were coming from home. On the destination end, the majority of riders (60 percent) were going to college/university. Perhaps more interesting were the number of riders starting or ending their trip at work. On the origin end, 5 percent were coming from work while 7 percent were destined to work. **Exhibit 2-22** shows the complete results.

**Exhibit 2-22**  
**Wolfline Trip Purpose**



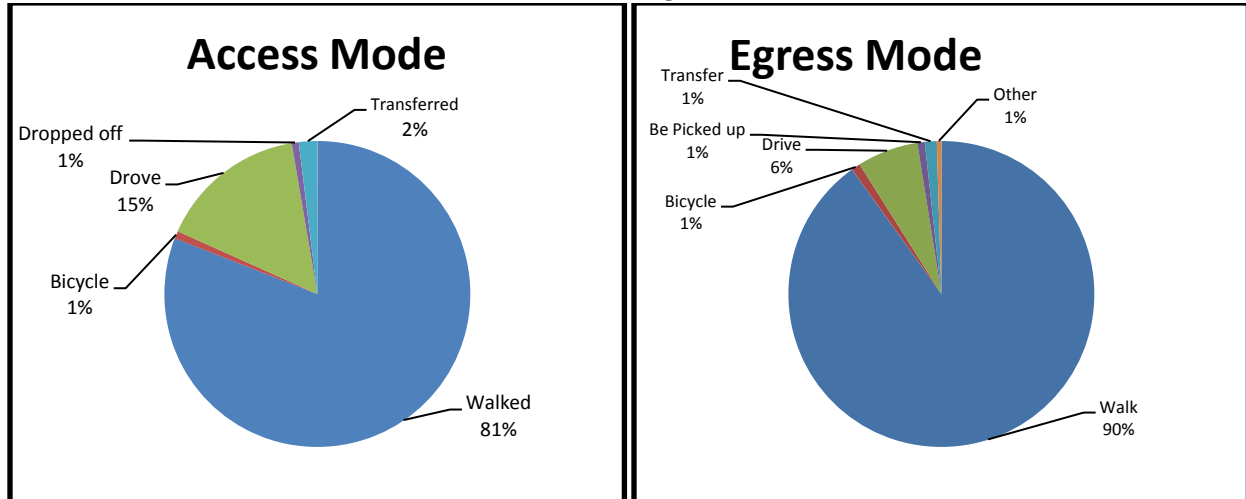
Source: 2010 Rider Survey

When excluding “home” as a trip purpose, not surprisingly the major trip purpose was for college/university with 82 percent of the trips. Work accounted for 9 percent of the trips, which could reflect both faculty/staff traveling on Wolfline, or students traveling to/from their jobs.

When asked their access and egress modes, the majority of riders indicated they walked to or from the bus, with 81 percent walking to and 90 percent walking from. More interesting is that 15 percent drove to catch Wolfline and 6 percent indicated they would drive away from the bus stop. These percentages indicate riders are using Wolfline more as a park & ride service than the ridership levels at the official park & ride lots would indicate. Some of these riders may still have a designated parking space on

campus, or may be parking on nearby streets, but use Wolfline to travel to other locations around campus. **Exhibit 2-23** shows the results.

**Exhibit 2-23**  
**Wolfline Access/Egress Modes**

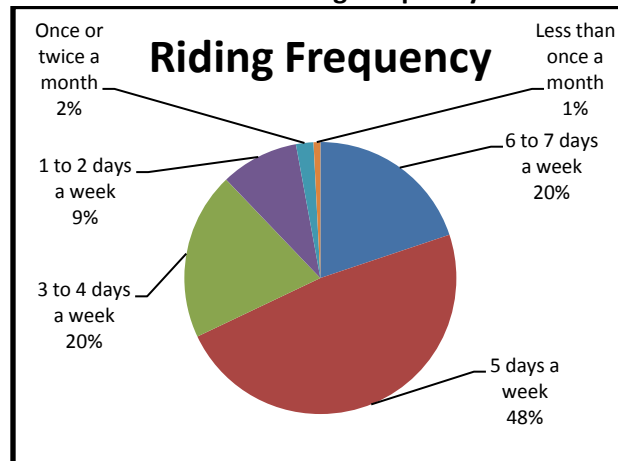


Source: 2010 Rider Survey

### 2.5.2 Rider System Use

Riders were asked how frequently they use bus service. As illustrated in **Exhibit 2-24**, a plurality of Wolfline riders ride the bus five days per week, with 48 percent using the bus every weekday. Surprisingly, another 20 percent use the bus six to seven days per week even though Wolfline only offers one regular route on the weekend. This high response is likely due to the wording of the question, “How often do you ride the bus?” not just Wolfline service. These riders are likely using CAT for their weekend travel.

**Exhibit 2-24**  
**Wolfline Riding Frequency**

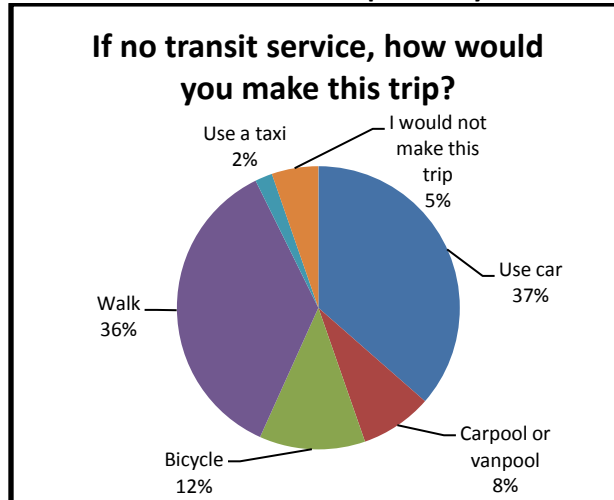


Source: 2010 Rider Survey

### 2.5.3 Transit Dependency of Riders

To gain an understanding of the impact of the bus service on mobility, riders were asked how they would travel if Wolfline service was not available. The largest number of responses was evenly divided between walking and using a car. These responses indicate that Wolfline is both a pedestrian accelerator and an alternative to auto. The findings are shown in **Exhibit 2-25**.

**Exhibit 2-25**  
**Wolfline Rider Dependency**



Source: 2010 Rider Survey

## 2.6 Other Surveys

NC State conducted several other surveys as part of the overall study effort.

### 2.6.1 Customer Satisfaction Survey

In October 2011, NC State conducted an online customer satisfaction survey as part of the broader Wake County study to a supplement to the earlier rider survey. A total of 307 responses were received. When asked to rank potential transit improvements, the following improvements were the top three choices:

- Frequency of service
- Expanded evening service hours
- Expanded weekend service hours

When asked for specific recommendations, the following responses occurred most frequently:

- Fourteen comments want more service from the apartments along Gorman St. (N of Avent Ferry) to Centennial Engineering buildings
- Thirteen comments want increased service from Main to Centennial Campus
- Eight comments expressed a desire for better weekend service

### 2.6.2 Park & Ride Survey

NC State conducted a survey of park & ride patrons at the Carter Finley and Westgrove Lots in March 2011. A total of 347 surveys were received from Carter Finley and 166 from Westgrove. Among the findings:

- 78 percent of the Carter Finley patrons and 69 percent of the Westgrove patrons indicated that the reason for using the park & ride was “prefer not to buy” a parking permit.
- 62 percent of the Carter Finley patrons used the lot daily and 30 percent used it 2-3 days/week; for Westgrove, 70 percent used it daily and 25 percent used it 2-3 days/week.
- When asked “what town are you traveling from?” 70 percent of the Carter Finley patrons came from Raleigh or Cary; for Westgrove, 78 percent came from Raleigh or Cary.

Riders were asked if there was a more convenient location for a park & ride lot. Out of the over 30 responses from both lots, the largest request was for Centennial Campus, with Avent Ferry and Cameron Village receiving several mentions.

### 2.7 Existing Traffic Levels

As part of the scope of services, HDR examined the traffic levels around campus in preparation for the analysis of potential roadway changes. This evaluation used available traffic counts from NC State, the City of Raleigh, and the North Carolina Department of Transportation, adjusted to reflect a common horizon year. The full traffic Technical Memorandum is included in the Appendix. The paragraphs below describe the existing conditions; future traffic levels are covered in Section 3.3.

Several intersections have a failing LOS F for individual approaches, where delays exceed 80 seconds per vehicle (about one traffic signal cycle). Most intersections where this occurs have failures in only one direction, but traffic flows smoothly in the other directions. As a result, the intersection as a whole is not considered to be failing. **Exhibit 2-26** lists the intersections that have at least one approach failing.

**Exhibit 2-26**  
**2012 Intersections with Failing Approaches**

Intersection	Approach	AM Peak Failure	PM Peak Failure
Dunn & Jensen	NB	X	X
Western & Gorman	EB	X	
Western & Gorman	WB		X
Western & Gorman	NB	X	X
Western & Gorman	SB		X
Hillsborough & Gorman	WB		X
Cates & Dan Allen	WB		X
Centennial Parkway & Lake Wheeler	EB		X
Varsity & Capability	NB		X

Source: HDR analysis of traffic counts

The maps on the following pages show the results for the intersections as a whole. **Exhibit 2-27** shows the results for the AM peak in 2012 and **Exhibit 2-28** shows the 2012 PM Peak (larger maps are in the appendix). The size of the circle is proportional to the amount of delay at an intersection, expressed as seconds of delay.

Only one intersection is considered to be failing today. Western Boulevard & Gorman Street is currently operating at an overall LOS F during both AM and PM peak hours. Total delay at this intersection averages 112.6 seconds per vehicle in the AM Peak and 125.2 seconds in the PM Peak. A simulation of the existing conditions using Simtraffic shows that the queuing from this intersection affects Gorman Street operations north of Western Boulevard, as well as Hillsborough Street immediately east of Gorman Street. The Hillsborough & Gorman intersection is approaching unacceptable delays with an average delay of 70 seconds per vehicle.

The delay at Dunn Avenue & Jensen Drive requires some explanation. This is the location of a parking deck, and the volumes entering/leaving the deck contribute to the delay. The reason the delay number is so high, though, is the pedestrian crossing at the transit stop directly opposite the left turn out of the garage.

These results indicate traffic is already a problem around NC State, especially on Gorman Street. Growth in the university population can only add to traffic issues. Traffic levels reflect both NC State related traffic and pass-through traffic from the area destined to nearby neighborhoods or en route to I-440 three-quarters of a mile to the west of Gorman. This study area will become more congested in the next 10 years as described in Section 3.3.

## 2.8 Travel Demand Management Strategies

NC State already has in place an aggressive TDM program under the brand 'WolfTrails'. the following alternative commute strategies are offered:

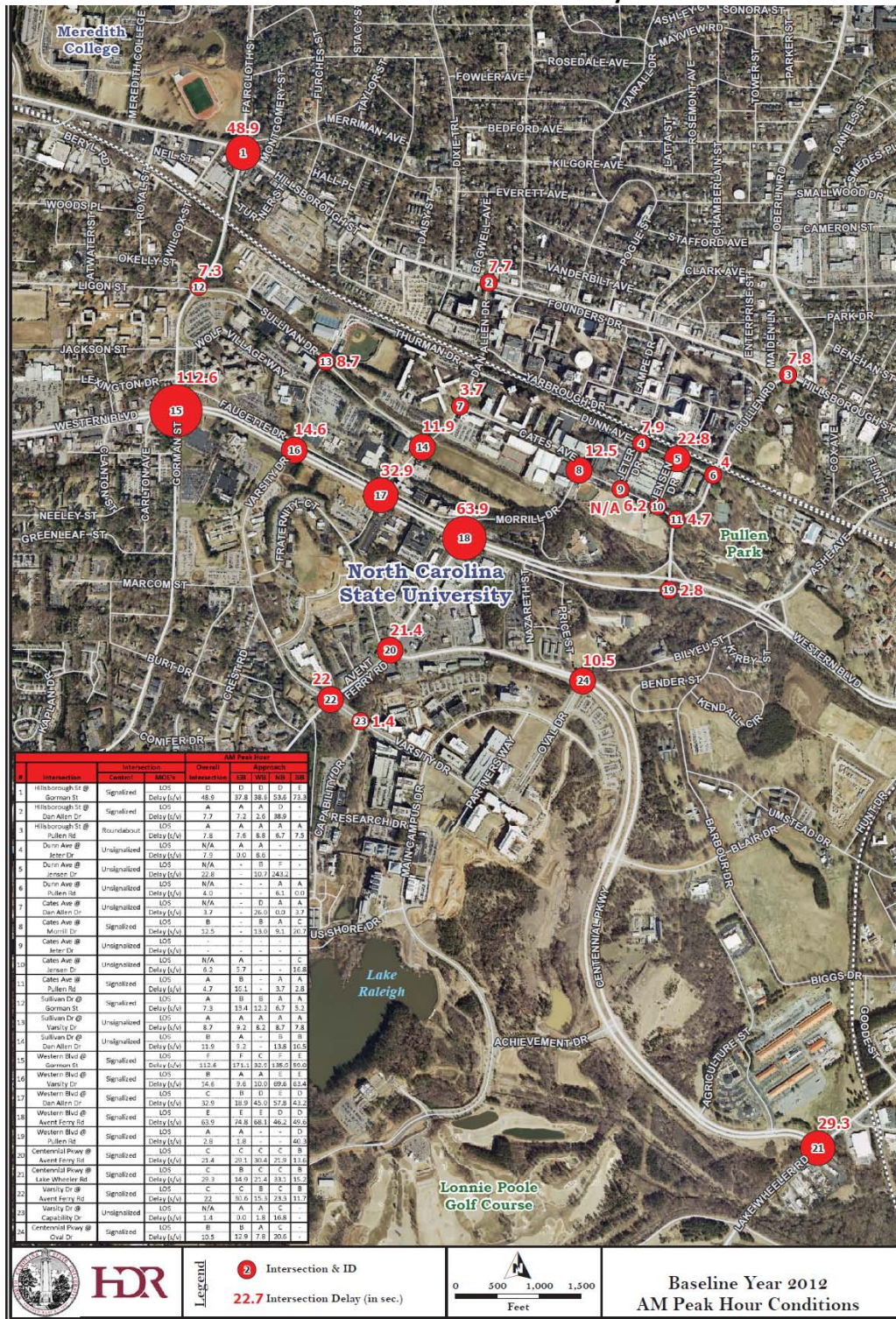
- NC State is recognized by the **Bicycle Friendly University (BFU)** program for promoting and providing a more bicycle-friendly campus for students, staff and visitors. The BFU program provides the roadmap and technical assistance to create great campuses for cycling.
- **Zipcar** is located on campus. It is a car-share program that offers the convenience of car ownership without the hassles of having a car. There are three vehicles available for use at NC State – two Prius hybrids and one Scion XB crossover -- parked in designated spots around campus. These cars will be available to students, faculty and staff of the university to borrow 24 hours a day, 7 days a week. The low hourly rate (\$8/hr) includes gas, insurance and roadside assistance. For more information, visit [www.zipcar.com/NCState](http://www.zipcar.com/NCState) or check out: [Zipcar at NC State](#).







Exhibit 2-27  
2012 AM Peak Intersection Delays

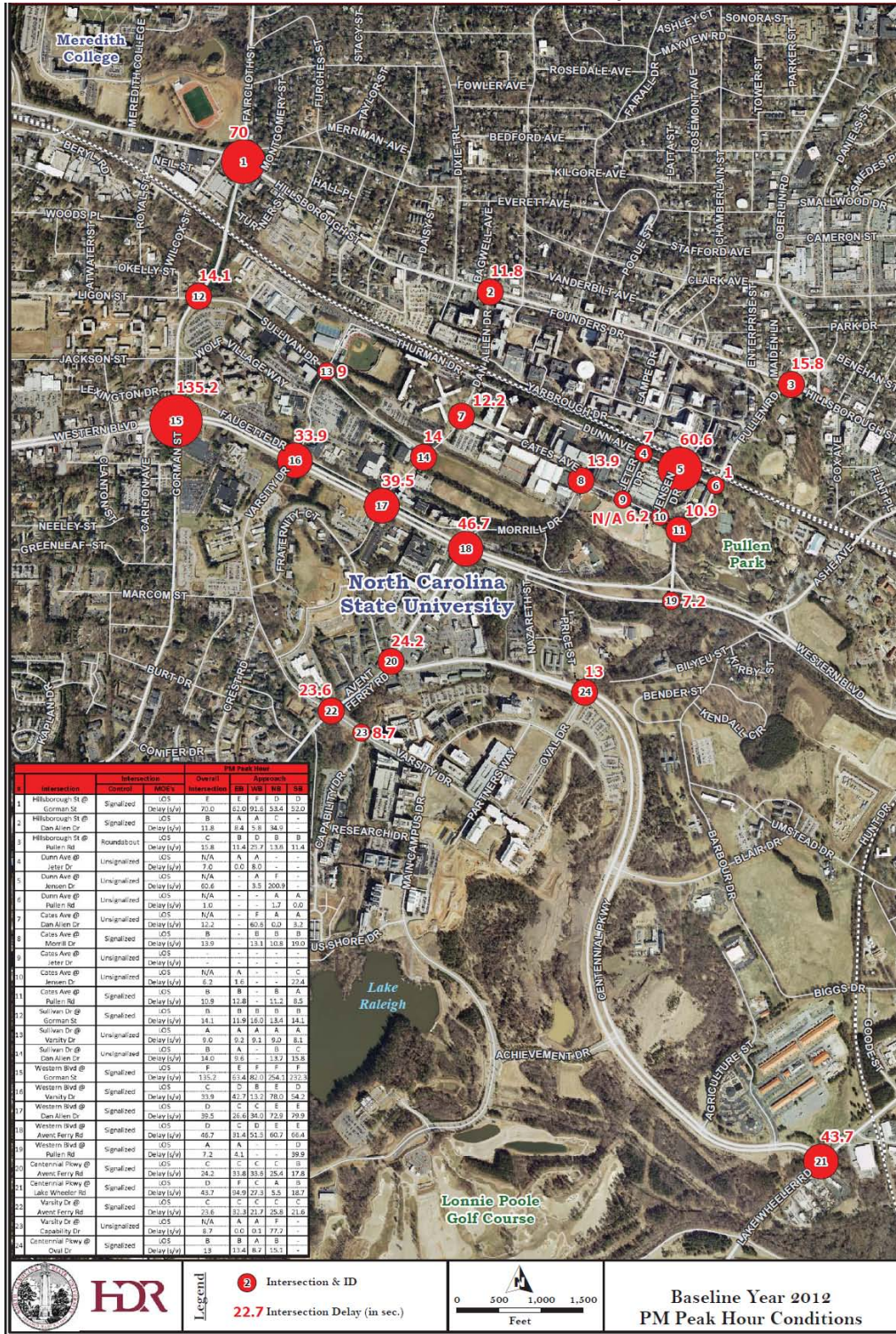


Source: HDR analysis of traffic counts






Exhibit 2-28  
2012 PM Peak Intersection Delays



Source: HDR analysis of traffic counts

- **Zimride** is a new way to share rides out of town or coordinate your daily commute. Zimride uses Facebook integration to make it convenient to find a friend, classmate or fellow NC State employee to carpool with.   
Have a car? Add your ride offer and split the costs by driving with friends, classmates or colleagues. Need a ride? Add your ride request and get to where you want to go. For more details see: [zimride.NC State.edu](http://zimride.NC State.edu).
- **Alternative Commuter Benefits.** For those who ride the bus, ride a bike or walk to work, WolfTrails offers rewards for NC State's alternative commuters. Sample benefits include free or reduced cost parking permits for a certain number of days per year for those occasions when a commuter needs to bring a car. [Details>>>](#)
- **WolfWheels Bikes Available for Rent.** NC State recently kicked off a bicycle rental program called WolfWheels, which is hosted by the Campus Recreation department at Carmichael Gym. Bicycles are available for students, faculty and staff to rent at \$3/day, \$6/weekend, \$18/week and \$99/semester. For more information, visit [www.NC State.edu/wolfwheels](http://www.NC State.edu/wolfwheels).
- NC State also participates in the **GoPass program** offered by Triangle area transit providers. Under this program, all faculty, staff, and students currently can ride CAT and TTA transit systems at no cost. GoPasses are available on line: no charge to students; for faculty, staff, and corporate partners a \$25 annual fee is being introduced in 2012-13. All walk in customers will also pay a \$5 “rush” service fee.

As this list shows, NC State already has in place a wide variety of incentives to commute in different modes other than driving yourself to campus. Not included in the above list is the most effective way to get people to use other forms of transportation – charging fixed or variable rates for parking, often adjusted to demand and supply conditions. Besides downtown and RDU airport, NC State’s deck paylots are the only location in Wake County that has market rate charges for parking.



### 3 Analysis and Potential Enhancements

In coordination with the Technical Team and based upon feedback from the Advisory Committee, a set of goals and objectives were identified for Wolfline service. Based upon these goals and objectives, a series of potential service and capital enhancements were developed. These potential enhancements address existing service/capital shortcomings; anticipate the magnitude and location of future growth in enrollment and staffing; and improve connections with other transit services.

#### 3.1 Wolfline Goals

Before developing service and capital improvements for the Wolfline service, a clear understanding of the goals and objectives of Wolfline is required. Based upon discussions between HDR and the Technical Team, the following goals for Wolfline were identified:

- Provide mobility for students, faculty, staff & visitors around campus
- Focus on internal circulation and peripheral park & rides
- Maintain connectivity to local and regional bus systems
- Operate in a cost-effective manner

While basic, these goals are, important for what is not included as what is included. Several options for Wolfline service were discussed:

1. The “ECU Model” – This service model is the one used by East Carolina University in Greenville. ECU Transit is a comprehensive, citywide service that has two basic objectives: provide intra-campus mobility; and provide service throughout the community for students where a funding partner is available. Under this latter objective, ECU Transit will serve any apartment community that desires service if the apartment community pays for the service. ECU Transit has little relation to the City of Greenville bus service.
2. The “UNC Model” – This service model fully integrates the university and city systems. A separate university service is not provided, but UNC-Chapel Hill pays for the full cost of some routes focused on the university and a portion of the costs for the general community routes.
3. The traditional “Wolfline Model” – the traditional role for Wolfline, and the role of most university transit systems in the nation, is to provide intra-campus shuttle service and to rely on the city bus services (CAT and TTA for Wolfline) to provide the connections to the broader community.

The latter model was confirmed with the Technical Team and reviewed and confirmed with the broader Advisory Committee.

The focus on just campus origins and destinations is a key goal, but is not a hard and fast limitation. Wolfline already provides some service off campus, most notably to the apartment complexes along Gorman and Avent Ferry and to the Food Lion off Avent Ferry. Exhibit 2-10 in the previous chapter shows where Wolfline stops are located outside of the campus boundary. These off-campus services are

longstanding, and are considered an integral part of the Wolfline service area. No effort was made to reduce or eliminate these services.

Similarly, the Wolfprowl service, which provides late evening/night connections to downtown Raleigh, particularly the entertainment area along Glenwood South, was viewed as a desirable service to continue. Even though this area is about a mile from campus, the desire to provide a safe alternative to students having to drive their own vehicles is strong. CAT does not provide service this late, so no alternative service would be available if Wolfline did not operate. Should CAT extend their hours until 3:00 AM as the Wolfprowl does, then the Wolfprowl service might not be warranted.

For other destinations, the Wolfline service boundary was desired to be within a quarter-mile or so of campus. This boundary encompasses both the Gorman/Avent Ferry/Food Lion destinations already served, and Cameron Village, which is currently not served by Wolfline. The key is the time/distance impacts on Wolfline, so that if there is a key destination that can quickly and easily be served, it would be considered. Other destinations, most notably the apartment complexes south of I-40 on Lineberry, were judged to be outside of the Wolfline service area because of the time impacts to Wolfline routes that would be required to extend service to these locations.

### **3.2 Routing, Scheduling, and Capital Alternatives**

In developing the potential service changes for Wolfline, the recommendations were grouped into categories based upon the type of service. Wolfline operates three different classes of service: local, commuter, and nighttime. Different capital facilities support the service: transit centers, transfer facilities, and park & ride lots. Each of these service and capital types is distinct and has its own set of parameters, described below.

1. Transit Service
  - A. Local Services
    - a. Shorter routes providing frequent stops
    - b. Headways of 30 minutes or better
    - c. Span of service from 7:00 AM – 6:30 PM or longer
    - d. Heaviest-used routes extend to 10:00 PM
    - e. No weekend service
  - B. Commuter Services
    - a. Oriented for riders originating in peripheral areas
    - b. Longer routes that may include non-stop sections
    - c. Headways of 30 minutes or better
    - d. Span of service from 7:00 AM – 6:30 PM or longer
    - e. No weekend service
    - f. New connecting service between commuter rail/light rail stations and Centennial Campus
  - C. Nighttime Services
    - a. Begin service at 10:00 PM when major daytime routes end
    - b. Connect internal nighttime origins and destinations
    - c. Connect with Glenwood South Thu-Sat nights

- d. Headways of 30 minutes or better
  - e. Span of service from 10:00 PM – 3:00 AM
  - f. May operate on weekends at night or longer hours
2. Capital Facilities
- A. Transit Centers
    - a. Off-street facility with bus bays and boarding platforms, operator layover facilities (such as restrooms), and passenger amenities such as real-time bus arrival/departure times and bus shelters.
    - b. Includes overhead shelter covering platforms and bus loading areas.
    - c. Example is proposed transit center on Centennial Campus
  - B. Transfer Points
    - a. Similar to Transit Centers, but at a lower scale.
    - b. May be off-street location, or a series of shelters and pullout bays located on-street.
    - c. Does not include as many passenger amenities or operator restrooms.
    - d. Examples are Founders Drive and Carmichael Gym
  - C. Park & Ride Lots
    - a. Surface parking lots at periphery of campus
    - b. No charge to park
    - c. Example is Carter Finley Stadium
  - D. Streetside Amenities
    - a. Benches/shelters at heavily used stops
    - b. Bus pull-out bays
    - c. Queue jumper lanes
    - d. Real-time bus displays
  - E. Support Facilities
    - a. Bus size based upon demand (30-foot; 40-foot; articulated)
    - b. Buses and maintenance facility the responsibility of the service contractor

Within these broad service and capital parameters, conceptual changes were developed. The following sections describe the changes that were considered in the process. Not all of the changes carried through the process and were ultimately recommended at the end. Chapter 4 describes the final set of recommendations.

### **3.2.1 Local Services and Transit Centers**

Wolfline already provides an extensive amount of service coverage. There are no developed areas of campus that are not served, and Wolfline provides extensive hours of service. The potential service enhancements were directed at making the existing service work more efficiently by eliminating some overlapping services and fine tuning the schedules to match demand. A few suggestions were received to provide some direct service between locations that currently require a transfer, but for the most part, the existing service was meeting the travel needs.

The largest challenge facing Wolfline is to budget the appropriate amount of new service to meet the growing population demands of the university. Even though population growth projections are lower

than past assumptions, the university is still projected to grow by 10,000 or a 20 percent increase over the next ten years. This growth will be concentrated in the Centennial Campus, which has more limited Wolfline service than the main campus. Anticipating this growth to avoid crowded conditions and to reach more areas of the campus will require more resources. Meeting these demands in a cost-effective way will be a challenge.

### 3.2.1.1 *Route Consolidations and Extensions*

The study area for the 2012 *Campus Mobility Plan* covers about 15 square miles when considering the campus proper and the surrounding areas. Within that area Wolfline operates 12 routes from 7:00 AM to 10:00 PM, and more service until 3:00 AM. Additional transit service is provided by CAT and TTA routes. This amounts to a lot of transit service in a small area.

One of the first examinations was to evaluate the existing route coverage to verify that all current locations were being served and determine if any duplicate services exist. Comments from staff, the advisory committee, and the university at-large offered several invaluable suggestions.

This examination confirmed that the geographic coverage provided by Wolfline was excellent. All areas of campus needing service had some service provided. Several areas for potential enhancements were noted. These enhancements include:

#### **Combine 2 Hillsborough Street Shuttle with 4 Westgrove**

These routes overlap one another in the Wolf Village and ES King Village area, and much of the 4 Westgrove overlaps with the 6 Carter Finley along Hillsborough Street. By rerouting the 4 Westgrove to follow the 2 Hillsborough Street Shuttle, the duplication would be eliminated. Concerns were expressed over the routing around Wolf Village and whether the new routing would require Wolf Village residents to first go to Westgrove before reaching the main campus. No vehicles were estimated to be saved by combining the routes.

#### **Combine 3 Engineering with 3A Centennial Express**

These routes have a great deal of overlap, with the exception that the 3 Engineering can go deeper into the historic portion of the north campus since smaller vehicles are used on this route. The Centennial Express is something of a misnomer since the travel times are no faster between Centennial and the main campus than on the 3 Engineering. Concerns were expressed about losing the closer-in service along Stinson. One bus is estimated to be saved by consolidating the routes.

#### **Combine 6 Carter Finley with 8 Southeast Loop**

This suggestion arose from the desire to connect the Carter Finley park & ride and the Centennial Biomedical Campus (Vet School) with a direct trip to Centennial Campus. Currently riders must transfer among routes to make this connection. Ridership between these routes is unbalanced, with the 6 Carter Finley being less used than the 8 Southeast Loop. The combination was estimated to require an additional bus because more service would be provided on the 6 Carter Finley end than is currently provided.



**Extend Service to Cameron Village**

Cameron Village is located one-quarter mile from the Bell Tower. This distance is close enough to walk, but the number of destinations in Cameron Village and the potential ridership demand is high. Connecting to Cameron Village also provides service to another grocery store, Harris Teeter, in addition to the Food Lion off Avent Ferry. Both the 7 Wolfline Shuttle and the 2 Hillsborough Street Shuttle were considered as candidates for extending service.

**Reroute 10 Southside Circulator**

This is a relatively new route for Wolfline, and is the only route providing service to the southern portion of Centennial Campus. Unfortunately, there is little ridership from the golf course, alumni center, or magnet middle school. Several requests were received to provide connections to Centennial Campus from the apartments along Avent Ferry and Gorman, particularly along Gorman. No direct service is available to Centennial. By reorienting the 10 Southside Circulator away from the sparsely populated south to Gorman/Avent Ferry, a more productive service can result.

**3.2.1.2 New Local Route**

An additional local route was only being considered for the Centennial campus. No new local routes were considered for the main campus. This campus is not anticipated to see any growth over the next 10 years, and is projected to have a decline of about 4 percent or 1,000 people. To be conservative, no reduction in bus service to the main campus was contemplated, but no new daytime service was planned, other than a connection to the commuter rail station noted under the commuter discussion.

**New Centennial Circulator**

One of the longer term growth objectives for the Centennial Campus is to establish it as a town center-type area, with all necessary amenities. The main campus area has residential, classroom, and eating/shopping locations all on campus, making it possible to stay on campus for most needs. Centennial Campus does not have the same level of amenities in place now, but the long-term growth plans call for student housing and more eating/shopping opportunities. The first student housing is under construction and its 1200 beds (about the size of Wolf Village) are planned to open in time for the Fall 2013 semester. When this occurs, the need for internal circulation on Centennial will increase. To address this need, an internal route was proposed. It could extend from the Farmers Market to the southeast, but would not provide a connection to the main campus. Other routes already provide that connection. No other local route needs were identified. Longer term, this route will be adjusted to serve more destinations on Centennial Campus as they are built, and headways will be decreased based upon demand.

**3.2.1.3 Schedule Adjustments and Bus Sizing**

Ridership levels on all routes were closely examined to determine if the frequency of service match the level of demand. Thanks to an abundance of information from the Automated Passenger Counters (APC), extensive information was available on total ridership for each trip and the max load of passengers on board each trip. All trips for the Spring 2011 semester were analyzed to determine appropriate schedules.

As described in Chapter 2, the percentage of trips with loads of 100 percent to 125 percent of the number of seats (the load factor); 125-150 percent load factor; and a greater than 150 percent load factor were determined. The latter amount is the most critical since a 150 percent load factor is considered a “crush load” and LOS F. Since crush loads can occasionally occur without indicating a problem, a 2 percent level was judged as acceptable; that is if 2 percent or fewer of the trips had a crush load during the semester, the route headway was acceptable. For a route with a 10-minute headway for 12 hours per day, this amounts to about 1.36 bus trips per day with a crush load. Given the ridership patterns, this overload is likely to occur between 9:30 and 10:00 AM.

For the future, an estimate of ridership growth had to be developed. To do so, the projected growth rate in the university population was applied to the Spring 2011 ridership by trip levels. Separate growth factors were applied based upon the campus served by a route. If the route served the growing Centennial Campus, the reported ridership by individual trip was increased by 83.2 percent for the initial five years and a total of 133.8 percent for the full 10 years. These growth rates are the same as the overall population growth rates for the campus and amount to a compounded annual growth rate of 10.6 percent for the first five years and 8.0 percent for the second five years. For routes that did not serve the Centennial Campus, no growth in ridership was assumed to be conservative rather than mirroring the projected 2 percent decline in the first five years and additional 2 percent decline in the second five years projected for the population.

By applying the growth factor to the actual reported ridership on every trip for a route for the entire semester, a good estimate of the potential loads can be made. These load estimates were then examined to determine what combination of headways and bus sizes would result in not exceeding the desired 2 percent cap on crush load trips. For routes without overload problems, headways were increased to a maximum of 30 minutes to determine if the frequency could be reduced. For routes with overloads, headways were decreased until fewer than 2 percent of the trips had crush loads.

Some route’s growth was sufficient to require very short headways of less than 10 minutes. The 9 Gorman Street Local already offers a nine minute headway, and other routes are projected to have their headways decreased below this level by 2022. Once the headways drop below this threshold of 10 minutes, the use of 60-foot articulated buses may be warranted. By converting a route to these larger buses, with a 60-seat capacity or 90 crush load capacity, the number of trips can be reduced while still maintaining a very frequent service with less than a 15-minute headway. Wolfline does not have this vehicle in its current fleet and the contractor does not have the capability to maintain these sized vehicles at their maintenance facility, although CAT and Chapel Hill Transit do have bays and lifts large enough for these buses at their maintenance facilities. Due to these limitations and the contract terms with First Transit, articulated buses cannot be added to the fleet until the next contract is negotiated in 2017.



**Adjust Headways to Meet Existing Demand**

As shown in Chapter 2, few routes reached the crush load threshold of demand. Only the 1 Avent Ferry, 8 Southeast Loop, and 9 Gorman Street Local had an excessive number of

overloads. Headways on these routes were examined for adjustment to meet demand. The 9 Gorman Street Local was also considered for adjustment in the afternoon since its headway is increased in early afternoon rather than continuing at peak levels until 4:00 PM, as occurs with other routes.

Schedules were examined to determine if there were any gaps during the day when service was not being provided every 30 minutes or better. The largest gap is on the 10 Southside Circulator, which does not provide midday service. Additional gaps were identified on the 1 Avent Ferry; 3 Engineering; 8 Southeast Loop; and 9 Gorman Street Local, all after 6:30 PM as the headways get increased from their daytime levels. Adjusting the trip times modestly will ensure that service is provided at least every half hour throughout the day.

**Suggested Headway Standard**  
For Wolfline, a reasonable policy is to provide service every 30 minutes or better; up 45 minutes can be acceptable under low ridership conditions when a bus can be saved.

**Adjust Headways to Meet Projected Demand**

As described above, only Centennial Campus routes were projected to see a growth in ridership. Based upon the projected growth, the 3A Centennial Express, 8 Southeast Loop, 9 Gorman Street Local, 10 Southside Circulator, and 11 Village Link were projected to need additional trips before 2022. Both the 3A Centennial Express and 9 Gorman Street Local were projected to need 7.5 minute headways in the next two years, with further growth expected.

Because the headways on the 3A Centennial Express (which is combined with the 3 Engineering); the 8 Southeast Express; and the 9 Gorman Street Local were projected to be below 10 minutes, these routes are considered for conversion to articulated buses when the new operating contract is negotiated.

**Adjust First and Last Trips Based Upon Demand**

Ridership during the first and last half hour of service on each route was examined to determine if earlier or later service is warranted. When ridership during the half hour exceeded 20 riders, additional service is indicated; when ridership is less than five riders during the half hour, cut backs may be warranted.

Earlier trips, before 7:00 AM appear warranted on the 5 Varsity and 9 Gorman Street Local, and may be warranted on the 8 Southeast Loop, which already has service before 7:00 AM. The first two trips on the 5 Varsity, before 7:30 AM, average 17 riders on the 7:11 trip and 23 riders on the 7:26 trip. This level may warrant an earlier trip, around 6:56. The 9 Gorman has three trips before 7:30 – the 7:00 trip averages 13 riders; the 7:12 averages 14 riders; and 7:24 averages 26 riders. An earlier trip around 6:45 may be warranted. On the 8 Southeast Loop, the first trip at 6:58 carries 20 riders, the highest

**Suggested Span of Service Standard**  
For Wolfline, the core span of service during which all routes operate should be 7:00 AM to 6:30 PM, matching the times of most current routes. For routes with expanded hours, service should operate until 10:00 PM when night service begins. Additional trips should be offered based on demand.

load on any route’s first trip. The next trips at 7:10 and 7:22 carry 17 and 16 riders respectively. This ridership level may warrant an earlier trip around 6:43.

In the evening, service after 10:00 PM appears warranted on the 1 Avent Ferry, but this is when the night service takes over. The 4 Westgrove and 10 Southside Circulator should have a trip added after 6:00 PM to extend service to at least 6:30 PM on all routes.

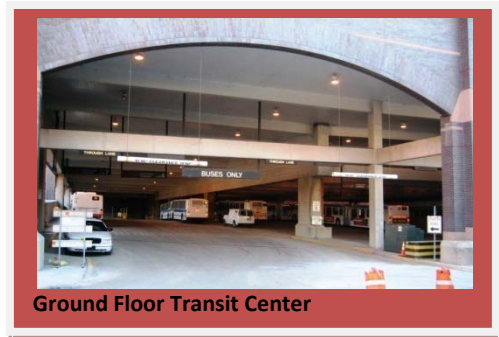
Two routes appear to have too long of a span based upon passenger loads. The 5 Varsity and 8 Southeast Loop carry an average of three riders on their last trips after 9:30 PM. Based upon the desired rider threshold of at least five riders, these trips could be eliminated, but the night service begins at 10:00 PM, which implies these trips should be maintained to keep a half-hour headway until the night service takes over.

**3.2.1.4 New Transit Focal Points**

Wolfline has one dedicated focal point for transit service – the improvements along Founders Drive. Several other locations are major stops, notably Carmichael Gym, Dan Allen @ Witherspoon, and Wolf Village, but the level of amenities at these stops is a standard shelter. There are no major transit facilities on Centennial Campus.

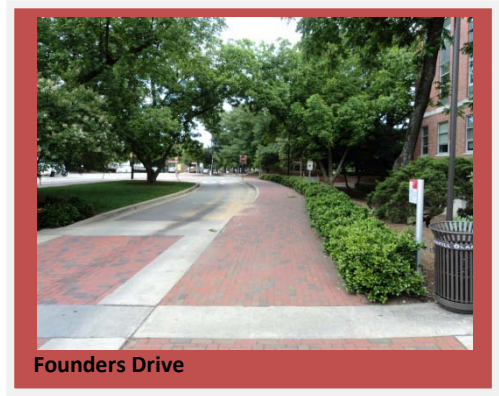
Transit focal points serve multiple purposes. First, they are a location where riders can get direct service to multiple destinations, and transfer among routes in a safe and sheltered environment. Depending upon the level of amenities provided, the focal points can provide information about the bus services and provide restroom facilities for operators and possibly the general public. Transit focal points also serve as a “billboard” for transit – a clear identifier that transit is located in an area and is available for use. The 2012 *Campus Mobility Plan* includes the enhancement of the existing focal point on Founders Drive and the establishment of additional focal points throughout the university.

Two types of focal points are envisioned – an off-street facility where buses meet out of regular traffic flow, and improved on-street facilities that may include pull-out bays. Off-street facilities can be a linear arrangement, such as Founders Drive, or can have a central passenger platform around which buses congregate. Transit centers can be located out in the open, but with an overhead shelter covering the platform and bus loading doors. Many imaginative designs have been constructed that blend the transit center into its surroundings. One example to the right shows how a transit center has been blended into a residential area by mimicking an old-fashioned train station. Another approach is to include a transit center in the ground floor of a parking deck or other structure. This approach maintains an area as a building site, while still providing a convenient and sheltered location to catch transit.



**Founders Drive**

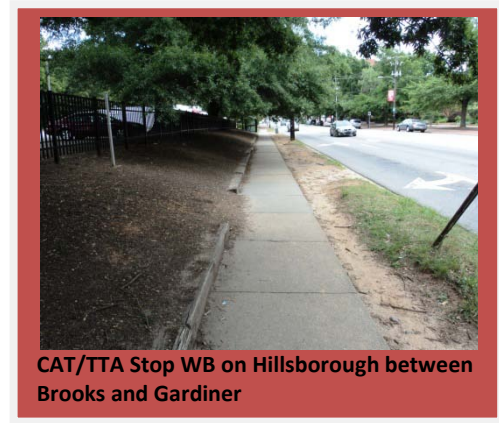
Founders Drive is used only by Wolfline buses, which operate in a one-way direction eastbound, forcing most routes to operate in a clockwise loop on the main campus. The standard routing is eastbound on Founders; southbound on Pullen, Dunn, Jeter, Cates, and Morrill; westbound on Western; and northbound on Dan Allen. This routing pattern was examined to determine if any changes would be worthwhile, and what the implication would be on the design of Founders Drive. The conclusion was that Founders Drive is working relatively well, and the costs to convert to a



Founders Drive

two-way operation were prohibitive and would cause unacceptable impacts to nearby buildings, so no change in the one-way operation was warranted. One potential change would be to decrease the size of the standard one-way loop by routing buses along Cates to Dan Allen instead of using Morrill and Western, but Cates has several residence halls and concerns exist about the noise impacts from having a major transit street located on Cates.

While no changes are contemplated for Founders Drive itself, its one-way operation and use by only Wolfline buses limits its ability to serve as a major connecting point with CAT and TTA buses that operate on Hillsborough Street. Neither CAT nor TTA wants to come onto Founders Drive due to the time impacts on their schedule, so the challenge is to provide a seamless path from Founders Drive to improved stops along Hillsborough in both directions. The recent improvements along Hillsborough to reduce the number of traffic lanes and widen sidewalks have been great, but they do not extend west of Gardiner Street where most of the Founders Drive activity occurs. The streetscape improvements need to be extended to Dan Allen to provide the same level of amenity for CAT/TTA riders, especially those transferring to/from Wolfline. Larger shelters, with clear pedestrian pathways to/from Founders Drive are needed, and the westbound shelter needs to be located at a pedestrian crossing. The current westbound shelter is a large size, but is not on a wide sidewalk and is located midway between the signalized crossings at Brooks and Gardiner, over 200 feet from the nearest marked crosswalks. These improvements are not necessarily NC State’s responsibility, but should be included in a project to extend the streetscape improvements.



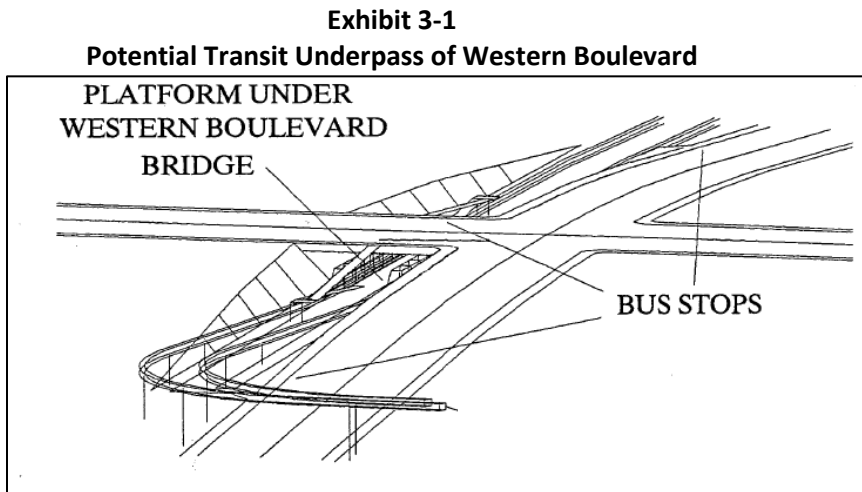
CAT/TTA Stop WB on Hillsborough between Brooks and Gardiner

**Western & Avent Ferry**

Similar to the operation at Founders Drive, CAT and TTA have buses operating along Western Boulevard, but with no convenient connection to Wolfline service. For some time, a grade-separated crossing of Western has been contemplated, either as a pedestrian/bicycle-only



facility or for a transit facility. In a 1995 paper, NC State considered the potential alignment for a monorail system on campus. This alignment is included in the Physical Master Plan still in effect today. As part of the study, an underpass was proposed at Avent Ferry/Morrill with Western Boulevard, where the monorail would go under Western. **Exhibit 3-1** shows how this could be accomplished, looking north toward the main campus.



Source: Excerpted from "Intermodal Concept for North Carolina State University Monorail," 1995

While monorail is not being recommended in this 2012 *Campus Mobility Plan* (see Fixed Guideway section), the provision of an underpass is highly desirable. An underpass would provide pedestrians and bicyclists a safer crossing of Western, and would allow transit vehicles to avoid delays at the intersection. A shared transit/pedestrian/bicyclist underpass would satisfy many objectives, and could be sized to permit monorail or any other transit technology to use it at some point in the future. However, affordability and functional integration of such an ambitious multi-modal project at this location still remain at issue.

The Capital Area Metropolitan Planning Organization (CAMPO) will be conducting a study in 2012 to develop a conceptual design for this underpass. There are several issues to be resolved; the largest challenge may be determining how northbound buses would use the underpass since they would have to cross southbound auto traffic on Avent Ferry and Morrill if the underpass is only on the west as shown in Exhibit 3-1. Another challenge is providing convenient transfer capability for CAT and TTA buses on Western. Conceptually, a stop would be provided on top of the underpass allowing CAT/TTA riders to have a vertical transfer to Wolfline buses below. A Wolfline stop could be provided simply in the underpass, and farside of Morrill Drive in the westbound direction on Western. The challenge is providing an eastbound stop on Western. At the illustrated location, the stop would be nearside<sup>4</sup> of Avent Ferry in what is currently a right-turn only lane. Any CAT/TTA bus would block right turning autos and would have to quickly merge back into eastbound Western traffic before crossing the intersection. A farside queue-

<sup>4</sup> Bus stops have three locations, defined by their relationship to an intersection: "nearside" or before the bus crosses through an intersection; "farside" after a bus crosses through; or "midblock" when a stop is not located at an intersection.



jumper lane would give buses more room to maneuver. Regardless of how this CAMPO study resolves the issue, the objective remains to provide a short, convenient transfer between buses on Western and buses on Avent Ferry/Morrill.

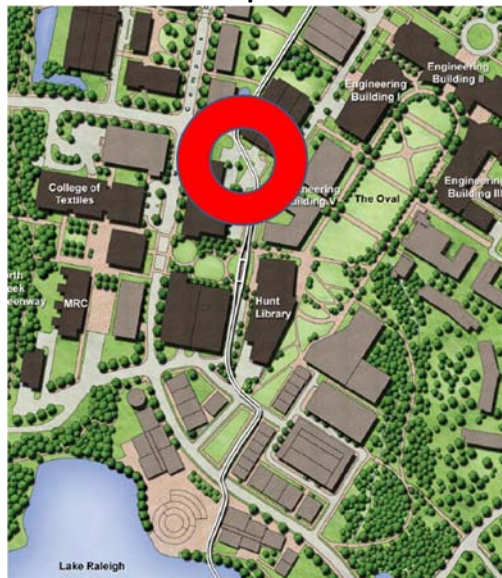
**Centennial Campus Transit Center**

Transit does not have as strong and visible presence on Centennial Campus as it does on the main campus. To provide a more prominent location where routes can congregate, an off-street transit center is considered for Centennial Campus. Ideally, this facility will be located where Wolfline routes can easily enter and depart; that is in the heart of the campus where many riders will have a short walk to their ultimate destination; and that gives Wolfline a suitable presence on campus to encourage more use of the system.

The conceptual location is near the existing heavily used stop at Varsity and Partners Way. This is the second heaviest stop in the Wolfline system, used by nearly 2500 riders per day. This location is also by the new Hunt Library nearing completion, which will become the heart and soul of the Centennial Campus. **Exhibit 3-2** shows the conceptual location for this transit center – northwest of Hunt Library and east of the Engineering Buildings where a small surface parking lot exists. This location is just under an acre in size, which is sufficient space for a modest transit center. It has some challenges, notably the loading dock for the Partners I Building.

A location further south was suggested, to be more in the Town Center area envisioned for Lake Raleigh. Such a location offers more room and could be integrated into new development, but its proximity to Lake Raleigh limits the number of destinations that can be within a five-minute walk (much of that area would be in the lake). Regardless of the ultimate location for this transit center, the principal objective is to have an off-street location where buses can congregate and that is centrally located to the majority of destinations on the campus.

**Exhibit 3-2  
Potential Centennial Campus Transit Center Location**



**Wolf Village Way**

The existing stop at Wolf Village Way is among the most active stops in the Wolfline system. Currently, a large shelter is in place westbound with a pull out bay sufficient for two buses. This size causes some limitations when three buses queue up to serve passengers. Eastbound, no stop is provided and parking spaces occupy the area where a stop would be located. This lack of an eastbound stop is not a problem with the current routing, but with some of the revised routes to provide two-way service on Wolf Village Way, no place is provided for a stop in this direction. In the future, a revised area with relocated parking and an additional shelter will provide more flexibility.



**Wolf Village Stop**

**3.2.2 Park & Ride Lots and Commuter Services**

One of the key objectives for Wolfline is to provide shuttle service for riders who park in peripheral lots. By encouraging riders to do so, traffic congestion is minimized around campus by intercepting riders before they reach campus and by eliminating the need for drivers to circle the campus and surrounding neighborhoods looking for a free parking space.

**3.2.2.1 Park & Ride Lots**

Wolfline offers a limited amount of this peripheral parking shuttle currently. The largest lot is at Carter Finley stadium, where approximately 250 spaces are available for park & ride patrons. More spaces are available as part of the Carter Finley and PNC Arena supply, but only 250 spaces are in the general area served by Wolfline. These lots are occasionally pre-empted for use by the North Carolina State Fair or by major events in PNC Arena. When this disruption occurs, bus service is detoured and riders are relocated to other parking spaces. Smaller, informal park & ride lots are provided at Westgrove, by the Westgrove Towers and KMart, with 126 spaces, and the Food Lion with about 25-70 spaces, depending upon the amount of spillover. No formal arrangement exists between the University and the private owners. To reduce the demand for more parking spaces in the heart of the campus, and to help accommodate projected growth, additional park & ride spaces are projected to be needed, and a more permanent arrangement is desirable.

To determine reasonable estimates of potential demand, usage at the Carter Finley lot was evaluated. During four days in September 2011, counts at the Carter Finley lot showed an average of 206 cars (80 percent occupancy). This average occupancy was compared with the number of students, faculty, and staff who live within the presumed



**Carter Finley Lot with approximate parking area**

capture area of the lot. Specific origin locations were not available, so the common industry definition of a parabola shape centered on the major travel corridors was used. This shape extends about five miles upstream and about four miles either side of the travel corridor at its furthest point. When superimposed on the home locations of the NC State population from 2010, the lot was found to capture 4.6 percent of the estimated 6,332 within the capture area. The capture rate varied between the faculty/staff and student categories, with only 1.7 percent of the faculty/staff using the park & ride and 5.7 percent of the students doing so.

The Carter Finley lot serves the area northwest of the university well, but is less attractive for riders from the south and east sides, who would have to travel out of their way to reach the park & ride. Two other quadrants were considered as desirable locations for park & ride service – the southwest and southeast quadrants. The northeast quadrant was not considered to be desirable for two reasons – this quadrant includes downtown, which provides a high level of transit service to the university; and there were few potential locations for a park & ride on the periphery of the university. One area that might have room for a park & ride lot is the Cameron Village area, but it is unlikely the merchants would support having spaces in their vicinity being taken up by all day commuters to NC State. Similarly, the area has had problems in the past with students taking up on-street spaces from residents, so much so that the City instituted a residential parking permit program.

**Exhibit 3-3** and **Exhibit 3-4** show a table and map respectively for the existing Carter Finley lot and the proposed locations – two alternate locations in the southwest and one location at the Farmers Market. Demand at Farmers Market has been increased at the faster compounded annual population growth rate for Centennial Campus of 8 percent over the 10 year period while Carter Finley and Southwest lots have been increased at the slower overall population growth rate of 1.7 percent annually. The table has increased the estimated parking space need by 10 percent over demand to provide a cushion for effective supply. The capture areas have been superimposed on the student/faculty/staff home locations from 2010.

#### **Southwest Area Park & Ride Opportunity**

Two broadly defined locations were considered for a park & ride service from the southwest area. This is the quadrant currently served by the Food Lion lot. The Food Lion lot capacity is constrained and little opportunity exists to expand this lot. The two alternate locations considered were nearby, roughly centered around Avent Ferry & Gorman, and near the interchange of I-40 & Gorman. Around the Avent Ferry & Gorman area, it will be difficult to find available land, but some sparsely developed parcels are located nearby on Trailwood Drive that may be suitable, although some have issues with wetlands. Finding a location near here would also match well with the recently developed CAT Short Range Transit Plan, which calls for a CAT transit center near this location. By combining the CAT transit center with the Wolfline park & ride, both systems can benefit.

The other location considered at the interstate provides a more visible location for motorists on the freeway, and more land is available, either on nearby parcels or within the footprint of the interchange. This location does not work as a CAT transit center, and is more remote from some of the major apartment complexes and is further from the university, which will increase operating costs.



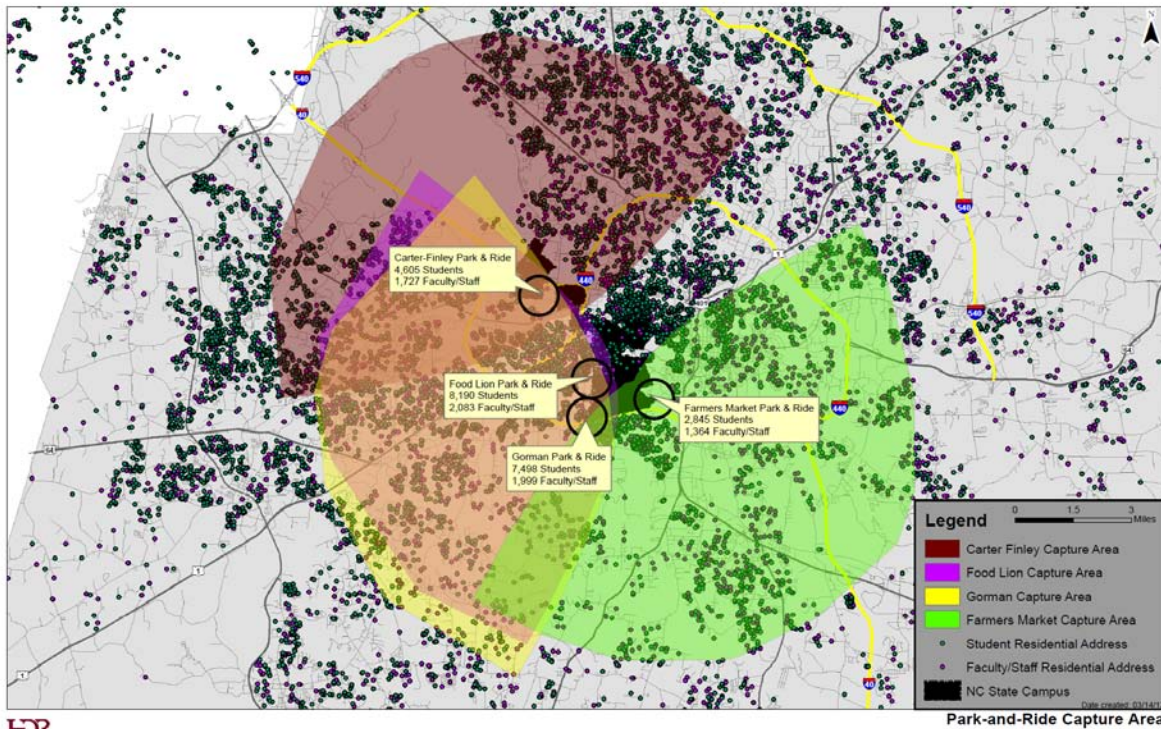
**Exhibit 3-3  
Estimated Parking Demand**

<b>Carter Finley</b>	<b>Residents</b>	<b>Est Parkers</b>	<b>Cap Rate</b>	<b>5 years</b>	<b>10 years</b>
Students	4,605	263	5.7%	285	310
Faculty/Staff	1,727	30	1.7%	33	35
<b>TOTAL</b>	<b>6,332</b>	<b>293</b>	<b>4.6%</b>	<b>318</b>	<b>345</b>
<b>Gorman &amp; Avent Ferry</b>		<b>Est Parkers</b>		<b>5 years</b>	<b>10 years</b>
Students	8,190	514		558	607
Faculty/Staff	2,083	40		43	47
<b>TOTAL</b>	<b>10,273</b>	<b>554</b>		<b>601</b>	<b>653</b>
<b>Gorman &amp; I-40</b>		<b>Est Parkers</b>		<b>5 years</b>	<b>10 years</b>
Students	7,498	470		511	555
Faculty/Staff	1,999	38		41	45
<b>TOTAL</b>	<b>9,497</b>	<b>509</b>		<b>553</b>	<b>600</b>
<b>Farmers Market</b>		<b>Est Parkers</b>		<b>5 years</b>	<b>10 years</b>
Students	2,845	178		194	211
Faculty/Staff	1,364	26		28	31
<b>TOTAL</b>	<b>4,209</b>	<b>205</b>		<b>222</b>	<b>241</b>

Source: Analysis of home locations for 2010

Note: Parking demand has been increased by 10% to reflect effective parking supply

**Exhibit 3-4  
Park & Ride Capture Areas**



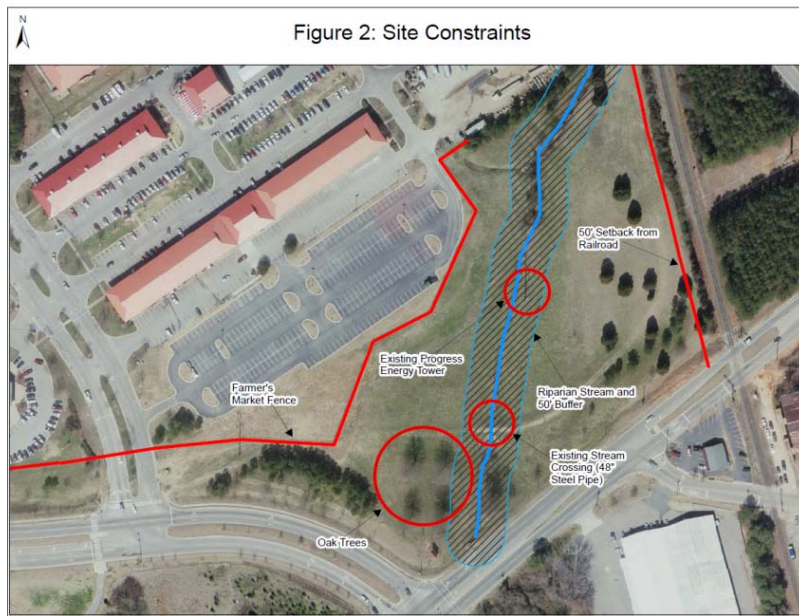
The capture area analysis shows that the two locations are not very different in the number of students/faculty/staff within their respective capture areas. Gorman & Avent Ferry has a slight lead, with about 10,000 in its capture area – 8,000 students and 2,000 faculty/staff. Gorman & I-40 serves about 9,500 – 7,500 students and 2,000 faculty/staff. Neither lot has the clear advantage on demand, but given the opportunity for joint development with CAT and the closer proximity to campus, the Avent Ferry & Gorman area has the advantage, if land can be found.

**Farmers Market Expansion Opportunity**

The Farmers Market has been considered as a park & ride location for some time. It is immediately adjacent to the Centennial Campus; is located near I-40 & Lake Wheeler Road interchange; and peak parking demands are complementary – Wolfline during the week and the Farmers Market on the weekend. The capture area analysis shows about 4,000 students/faculty/staff within its capture area, roughly 3,000 students and 1,000 faculty/staff.

The university has previously approached the Farmers Market about using their parking lots, but these efforts have been rebuffed. In 2007, NC State hired MAB to evaluate the potential for building a park & ride lot on land adjacent to the Farmers Market, but not using the Farmers Market property. This parcel is also owned by the State of North Carolina and is located southeast of the Farmers Market. This quadrant had some challenges, notably the presence of a stream and Progress Energy transmission lines, and a lower site elevation from the Farmers Market, but MAB identified the potential to have over 400 spaces. **Exhibit 3-5** shows the site constraints.

**Exhibit 3-5**  
**2007 Farmers Market Site Constraints**



Source: Martin/Alexiou/Bryson. *Feasibility Study for Farmers Market Park-and-Ride Facility, North Carolina State University*. March 23, 2007

Since that time, the Farmers Market has indicated they may be more willing to have a shared parking arrangement. With this willingness a new potential exists to overcome some of the site limitations in the report. By sharing spaces with the Farmers Market, and constructing expanded spaces as part of their lot, the expansion can all occur on one side of the stream buffer and power line easement. The different site elevations will be a challenge, but there should not be any environmental issues with regarding the lot since the area is all a maintained lawn and not in a natural state.

**Exhibit 3-6** shows one alternative for shared use. By sharing the back parking aisle, 88 current spaces could be used, shown in the darker shading. There are another 31 spaces in a short aisle underneath the lighter shaded expansion area, giving 119 spaces currently available that could reasonably be shared. By expanding the parking area to square it off to the east and add another aisle to the south, shown in the lighter shading, roughly 200 spaces could be provided.

**Exhibit 3-6**  
**Farmers Market Potential Shared Use Area**



Source: Image from Google Earth

### 3.2.2.2 Commuter Services

Besides the physical park & ride lots, the associated commuter transit services are recommended for changes.

#### 6 Carter Finley

The 6 Carter Finley will continue to provide the park & ride service from the Carter Finley lot. As noted in the Local Services section, this route may be combined with the 8 Southeast Loop at a



later date. There is some support for this combination to provide a one-seat ride from Carter Finley to Centennial Campus, but the loads between the routes are unbalanced and an additional bus would be required.

The 6 Carter Finley does warrant some schedule adjustments. Loads during the first half-hour of service are sufficient to warrant an earlier trip between 6:30 AM and 7:00 AM. Evening loads are not as heavy, with ridership dropping below five riders per half hour after 8:00 PM. Trips after this time are unwarranted.

### **New Commuter Bus Service**

The two new park & ride lots – Southwest and Farmers Market, would be served by an “express” route designed to quickly ferry passengers from the lots to the campuses. Express is used in quotation because even though these routes may have stretches with no or few stops, the distances are short since the lots are located in close proximity to the campus. These routes would serve both Centennial and the main campus precincts. Span of service is 7:00 AM to 6:30 PM, with increases based upon demand. Recommended headways would be 30 minutes or less.

### **Commuter Rail Shuttle**

Triangle Transit is planning on implementing commuter rail service between Garner and Durham along the NCR corridor. This service will include one stop on the NC State campus, planned for the intersection with Dan Allen. Timing for this service is uncertain since it is dependent upon the implementation of a dedicated sales tax for transit. This tax may be subject to a referendum in Wake County in November 2012, but this timing may be delayed and the referendum may not pass if it is held. If it does pass, commuter rail service could begin by 2018.

Whenever the service is implemented, a shuttle bus service is needed between the commuter rail station and Centennial Campus. No additional service is needed to the main campus since so many Wolfline routes pass by the proposed station location, but the clockwise orientation of these routes would result in a slow trip to Centennial. With the growth in the Centennial population, including the growth in the corporate partners, a more direct route south along Dan Allen is needed to coincide with the opening of the commuter rail.

## **3.2.3 Nighttime Services**

### **3.2.3.1 Nighttime Bus Routes**

The three nighttime services, those routes that operate past 10:00 PM, have a mixed performance. The 2 Hillsborough Street Night Shuttle carries an average of 43 people after 10:00 PM, but only 12 people after 12:30 AM, about three people per trip. The Werewolf service carries 180 people, with at least eight people on every trip. The weekend Wolfprowl carries 133 people, or 6-18 people per trip.

As a whole, these routes are doing well enough that nighttime service should be continued. The service span is appropriate, with the last trip needed around 3:00 AM, both based upon the ridership on these routes and on the usage of the Budd Security Group escort.

The demand for late night ridership as shown in Exhibit 2-18 indicates that while there are riders at night, the numbers of riders are not high enough to warrant the continuation of the daytime route network; only 1 percent of the daily ridership occurs between 10:00 PM and 3:00 AM. Therefore an abbreviated route network was considered for the evening hours. 10:00 PM was still judged to be the appropriate cut off point between the two services based upon comments received.

The modified evening network envisioned three basic routes, plus the Wolfprowl service. The three basic routes were envisioned to connect:

- The DH Hill area with Centennial and the Avent Ferry/Gorman area apartments;
- The DH Hill area with the Wolf Village/ES King Village area; and
- The Wolf Village/ES King Village area with Centennial Campus.

By implementing this route network, all of the main campus areas would be connected at nighttime. The 2 Hillsborough Street Night Shuttle would be discontinued, with the regular 2 Hillsborough Street Shuttle operating until the 10:00 PM switchover. The Werewolf service can be reoriented into a more direct service between the main campus and the Centennial Campus. More details are provided in Section 4.1.2.

The Wolfprowl route was judged to be acceptable as is, with only one minor modification. The ridership performance was high enough to warrant the continuation of the entire span from 9:00 PM to 3:00 AM, but not to expand the span of service. The one modification is to extend the route to Wolf Village, providing a more direct service to a major residential concentration of riders.

### **3.2.3.2 Nighttime Security Escort**

The relationship between the security escort service provided by the Budd Security Group for University Housing and the nighttime Wolfline routes was examined. This relationship has been the topic of internal conversations at the University as demand for the escort service has increased. Demand is at the point where it is beginning to compromise the resources that are available.

Several potential changes were discussed over the course of this study. One choice is to leave the services as is – a separate, limited Wolfline service, and a specialized demand-response security escort. On the other end of the spectrum is to merge the escort service into the Wolfline service, with Transportation assuming responsibilities to maintain the service, or to merge some or all of it into the Wolfline network.

Potential changes to the Wolfline night service would be to move away from the fixed-route model to a flexible service. Three practical options exist:

1. Have fixed pick up points, but allow riders to request a deviated drop off point within a certain distance. This allows you to operate without a dispatcher;
2. Allow on request pick up and drop off deviations. Pick up deviations would require a call to a dispatcher, but drop off deviations could be requested directly from the operator.

3. Go to a demand-response model with no fixed pick up or drop off locations, or with only a few designated locations (e.g. DH Hill, Hunt, Wolf Village). There would be no set route in between the key points and a dispatcher would need to arrange the trips. This latter option is essentially what Housing does today.

The nature of the security escort makes it difficult to eliminate entirely. Typical users of this type of service are females, mostly traveling alone between remote areas. Security is the primary reason behind using this service – users do not feel secure waiting at a bus stop late a night. It will be difficult to transition all of these riders to a regular Wolfline service.

Some riders may voluntarily shift over to Wolfline if some limitations are addressed. One usual concern is the amount of time that a rider will need to spend waiting at a bus stop. The introduction of the TransLoc system with its real-time bus location allows riders to know with some degree of certainty when the bus will arrive at their stop. Riders will still need to walk to the stop, but the wait time should be minimal. Improved lighting at the stops will also increase security, and the “blue light” panic buttons could be installed near the major night boarding locations.

The final concern that can be addressed by Wolfline is the coverage of the routes. As noted above, there are three main travel patterns that need to be addressed. With an improved nighttime network, all of these travel patterns will have more direct service, and more areas will have late night coverage.

Even with these changes to the Wolfline network, a separate escort service will still be needed. Some riders will not feel comfortable using bus service late at night, primarily for their trip back to a residential hall. This service should be maintained.

### 3.3 Traffic Pattern and Roadway Modification Analyses

NC State has long considered implementing additional access controls to reduce traffic levels and enhance Wolfline transit performance in the Dan Allen Drive corridor, a university-owned road spanning main campus linking two heavily traveled state arterials: Hillsborough Street and Western Avenue. As part of the 2012 *Campus Mobility Plan*, NC State Transportation asked HDR to evaluate the traffic impacts of closing Dan Allen Drive at the mainline rail overpass during the daytime. Under such a scenario, only buses, university service and emergency vehicles would be granted 9AM-5PM gate access. The primary objectives of this proposal are threefold: to improve the on time performance of Wolfline transit buses (a majority of routes travel south to north towards the Founders Drive busway parallel to Hillsborough Street); to reduce mid day traffic congestion and private vehicle trip making; and to promote a safer pedestrian and bicycle travel environment. HDR’s work focused on potential traffic congestion impacts on internal and campus edge roadways for two scenarios – a daytime Dan Allen closure with no other major roadway changes; and a closure accompanied by several roadway changes.

The traffic evaluation considered the projected growth in the population for NC State, its allocation among the main campus and Centennial Campus, and the growth in general background traffic. Full details of the assumptions and the traffic allocation can be found in the Traffic Forecasting and Capacity Analysis Technical Memorandum included in the Appendix. The sections below summarize the findings.

### 3.3.1 2022 Baseline Conditions Due to Growth

The initial test was to determine the level of traffic congestion without any changes to the roadway network. This evaluation focused on the intersections – which is where most delays occur and where choke points exist. The impacts of just growing the baseline traffic levels out to 2022 are that several intersections “fail” with LOS F, assuming no improvements are made by NCDOT or the City of Raleigh over the next decade. The intersections with an overall failure in either the AM or the PM peak are predominantly on the campus edge:

- Hillsborough Street & Gorman Street (AM and PM)
- Western Boulevard & Gorman Street (fails in 2011) (AM and PM)
- Western Boulevard & Dan Allen Drive (PM only)
- Western Boulevard & Avent Ferry Road (AM and PM)
- Varsity Drive & Avent Ferry Road (AM and PM)
- Centennial Parkway & Avent Ferry Road (PM only)
- Centennial Parkway & Lake Wheeler Road (AM and PM)

Only two non-signalized intersections on campus showed failing characteristics– Dunn Avenue & Jensen Drive and Varsity Drive & Capability Drive.

The Dunn & Jensen intersection appeared to fail largely because the projected 2022 pedestrian count is 430 crossings in the peak hour. Foot traffic essentially increased the delay for vehicles; however, the actual number of vehicles affected is small. Based on this analysis, the intersection would not warrant the installation of a traffic signal during the planning period..

At the second campus location analyzed, the Capability & Varsity intersection, a traffic signal would be warranted. If installed here or nearby, the signal would need be designed to minimize any impacts to the Avent Ferry & Varsity intersection. A traffic signal warrant study is warranted before taking action here..

### 3.3.2 Alternative 1: Dan Allen Closure Only

Under this scenario, Dan Allen Drive would be closed between 9-5 daily, Monday through Friday, to all through vehicular traffic except Wolfline buses and other authorized university service and emergency vehicles. The scenario tested in this study involved gated closure between Sullivan Drive and the railroad bridge, although subsequent planning reviews suggest that the closure gates are best located at the rail overpass itself.. This scenario tested, therefore, produced representative Results.

NC State is most interested in closing the roadway during peak times, from 9:00 AM to 5:00 PM, with the roadway open to all traffic outside these hours. Because the travel demand model relied upon does not perform midday evaluation the PM Peak period was chosen for evaluation. This time represents the worst traffic conditions for the campus area roadways in general. With a closure extending to 5:00 PM, at least a portion of the PM Peak will be affected, whereas the beginning of the closure at 9:00 AM will miss all of the AM Peak. **Exhibit 3-7** shows the results. A larger version of the graphic is included with the Technical Report in the Appendix.

The traffic evaluation found the following:

- Closing the Dan Allen Drive causes traffic to shift to the surrounding roadways of Hillsborough Street, Gorman Street, Pullen Road, and Western Boulevard.
- The intersection of Western Boulevard & Dan Allen Drive will see significantly decreased delay and will allow the intersection to operate at a satisfactory LOS over the planning period.
- The redistribution of traffic due to closure will significantly increase the delay experience at the intersection of Hillsborough Street and Gorman Street (which was already failing in 2022).
- Western Boulevard & Avent Ferry Road and Western Boulevard & Gorman Street will also experience increased delay.

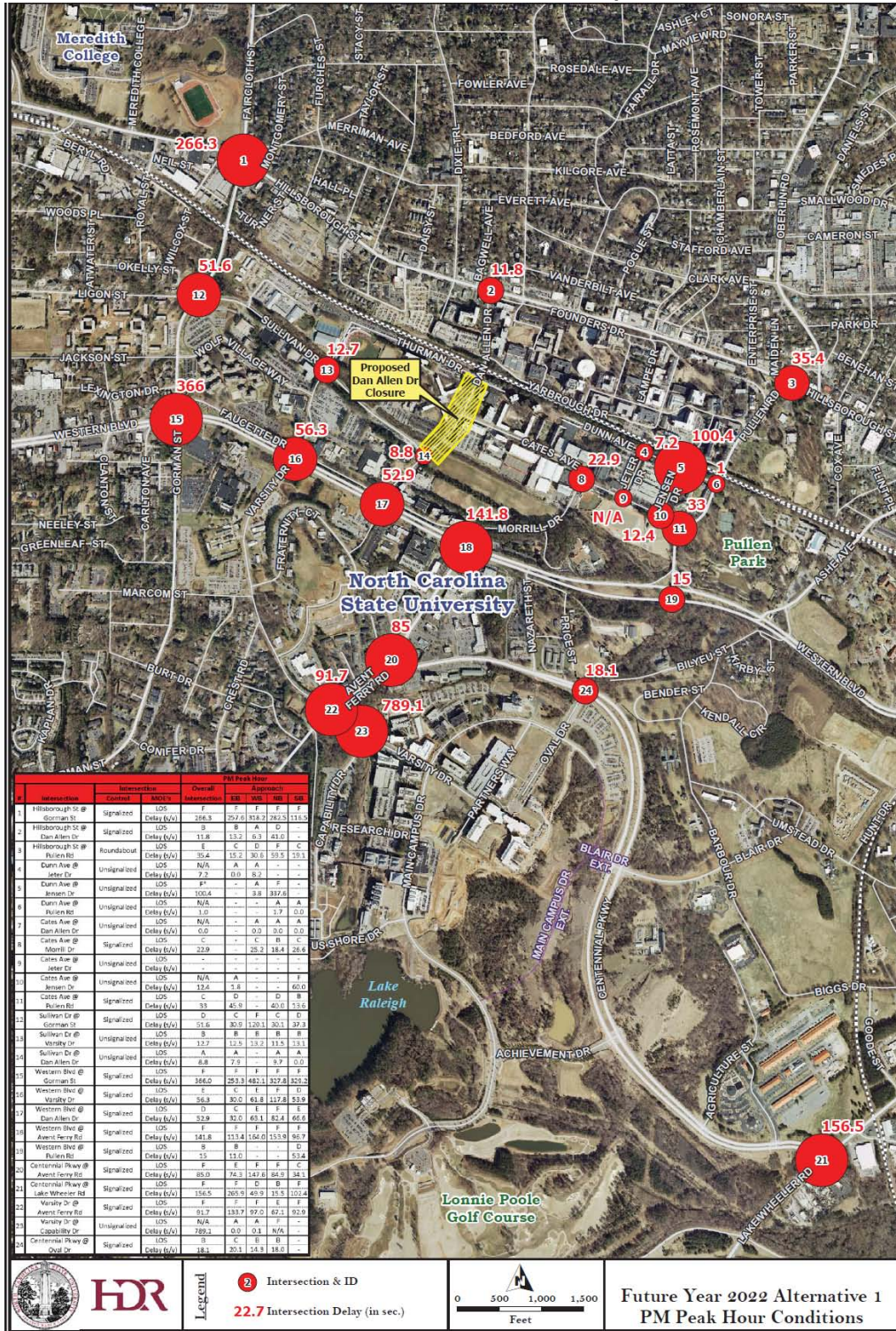
After the traffic evaluation was completed, plans were announced that NCDOT would be resurfacing Hillsborough Street during which time the lane markings would be restriped. This restriping would create a continuous left-turn lane and one through lane in each direction. The plan greatly enhances safety by creating pedestrian refuge in the southeast quadrant of Gorman/Hillsborough and by creating a center two-way left turn lane on Hillsborough Street. The proposed plan eliminates an eastbound through lane at both Gorman and Dan Allen. Currently, the eastbound direction has a lane drop at Turner, and the restriping moves it west one block to Gorman; there is a one-block section with two eastbound lanes between Friendly and Brooks. Westbound, a lane is removed from Gardner to Furches, with the exception of the Dan Allen intersection which maintains two westbound lanes.

As a sensitivity analysis, a new model run was undertaken for Alternative 1 with this restriping in place. Taking out a lane was found to increase delay; the most pronounced effect was in the AM peak hour because eastbound is inbound.





Exhibit 3-7  
2022 Alternative 1 Traffic Delay



Source: HDR analysis of traffic counts

### 3.3.3 Alternative 2: Dan Allen Closure with Prospective Pullen Road Extension and Western/Avent Ferry Tunnel

Under Alternative 2, area roadways were assumed to receive some improvements. Two improvements that have been discussed for the NC State area are to extend Pullen Road to the south to connect with the intersection of Centennial Boulevard & Oval Drive, and the implementation of a transit/bicycle/pedestrian tunnel underneath Western Boulevard adjacent to Avent Ferry Road.

The Roman Catholic Diocese of North Carolina owns the property south of Western Boulevard. This property houses the Diocesan headquarters and was the site of the Catholic High School before the current Cardinal Gibbons High School was opened next to the PNC Arena. The Diocese plans to build a 2,000-seat Holy Name of Jesus Cathedral<sup>5</sup> to replace the current Sacred Heart Cathedral in downtown Raleigh. While roadway changes will be included, the specific changes will have to meet the requirements of Raleigh's Unified Development Ordinance. It is likely that Pullen Road will be extended south to connect with Centennial Parkway, but the exact alignment and connection points have not been determined. Neither has a decision on whether an interchange will be required at Western Boulevard & Pullen Road. A half interchange already exists for westbound Western Boulevard traffic, and the eastbound traffic may also be separated from Pullen Road traffic in the future. The tested scenario included the interchange and connected Pullen Road to Oval Drive.

The other modification was to assume one or a pair of tunnels under Western for buses, bicyclists, and pedestrians. All travel modes are critical, especially pedestrian, because of the amount of pedestrian traffic across Western and which affects the traffic signal timing. **Exhibit 3-8** shows the results.

This analysis found:

- Both the Pullen Road extension and the tunnels under Western Boulevard will provide significant relief to the intersections of Western Boulevard & Avent Ferry Road, and Centennial Parkway & Avent Ferry Road so that delays are at or below failure levels
- The redirection of traffic will cause the intersection of Centennial Parkway & Oval Drive to get worse, and the intersections of Pullen Road with the Western Boulevard ramps to be failing.
- These two projects will have minimal effect on the major delays at Gorman Street & Hillsborough Street and Gorman Street & Western Boulevard
- The pedestrian/bicycle/transit tunnel at Avent Ferry Road will help in decreasing the delay at the intersection by 57 seconds/vehicle in the PM peak hour in 2022.

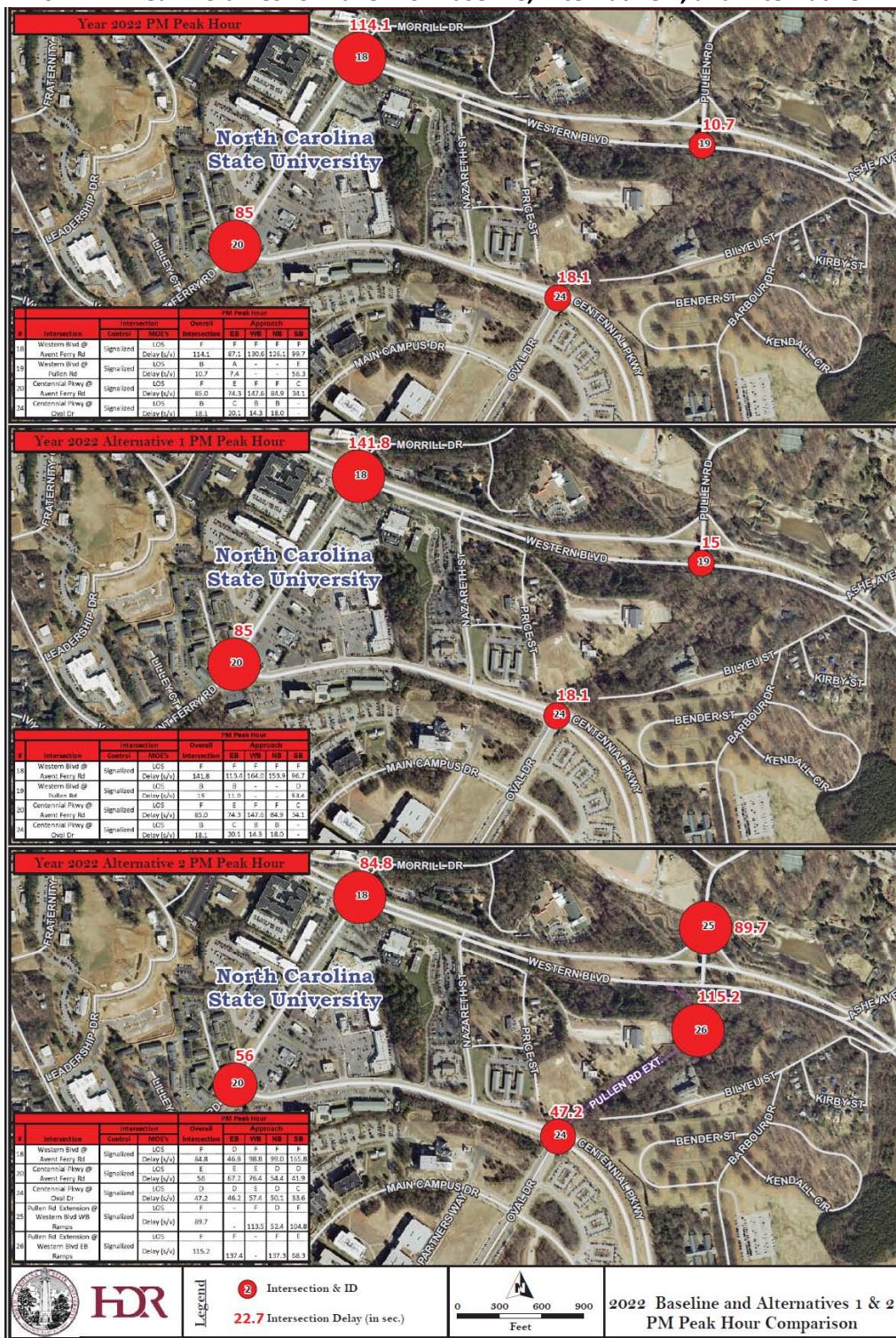
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<sup>5</sup> See <http://www.holynamecathedralnc.org/> for more details on the cathedral including renderings and site plans.





Exhibit 3-8  
2022 PM Peak Volumes for Pullen for Baseline, Alternative 1, and Alternative 2



Source: HDR analysis of traffic counts

### 3.3.4 Other Road Network Changes

The Physical Master Plan includes several roadways on Centennial Campus and the South Campus precinct that will benefit Wolfline operations. These roadways are around Hunt Library, the student housing under construction, and improvements in the Greek Village area. The proposed Wolfline changes were developed with the planned roadway network in mind.

An additional roadway project that could benefit Wolfline is the NCDOT planned reconstruction of I-440 between the Central and West campus precincts. There is currently a one-lane tunnel under I-440, with an 11-foot clearance horizontally and vertically. While a bus can fit through this tunnel, it has some operational challenges – the dimensions require navigating the tunnel slowly; vehicles in opposite directions have to take turns; and the grade change on the western side could lead to the bus scraping bottom. An improved tunnel as part of the reconstruction of the interstate could allow the 4 Westgrove to use this tunnel and completely avoid the congested intersections of



Western & Method and Hillsborough & Gorman. Such a rerouting would require the abandonment of the Westgrove Park & Ride, but with the new and expanded park & ride lots, Westgrove is no longer needed. Construction on I-440 is scheduled to begin in 2016.

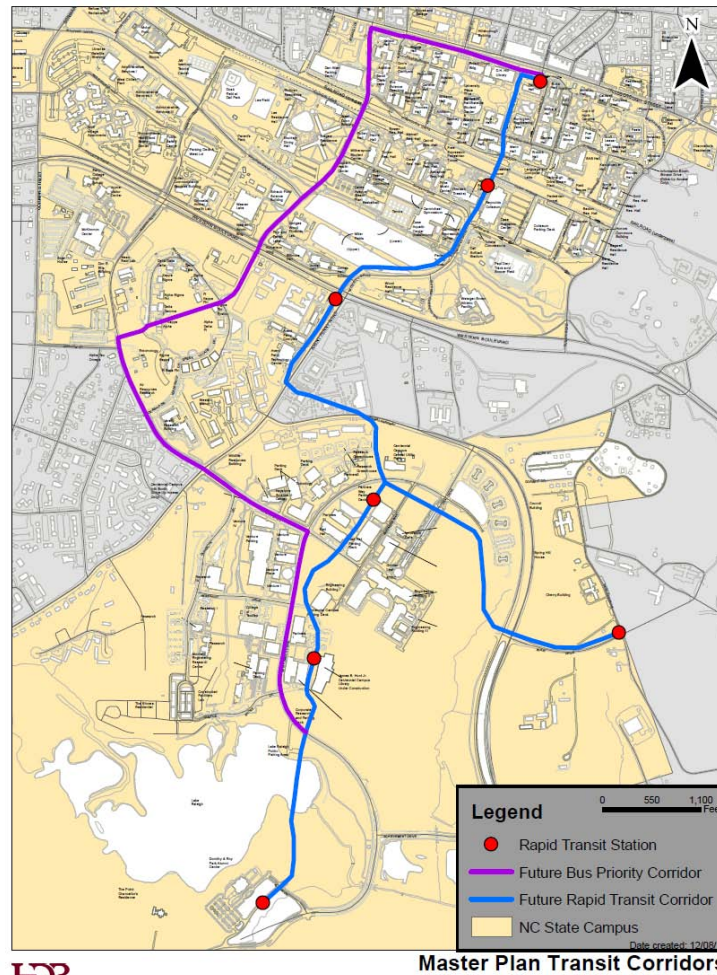
### 3.3.5 Dedicated Transit Guideway

The current Physical Master Plan includes two transit corridors as shown in **Exhibit 3-9**. One corridor is identified as a Future Bus Priority Corridor and the other as a Future Rapid Transit Corridor. This latter corridor has been variously envisioned as a monorail, automated guideway transit (AGT) corridor similar to an airport shuttle train, or a personal rapid transit (PRT) corridor – smaller pod vehicles offering direct trips such as is in place at West Virginia University. The Physical Master Plan corridors were taken to the community meetings to solicit feedback for their long-term inclusion.





**Exhibit 3-9  
Physical Master Plan Transit Corridors**



**HDR**  
ONE COMPANY | Many Solutions  
Master Plan Transit Corridors  
NC State | NC State Mobility Study | Future Rapid Transit

Source: NC State Physical Master Plan as updated June 2011

One of the main objectives for this type of priority treatment and technology is to move large volumes of riders in a quick fashion. The rapid transit technologies, such as the monorail or AGT technologies can be expensive, costing in the range of \$50 million per mile. To connect the DH Hill Library to Hunt Library could be 1.75 miles for a total cost of nearly \$90 million. To justify that expense, the volume of riders back and forth needs to be high and beyond the level that could be accommodated by less expensive technologies, such as buses. The principal route that follows the alignment is the combined 3 Engineering/3A Centennial Express. With their combined ridership levels, a 7.5 minute headway is needed in the next two years; a four minute headway by five years; and a three-minute headway in 10 years if 40-foot buses are used or a five-minute headway with articulated buses. While these headways are very frequent, the expense of running these buses is less than building an overhead guideway.

The conclusion is that no guideway was needed in the ten year planning horizon, but could be needed in the longer term.



### 3.4 Campus Involvement

The NC State campus community was invited to participate in two town meetings to learn more about the recommended changes in the 2012 *Campus Mobility Plan*. The meetings were held in an open house style format with no formal presentation scheduled. Attendees were encouraged to meet with Project Team members, review the project maps and handouts, and to engage with other members of the university community to discuss the recommended changes. The following sections summarize the comments. More detailed information is in the Technical Report in the Appendix.

#### 3.4.1 Meetings

Two town meetings were held on the NC State campus. Each meeting had identical formats and included the same project maps and handouts. The first meeting was held on April 11, 2012 from 1:00 PM – 3:00 PM at the Witherspoon Student Center located in the Central Campus. A total of 49 people signed-in at the meeting. The second meeting was held on April 18, 2012 from 11:00 AM – 2:00 PM at Engineering Building I located on Centennial Campus. A total number of 31 people signed-in at the meeting.

#### 3.4.2 Major Feedback

A comment table was stationed at both meetings. The comment sheets gave attendees the opportunity to rate each recommended change, which was broken up by route changes, schedule changes, and capital improvements. The scale ranged from “excellent” to “don’t do it”. Respondents also had the opportunity to check “don’t know” in rating a particular change. A composite score was calculated based on weighing the total responses for each category and assigning a scaled preference score of 1 to 5 with 1 being “don’t do it” and 5 being “excellent.” Generally, a composite score over 3.5 indicates pretty strong support.

##### 3.4.2.1 Route Changes

Potential route changes presented to the community and their scores were:

**Exhibit 3-10  
Route Change Scoring**

Potential Route Change	Score
Combining the 2 Hillsborough Street Shuttle with the 4 Westgrove	3.3
Combining the 3 Engineering with the 3A Centennial Express	3.5
Rerouting the 5 Varsity through the McKimmon Center parking lot to avoid Western & Gorman	3.7
Combining the 6 Carter Finley with the 8 Southeast Loop	2.7
Extending the 7 Wolfink Shuttle to Cameron Village	4.1
Rerouting the 10 Southside Circulator to serve the apartments on Gorman	3.8
Rerouting the 11 Village Link from Western to Sullivan	3.7

The recommended route changes received generally strong support, with an overall composite score of 3.5. The route changes with the highest support included the recommendation to extend Route 7 to Cameron Village (score = 4.1) and rerouting of Route 10 to serve the Gorman St. area apartments (score

= 3.8). The route change recommendations receiving the lowest score was the proposal to combine Routes 6 & 8 (score = 2.7) and combining Routes 2 & 4 (score = 3.3).

**3.4.2.2 Schedule Changes**

Schedule changes presented to the community and their scores include:

**Exhibit 3-11  
Schedule Change Scoring**

Potential Schedule Change	Score
Add later trips on 1 Avent Ferry	3.8
Eliminate trips after midnight on 2 Hillsborough Street Night Shuttle	2.6
Add more trips between 6-8 PM on the 3 Engineering	3.7
Add earlier trip and delete last trip on the 5 Varsity	2.8
Add earlier trip and more frequent trips between 6-9 PM and during the day on the 9 Gorman Street Local	3.8
Add later morning & earlier evening trips; add later evening trip on the 10 Southside Circulator	3.8

The recommended schedule changes were generally supported, with an overall composite score of 3.4. Overall, the results were fairly predictable with the additional service/better frequency being more popular than where trips were being eliminated. The most popular schedule changes were adding an earlier trip and more frequent trips between 6:00 PM – 9:00 PM on Route 9 (score = 3.8) and the addition of a later morning, earlier evening, and later evening trips on Route 10 (score = 3.8). The least popular schedule changes were the recommendation to eliminate Route 2 trips after midnight (score = 2.6) and to add an earlier trip but delete the last trip on Route 5 (score = 2.8).

Respondents also requested in the general comments to add more evening and weekend service.

**3.4.2.3 Capital Improvements**

Capital improvements presented to the community and their scores were:

**Exhibit 3-12  
Capital Improvement Scoring**

Potential Capital Item	Score
Ligon Tunnel under I-440	3.5
Centennial Transit Center	4.2
New Southwest P&R	3.9
New Farmers Market P&R	3.9
Pedestrian underpass at Western	4.7
Pullen Road extension	4.6
Express Bus Corridors	4.3
New Commuter Rail and station	4.0
Using 60-foot articulated buses	3.6

The recommended capital improvements were by far the most popular, with an average composite score of 4.1. Each of the recommended capital improvements received composite scores above 3.5.

The most popular capital improvements included building the pedestrian underpass at Western Boulevard/Avent Ferry Road (score = 4.7) and the Pullen Road extension (score = 4.6).

In the general comments, attendees also requested more improvements at bus stops, such as shelters and benches.

#### **3.4.2.4** *Comments on the Dan Allen Closure*

Respondents were asked an open-ended question regarding whether the proposed Dan Allen daytime closure would positively or negatively affect their travel around campus. A total of 26 submitted responses said it would have a positive affect, 18 submitted responses said it would have a negative affect, 17 submitted responses said it would not affect them, and 2 did not respond to the question.

The general themes that emerged from those who responded that it would have a positive affect were:

- Buses will travel more quickly along Dan Allen Drive, making bus trips more efficient.
- Improved safety for pedestrians and bicyclists.

The general themes that emerged from those who responded that it would have a negative affect were:

- Diversion of traffic to surrounding roadways, making them more congested.
- Increased difficulty in completing midday activities (work and non-work trips) and traveling around campus for classes, meetings, etc.

## 4 Recommended Changes

Based upon the input received from the Advisory Committee and the NC State community, and with further discussions with NC State Transportation staff, the list of changes recommended for implementation was narrowed down. Some of the potential changes discussed in Chapter 3 were dropped from being recommended, or were delayed until later years when their desirability should be confirmed.

The following sections present the recommendations in two ways – the first sections show the recommendations by time period. Three time periods are shown – the initial two years, Academic Year 2012-13 and 2013-14; the next three Academic Years, through 2016-17; and the final five year period through Academic Year 2021-22. Section 4.4 provides detailed recommendations by route.

### 4.1 2012-13 and 2013-14 Academic Years

During the initial two years, the recommendations are limited to those that can be accomplished at lower cost and that do not require major vehicle additions. Some vehicles are added in the second year, either through an addition to the contract with First Transit, or by operating with a lower spare ratio than desirable during portions of the day. No capital facilities are constructed during the first two years.

#### 4.1.1 Daytime Changes

##### General Schedule Parameters

One major objective is to modify schedules where required to meet the following minimum objectives. Most routes already fall within these parameters, so this recommendation amounts to tinkering with the existing schedules. More specific information on individual routes is given in Section 4.4.

- All routes operate from 7 AM to 6:30 PM at a minimum
- If 2 buses are on route, 2<sup>nd</sup> bus is in service between 8:30 AM to 4 PM at minimum
- If 3+ buses on route, headways can be feathered in over the following time periods:
  - Before 7 AM (1 bus in operation)
  - 7 AM – 8:30 AM (2 buses in operation)
  - 8:30 AM – 4 PM (3+ buses in operation)
  - 4 PM – 6:30 PM (2 buses in operation)
  - 6:30 PM – 10 PM (1 bus in operation)
- Headways should not exceed 30 minutes
- Night service switchover occurs at 10 PM

##### Major Schedule Adjustments

- 1 Avent Ferry requires one additional bus to go from a 12-minute headway to a 9-minute headway
- 3A combination with 3 results in route 3A going from a 15-minute headway to a 7.5-minute headway

- 9 Gorman Street Local requires one additional bus to go from a 9-minute headway to a 7.5-minute headway

### Route Changes

The route network for the daytime services is shown in **Exhibit 4-1**. Major route changes during the first two years consist of:

- Extend 2 Hillsborough Street Shuttle to Cameron Village after 10 AM (until 10 PM)
- Combine routes 3 Engineering and 3A Centennial Express. Combined route will follow the 3A Centennial Express routing with a modification to serve Hunt Library, but will be called 3 Engineering
- 8 Southeast Loop rerouted to Hunt Library stop
- 11 Village Link rerouted to serve Hunt Library stop and shift to Sullivan from Western

### Adjust Bus Assignment

The following bus adjustments will be made to match the fleet with passenger loads:

- Reduction of one bus from the combination of the 3 and 3A; three small buses will be saved from the 3 Engineering, and two full-size buses will be added to the 3A
- 4 Westgrove will switch from one full-size bus to one 30-foot bus
- 10 Southside Circulator will switch from one full-size bus to one 30-foot bus
- 11 Village Link will switch from one full-size bus to one 30-foot bus
- Net change – 30-footer pullout remains at six buses, requiring seven buses with spares; one less than current fleet. Full-size bus requirement increases by two due to increased frequency to handle overloads on the 1 Avenet Ferry and 9 Gorman Street Local

## 4.1.2 Nighttime Changes

### 4.1.2.1 Wolfline Routes

The nighttime services are adjusted as described in Chapter 3. **Exhibit 4-2** shows the nighttime route network and the major nighttime origins and destinations. This route network goes into service at 10:00 PM, when the daytime network stops.

The Wolfprowl service remains the weekend night service providing the connection to the Glenwood South district. It is extended to connect to the major residential complex of Wolf Village to provide a closer connection to the home trip end. If a single bus remains assigned to this route, headways will need to increase from 30 minutes to 40 minutes. The alternative is to run two buses at a 20 minute headway. A 40-minute headway is sufficient for the passenger loads and is not an overly long headway at that time of night, but the University may want to offer no worse than a 30-minute headway as a policy.

The Werewolf route is reoriented to be the connecting service between the main campus and Centennial Campus. This modification tightens the one way loop so that it no longer connects to the Wolf Village and ES King Village areas; the new routes, “Wolfbane” and “Full Moon” described below, provide this connection. By making this modification, faster connections are provided for riders on this route.



The new “Wolfbane<sup>6</sup>” route replaces the 2 Hillsborough Street Night Shuttle. It is essentially the same route except that it operates along the Dunn-Jeter-Cates-Morrill stairstep instead of operating on Pullen and Western. More origins and destinations are served by this routing. A new name is recommended for the night service since the routing is different than the daytime service.



A second new route, “Full Moon”, provides the Wolf Village/ES King Village to Centennial connection. This new route permits riders to travel in both directions rather than the Centennial to Wolf Village only path provided by the current Werewolf route.

The names selected for the nighttime services are potential names based upon the existing “werewolf” theme. Other names may be more appropriate. For movie buffs, perhaps “Van Helsing” or “(Larry) Talbot” would be good choices. The objective is to make the names imaginative and fun and to keep them as named routes and not have a number as a way to further distinguish them as nighttime routes. The daytime routes would continue to use both a number and a name.

No additional nighttime changes are recommended, but with the introduction of student housing on Centennial Campus, adjustment to the Werewolf or Full Moon routes might be warranted. If demand is strong enough, another nighttime route may be needed. This need should be revisited after the student housing becomes established.

#### 4.1.2.2 Security Escort Service

The security escort service operated under University Housing should continue as a complementary service to the Wolfline night routes. Some students will never feel secure waiting at a bus stop to travel home in the evening. Improvements to the nighttime Wolfline routes, by adding more routes and ensuring a 30-minute or better headway should encourage more students to use Wolfline rather than the escort service.

Usage of the escort service should be more closely tracked to monitor performance. Existing data was limited. One potential option to reduce costs would be to reduce the hours to 10:00 PM to 7:00 AM; these are the hours when Wolfline runs reduced service. By delaying the start of the escort service until 10:00 PM from 8:00 PM, the demand on the Budd Security Service would be reduced. Extending the hours until 7:00 AM from 6:00 AM is not likely to result in much demand given the low or no usage after 4:00 AM, but would result in 24-hour service for the University community.

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<sup>6</sup> Wolfbane - The highly toxic juice of the wolfbane plant placed on an arrowhead could kill wolves. The legendary poison was created by Hecate, Greek goddess of the underworld. It was powerful enough to ward off werewolves if hung on a door or grown around a house.

*“Even a man who is pure in heart and says his prayers by night, may become a wolf when the wolfbane blooms ... and the autumn moon is bright.” -from The Wolfman*

Exhibit 4-1  
AY 2012-13 to AY 2013-14 Daytime Routes

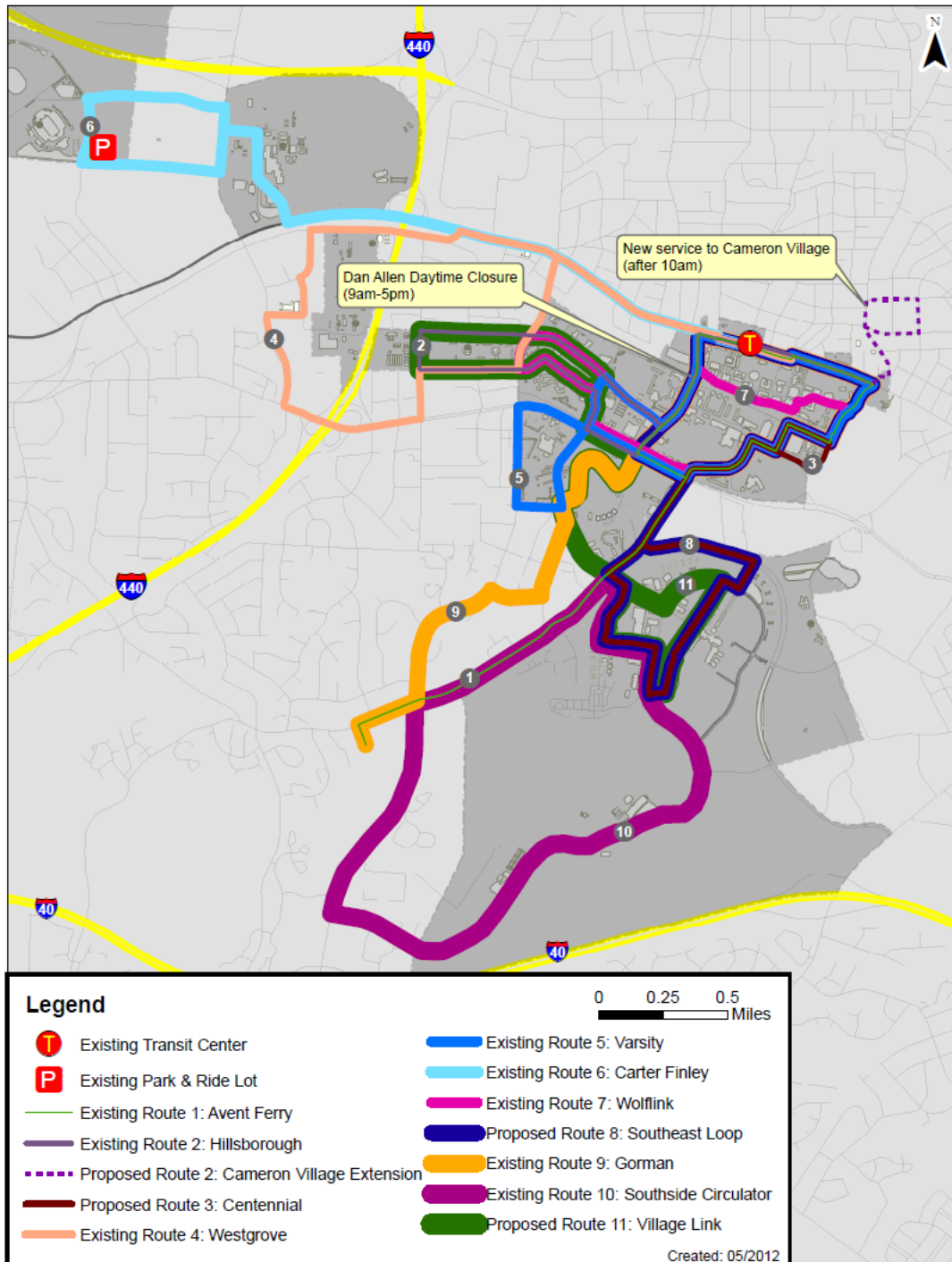
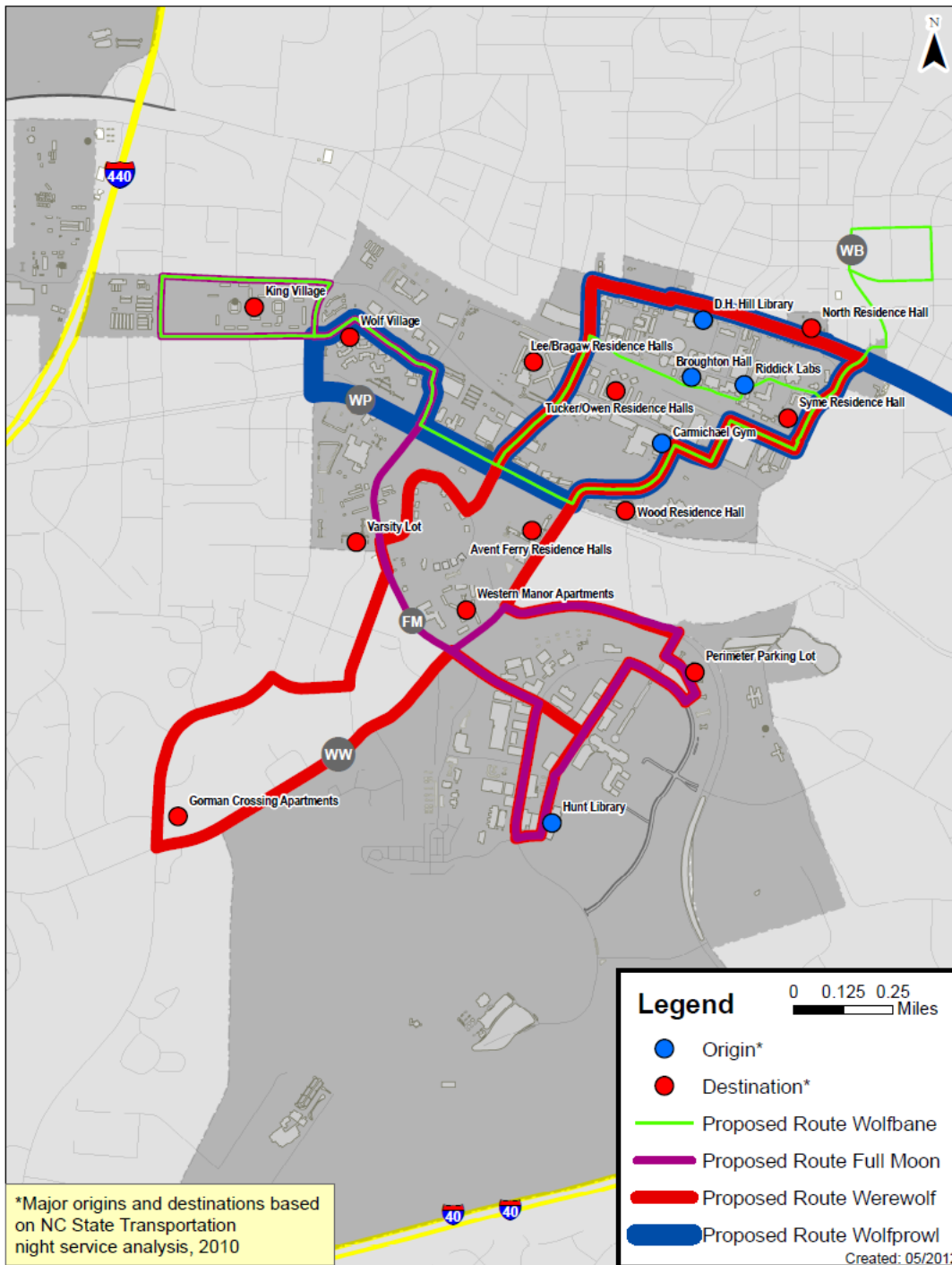




Exhibit 4-2  
AY 2012-13 to AY 2013-14 Nighttime Routes



**Recommended Wolfline Night Service Routes**  
First 1-2 years

## 4.2 2014-15 through 2016-17 Academic Years

In the next three years, the ability to modify service is assumed to be more flexible since sufficient time is available for the contractor to procure new vehicles and any contract modifications that may be required to support more service hours can be negotiated and budgeted. This time period, though, is still covered by the existing five-year contract with First Transit. As such, it was not considered reasonable to introduce larger, articulated buses into service. Articulated buses require different lifts and maintenance bays, which the current operating facility does not include. By waiting until a new contract, the selected contractor has sufficient lead time to lease or build their own longer maintenance bays, or work out an arrangement with either CAT or Chapel Hill Transit to use their maintenance facilities for the articulated fleet.

### 4.2.1 Service Changes

#### Major Schedule Adjustments

- 3A Centennial Express (new 3 Engineering): Decrease headway to 4 minutes (requires 3 buses)
- 8 Southeast Loop: Decrease headway from 12 minutes to 6.7 minutes (9 trips/hour) – will require 3 buses
- 10 Southside Circulator: Fill in remaining 3 hour gap in midday service
- 11 Village Link: Decrease headway from 30 minutes to 15 minutes (requires 1 bus)

#### Route Changes

The route network for the daytime services is shown in **Exhibit 4-3**. There are no changes to the nighttime network. Major route changes during the second three years consist of:

- 10 Southside Circulator: Reroute to serve apartments along Avent Ferry
- New 12 Centennial Circulator: New circulator service within the Centennial Campus to serve the new student housing with an initial 30-minute headway (will require 1 bus)
- New 13 Farmers Market: New P&R service from Farmers Market to Centennial and Main Campuses with an initial 40 minute headway (requires 1 bus)

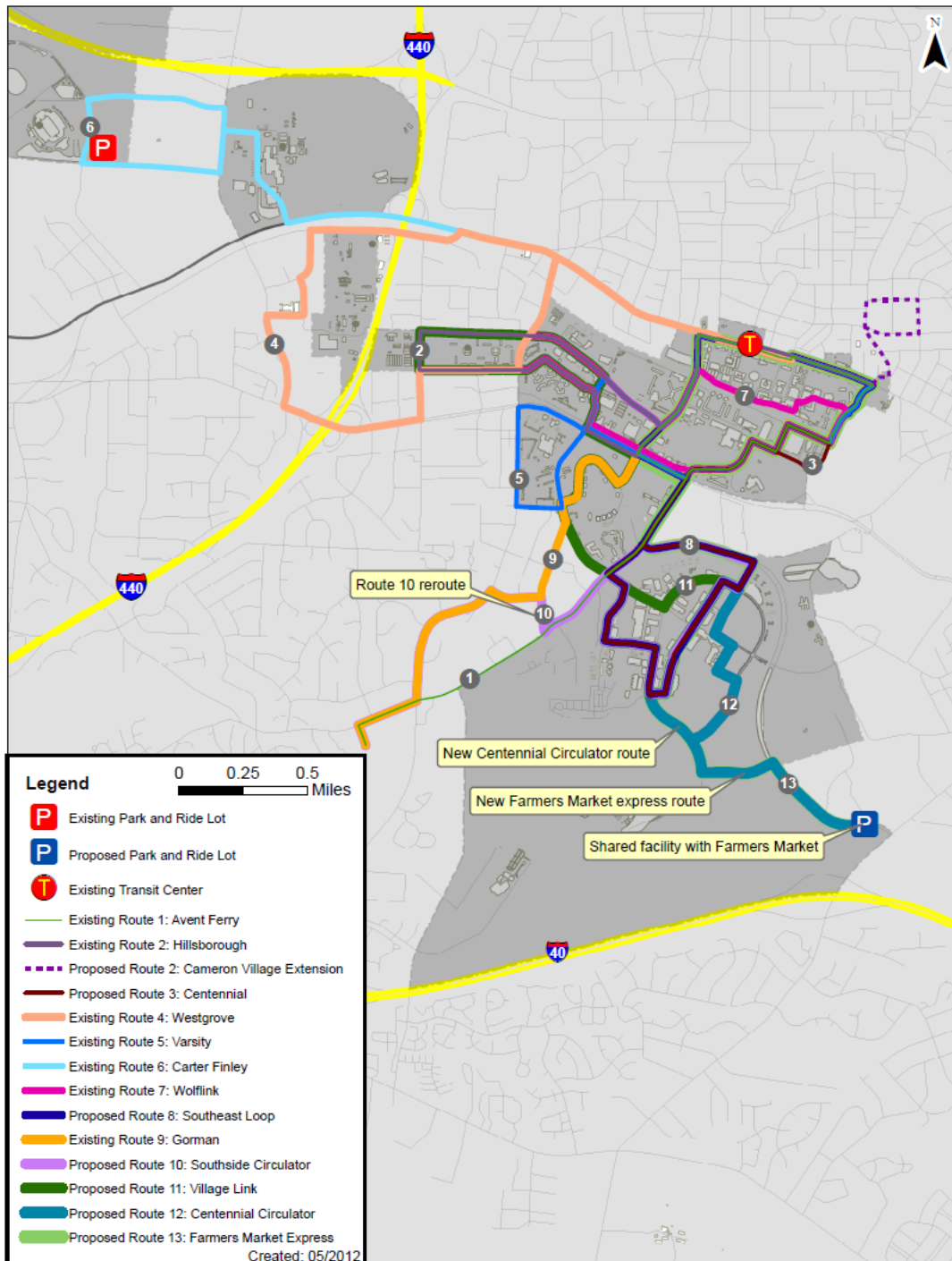
#### Adjust Bus Assignment

The following bus adjustments will be made:

- 8 Southeast Loop will double its full size buses by adding 3 more
- 10 Southside Circulator will double its 30-foot buses by adding 1 more
- 11 Village Link will double its 30-foot buses by adding 1 more
- The new 12 Centennial Circulator will have 1 30-foot bus
- The new 13 Farmers Market Express will have 1 full size bus
- Total change will be 8 more full sized buses including spares; 4 more 30-foot buses are needed with spares



Exhibit 4-3  
AY 2014-15 to AY 2016-17 Daytime Routes



Potential Wolfline Bus Service: Middle 3-5 Years



#### 4.2.2 Capital Improvements

The 13 Farmers Market Express will require the construction of a shared park & ride lot with the existing Farmers Market lot. This construction will double the amount of parking at the lot in the shared portion. A total of 200-250 spaces are needed, with half that number as new spaces.

### 4.3 2017-18 through 2021-22 Academic Years

The current contract with First Transit will have expired by AY 2017-18. This rebidding offers the potential to introduce articulated buses to the fleet and reduce the amount of vehicles in operation. Additional capital facilities come on line during this five year period and the overall service levels continue to increase to match the growth in enrollment and employment.

#### 4.3.1 Service Changes

##### Major Schedule Adjustments

- 3A Centennial Express (new 3 Engineering): Increase headway to 5 minutes with introduction of articulated buses (saves 1 bus)
- 8 Southeast Loop: Increase headway to 9 minutes with the introduction of articulated buses (saves 2 buses)
- 9 Gorman Street Local: Increase headway to 12 minutes with the introduction of articulated buses (saves 2 buses)
- 12 Centennial Circulator: Decrease headway to 20 minutes (requires 1 bus)
- 13 Farmers Market Express: Decrease headway to 20 minutes (requires 1 bus)

##### Route Changes

The route network for the daytime services is shown in **Exhibit 4-4**. There are no changes to the nighttime network. Major route changes during the final five years consist of:

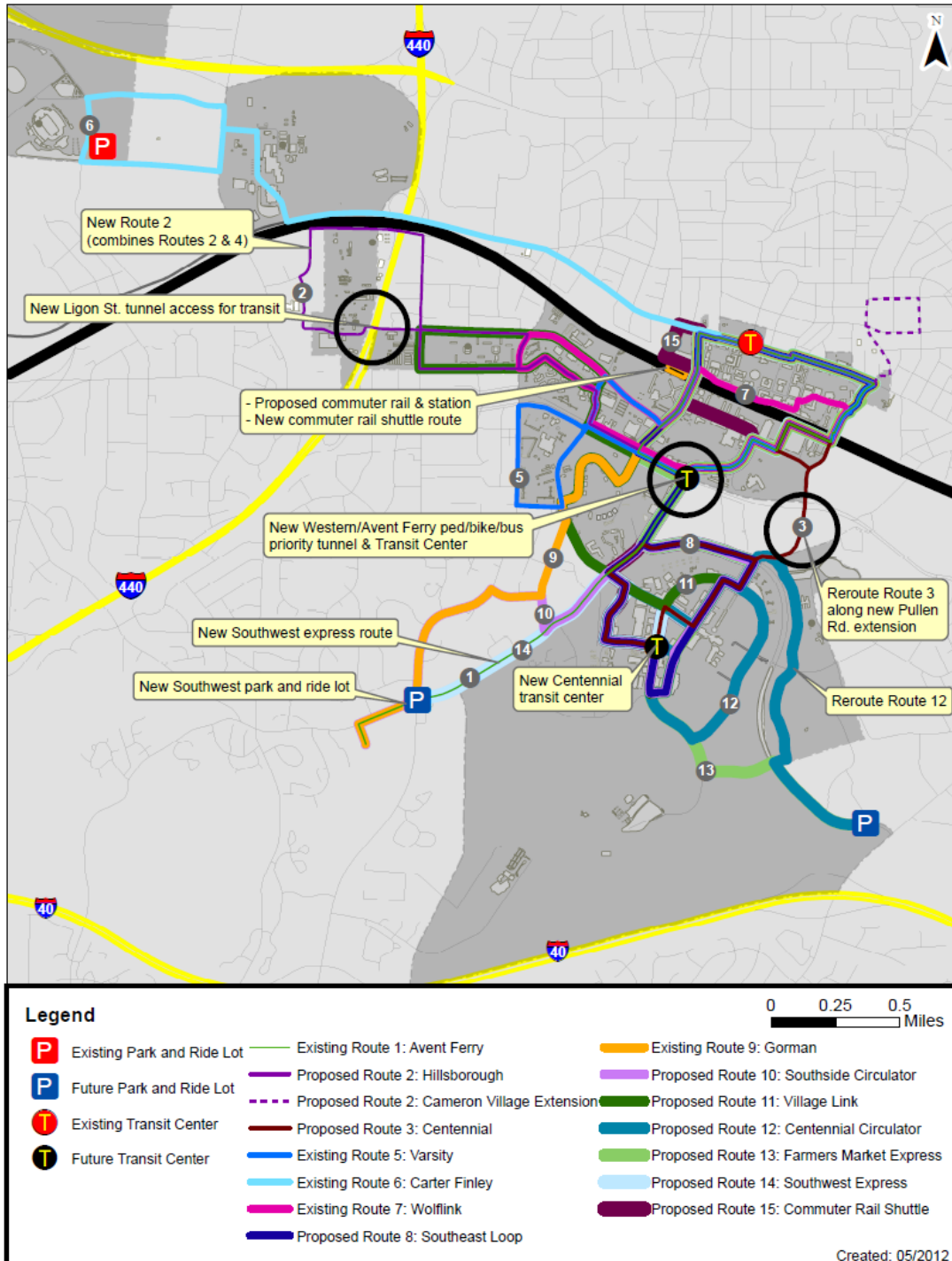
- 2 Hillsborough Street Shuttle combined with 4 Westgrove, after a new eastbound stop is constructed at Wolf Village and parking location is adjusted. The route is relocated to use the Ligon Street Tunnel.
- 3A Centennial Express (new 3 Engineering) rerouted to use Pullen Road extension to Centennial Parkway
- 12 Centennial Circulator: reroute to serve new developments on Centennial Campus
- New 14 Southwest Express providing service from new lot near Avent Ferry & Gorman; initial headway of 15 minutes (requires 3 buses)
- New 15 Commuter Rail Shuttle with 30-minute headway (requires 1 bus)

##### Adjust Bus Assignment

The following bus adjustments will be made:

- The combination of 2 Hillsborough Street Shuttle with 4 Westgrove saves one 30-foot bus but requires 1 new full sized bus
- The 3A Centennial Express articulated conversion saves 7 full size buses and requires 6 articulated buses

Exhibit 4-4  
AY 2017-18 to AY 2021-22 Daytime Routes



Potential Wolfline Bus Service: Remaining 6-10 Years

- The 8 Southeast Loop articulated conversion saves 6 full size buses and requires 4 articulated buses
- The 9 Gorman Street Local articulated conversion saves 6 full size buses and requires 4 articulated buses
- The 12 Centennial Circulator requires 1 more 30-foot bus
- The 13 Farmers Market Express requires 1 more full size bus
- The new 14 Southwest Express requires 3 full size buses
- The new 15 Commuter Rail Shuttle requires 1 full size bus
- Total change will be 17 articulated buses, including spares; 13 fewer full sized buses including spares; and 3 fewer 30-foot buses are needed with spares

#### **4.3.2 Capital Improvements**

Several capital items come on line during this five year period. They are shown in Exhibit 4-4.

- Avent Ferry Tunnel – the new bus/bicycle/pedestrian tunnel under Western Boulevard is opened
- Centennial Transit Center – a new Centennial Transit Center is opened near Hunt Library and the Engineering buildings
- Southwest Park & Ride – a new park & ride is opened adjacent to the planned CAT transit center in the vicinity of Avent Ferry & Gorman
- New traffic signal on Centennial Campus – a new traffic signal is anticipated to be warranted at either Varsity & Capability or Varsity & Main Campus Dr.

Several capital items are the responsibility of other agencies, but will affect Wolfline services. The timing of these facilities will be set by the other agencies, but they are anticipated to come on line during AY 2017-18 to AY 2021-22

- Ligon Street Tunnel (by others) – the tunnel is widened as part of the reconstruction of I-440.
- Commuter Rail Station (by others) – the new commuter rail station for the TTA service is opened near Dan Allen Drive
- Pullen Road Extension (by others) – Pullen Road is extended to Centennial Parkway allowing a new access route to campus

### **4.4 Recommendations by Route**

#### **1 Avent Ferry**

- Academic Year (AY) 2012-13 to AY 2013-14
  - Decrease headway from 12 minutes to 9 minutes from 8:30 AM to 4 PM (requires 1 bus)
  - Add in trip between 6:30 PM and 7:00 PM
  - Add in trip between 9:30 PM and 10:00 PM

#### **2 Hillsborough Street Shuttle**

- AY 2012-13 to AY 2013-14
  - Run regular route until 10:00 PM

- Increase headway from 15 minutes to 20 minutes to provide more running time
- Extend to Cameron Village after 10 AM (headway of 22 minutes)
- AY 2014-15 to AY 2016-17
  - No changes
- AY 2017-18 to AY 2021-22
  - Combine with 4 after Wolf Village stop improved

### **3 Engineering**

- AY 2012-13 to AY 2013-14
  - Combine with 3A

### **3A Centennial Express**

- AY 2012-13 to AY 2013-14
  - Combine with 3 Engineering and rename to 3 Engineering
  - Reroute to serve new Hunt Library stop
  - Decrease headway from 15 minutes to 7.5 minutes between 8:30 AM and 4 PM (requires 1 less bus than operated on 3 & 3A)
  - Operate 3 buses from 7-8:30 AM and 4-6:30 PM
  - Extend half hour service to 8 PM
- AY 2014-15 to AY 2016-17
  - Decrease headway to 4 minutes (requires 3 buses)
  - Extend half hour service to 10 PM
- AY 2017-18 to AY 2021-22
  - Reroute to use new Pullen Road extension
  - Convert to articulated buses
  - Increase headway to 5 minutes (will save 1 bus)

### **4 Westgrove**

- AY 2012-13 to AY 2013-14
  - Add trip between 5:30 PM and 6 PM
  - Switch to 30-foot buses
- AY 2014-15 to AY 2016-17
  - No changes
- AY 2017-18 to AY 2021-22
  - Combine with 2 after Wolf Village stop improved

### **5 Varsity**

- AY 2012-13 to AY 2013-14
  - Add trip between 6:30 AM and 7 AM

### **6 Carter Finley**

- AY 2012-13 to AY 2013-14
  - Add trip between 6:30 AM and 7 AM
  - Eliminate 4 trips after 8 PM

**7 Wolfink Shuttle**

- AY 2012-13 to AY 2013-14
  - Maintain smaller buses

**8 Southeast Loop**

- AY 2012-13 to AY 2013-14
  - Add an earlier trip around 6:45 AM
  - Add trip between 7:30 PM and 8 PM
  - Eliminate trip after 9:30 PM
  - Reroute to Hunt Library
- AY 2014-15 to AY 2016-17
  - Decrease headway from 12 minutes to 6.7 minutes (9 trips/hour) – will require 3 buses
- AY 2017-18 to AY 2021-22
  - Increase headway to 9 minutes and convert to articulateds (will save 2 buses)

**9 Gorman Street Local**

- AY 2012-13 to AY 2013-14
  - Decrease headway from 9 minutes to 7.5 minutes from 8:30 AM – 4 PM (will require 1 bus)
  - Reduce to 4 buses (12 minute headway) from 7 AM – 8:30 AM
  - Operate 16 minute headway (3 buses) between 4 PM – 6:30 PM
  - Operate 24 minute headway (2 buses) before 7 AM and after 6:30 PM
  - Add earlier trip between 6:30 AM and 7 AM
  - Add trip between 6:30 PM and 7 PM
  - Add trip between 8 PM and 8:30 PM
- AY 2014-15 to AY 2016-17
  - No changes
- AY 2017-18 to AY 2021-22
  - Increase headway to 12 minutes and convert to articulated buses (will save 2 buses)

**10 Southside Circulator**

- AY 2012-13 to AY 2013-14
  - Decrease headway from 16 minutes to 15 minutes if running time allows
  - Convert to smaller buses
  - Add trip between 11 AM and 11:30 AM
  - Add trip between 2:30 PM and 3:00 PM
  - Add trip between 6 PM and 6:30 PM
- AY 2014-15 to AY 2016-17
  - Reroute to serve Avent Ferry area apartments ( requires 1 bus)
  - Fill in remaining 3 hour gap in midday service
- AY 2017-18 to AY 2021-22
  - Reroute to serve new Centennial developments as they occur
  - Decrease headway to 20 minutes (will require 1 bus)



**11 Village Link**

- AY 2012-13 to AY 2013-14
  - Convert to smaller buses
  - Reroute to serve Hunt Library stop and shift to Sullivan from Western
- AY 2014-15 to AY 2016-17
  - Decrease headway from 30 minutes to 15 minutes (will require 1 bus)

**12 Centennial Circulator**

- AY 2014-15 to AY 2016-17
  - New circulator service on Centennial Campus
  - 30 minute headway initially (will require 1 bus)
- AY 2017-18 to AY 2021-22
  - Decrease headway to 20 minutes (will require 1 bus)
  - Further modifications to serve new Centennial developments

**13 Farmers Market Express**

- AY 2014-15 to AY 2016-17
  - New P&R service from Farmers Market to Centennial and Main Campuses
  - 40 minute headway (will require 1 bus)
- AY 2017-18 to AY 2021-22
  - Decrease headway to 20 minutes (will require 1 bus)

**14 Southwest Express**

- AY 2017-18 to AY 2021-22
  - New P&R service from Avent Ferry & Gorman to Centennial and Main Campuses
  - 15 minute headway (will require 3 buses)

**15 Commuter Rail Shuttle**

- AY 2017-18 to AY 2021-22
  - New shuttle service from commuter rail station to Centennial Campus
  - 30 minute headway (will require 1 bus)
  - Schedule should match train schedule, currently envisioned as 30-minute service during the peaks and a few midday trips. Bus schedule will need to be revisited when train schedule is established.

**Werewolf**

- AY 2012-13 to AY 2013-14
  - Maintain 10 PM start time and 2:30 AM end time
  - Reroute through Greek Village and away from ES King Village and Wolf Village (maintains 2 buses)
  - Maintain Saturday-Sunday service

**Wolfprowl**

- AY 2012-13 to AY 2013-14
  - Maintain 9 PM start time and 3 AM end time
  - Maintain Thursday-Saturday operation
  - Extend route to Wolf Village
  - Increase headway to 40 minutes (maintains 1 bus)
- AY 2014-15 to AY 2016-17
  - Potential second Wolfprowl route from Centennial

**Wolfbane**

- AY 2012-13 to AY 2013-14
  - New late night route to replace evening service on 2 Hillsborough Street Shuttle
  - Operate from 10 PM to 2:30 AM
  - Provide 30 minute headway (requires 1 bus)

**Full Moon**

- AY 2012-13 to AY 2013-14
  - New late night route connecting ES King Village and Wolf Village to Centennial
  - Operate from 10 PM to 2:30 AM
  - Provide 30 minute headway (requires 1 bus)

**4.4.1 Headway Adjustments**

For ease of reference, **Exhibit 4-5** shows the changes in headways by route over the course of the planning horizon. Rose-colored shading indicates the use of 30-foot buses; green shading indicates the use of articulated buses.

**Exhibit 4-5  
Headway Changes by Route and Phasing**

	Headway			
	Current	1-2 Years	3-5 Years	6-10 Years
1 Avent Ferry	12	9	9	9
2 Hillsborough St Shuttle	15	20	20	
2+4 combination				15
3 Engineering	10	combined with 3A		
3A Centennial Express	15	7.5	4	5
4 Westgrove	30	30	30	combo with 2
5 Varsity	15	15	15	15
6 Carter Finley	15	15	15	15
7 Wolfink Shuttle	10	10	10	10
8 Southeast Loop	12	12	6.67	9
9 Gorman St Local	9	7.5	7.5	12
10 Southside Circulator	16	20	15	15
11 Village Link	30	30	15	15
12 Centennial Circulator	x	x	30	20
13 Farmers Market Express	x	x	40	20
14 Southwest Express	x	x	x	15
15 Commuter Rail Shuttle	x	x	x	30
<b>Off-peak routes</b>				
Werewolf	22	20	20	20
Wolfprowl	30	40	40	40
Wolfbane		30	30	30
Full Moon		30	30	30
30 footers				
articulateds				

#### 4.4.2 Fleet Impacts

The changes in the fleet composition have been noted above. For ease of reference, **Exhibit 4-6** summarizes the changes by route over each of the three time periods. The spare ratio has been determined by bus type so that each type meets the desired 20 percent spare ratio.

Exhibit 4-6  
Changes in Fleet Composition

	Current	1-2 Years		3-5 Years		6-10 Years		
		Buses	Run Time	Buses	Run Time	Buses	Run Time	Buses
1 Avent Ferry	3	36	4	36	4	36	4	
2 Hillsborough St Shuttle	2	40	2	40	2			
2+4						45	3	
3 Engineering	3							
3A Centennial Express	2	30	4	28	7	30	6	
4 Westgrove	1	30	1	30	1			
5 Varsity	2	30	2	30	2	30	2	
6 Carter Finley	2	30	2	30	2	30	2	
7 Wolfink Shuttle	3	30	3	30	3	30	3	
8 Southeast Loop	3	36	3	40	6	36	4	
9 Gorman St Local	5	45	6	45	6	48	4	
10 Southside Circulator	1	20	1	30	2	30	2	
11 Village Link	1	30	1	30	2	30	2	
12 Centennial Circulator				30	1	40	2	
13 Farmers Market Express				40	1	40	2	
14 Southwest Express						45	3	
15 Commuter Rail Shuttle						30	1	
<b>Off-peak routes</b>								
Werewolf	2	40	2	40	2	40	2	
Wolfprowl	1	40	1	40	1	40	1	
Wolfbane		30	1	30	1	30	1	
Full Moon		30	1	30	1	30	1	
<b>Summary</b>								
Peak pullout	28		29		39		40	
Spares	6		6		8		8	
Total	34		35		47		48	
<b>Fleet Composition</b>								
Artics	0	0	0	0	0	17	17	
40-foot	26	2	28	8	36	-13	23	
30-footers	8	-1	7	4	11	-3	8	
	34	1	35	12	47	1	48	
<b>Breakdown of 30-footers</b>								
30 footers								
articulateds								

## 4.5 Travel Demand Management Recommendations

As part of the scope of services for the 2012 *Campus Mobility Plan*, an assessment of the Travel Demand Management (TDM) strategies used by NC State was made. As described in Section 2.8, NC State already provides an extensive list of alternative commute options.

Recommendations for enhancing this program are limited, but a few recommendations are possible.

1. Continue pricing parking at market rates and regular increase parking costs to bring supply in with demand.
2. Control the construction of new parking facilities to limit them to the periphery of campus.
3. Work with the corporate partners on Centennial Campus to limit the amount of parking provided and to charge the employees (not just employers) the cost of parking.
4. Expand the Zipcar program to more areas of campus. Currently, the only locations on campus are near Bragaw Hall in the Carriageway Lot and near the Craft Center on Dunn Avenue. Additionally NC State students have access to the Zipcars on the Meredith College campus. By offering Zipcars on Centennial Campus and other major locations, the service can be used by more people, including for those emergency trips between the major campuses.
5. Increase the availability of WolfWheels to have multiple rental locations around the university. At a minimum, locations should be provided on all campuses. Potential locations include:
  - a. The new Hunt Library and future Centennial Transit Center
  - b. Dan Allen Deck
  - c. Wolf Village
  - d. Greek Village
  - e. Centennial Biomedical Campus (Vet School)
6. Provide bicycle racks on all buses
  - a. At a minimum, these racks should be provided on the longer routes, especially 6 Carter Finley and the new Express routes. Ideally they are provided on all bus routes as a “bicycle accelerator”, that is they extend the range of bicyclists.
7. Offer carpool/vanpool services
  - a. This program can be offered through Triangle Transit. Their carpool matching program and vanpool program are available to all residents of the Triangle.
  - b. As an alternative, NC State could create their own program, using either in-house personnel, or contracting with a private company to do so.
  - c. Priority parking spaces should be made available to qualified vanpools and carpools.

## 4.6 Future Transit Guideway Corridors

One of the initial objectives of the 2012 *Campus Mobility Plan* was to evaluate the transit priority corridors that are included in the Physical Master Plan. The current corridors are shown in Exhibit 3-9.

At the outset, the evaluation focused on whether the travel demand across Western Boulevard was so large that buses would no longer be able to accommodate the demand. As indicated in Chapter 3, the conclusion was that articulated buses would be able to meet the need over the 10-year period covered by the 2012 *Campus Mobility Plan*. At the end of the 10-year period, the 3A Centennial Express would



operate at a 5-minute headway, as the major connecting route. Other major routes connecting Centennial area to the main campus, the 1 Avent Ferry and 9 Gorman Street local, would be running at a 9-minute and 12-minute headway respectively. Buses can safely operate at less than a 1-minute headway, indicating that there is room to grow the service further, but as headways decrease, the operating costs increase.

#### 4.6.1 Bus Priority Corridors

As noted in Section 3.3, the University is considering closing Dan Allen Drive to general vehicle traffic during most daylight hours, while allowing buses and other authorized vehicles to use. This is an example of the bus priority corridor implementation. By providing buses an exclusive roadway, their travel time speeds and reliability are greatly improved. This change is in keeping with making the University a more pedestrian-oriented campus since the bus volume will be far lower than the current auto volume. A similar all-day corridor already exists along Founders Drive.

The opportunities for other exclusive bus corridors at NC State are limited. None of the other roadways lend themselves to be converted to bus-only operation because they provide critical access for private vehicles to parking decks or surface lots. A few roadways might lend themselves to this type of operation, such as Faucette Drive, but the benefits were not judge high enough to warrant recommending these corridors at this time.

Short of creating an exclusive bus corridor is the potential to create “bus priority corridors” or “transit emphasis corridors.” These types of improvements are part of the long-range *Capital Area Bus Transit Development Plan*. In this plan, transit emphasis corridors were identified for Hillsborough Street and for Western Boulevard/Avent Ferry Road to serve CAT bus routes. These emphasis corridors have more frequent bus services (at least every 15 minutes peak) and a variety of capital improvements to benefit pedestrians/riders and bus operations. For pedestrians/riders, the capital improvements include a continuous sidewalk network, benches, and shelters with real-time bus displays. For bus operations, improvements include installing transit signal priority<sup>7</sup> so buses can move through traffic signals more quickly, and queue-jumper lanes<sup>8</sup> at selected intersections.

As noted, CAT has two transit emphasis corridors along the NC State border, which eliminates the need for NC State to make any improvements along Hillsborough, Avent Ferry, and the eastern portion of Western. Some NC State roadways do have very frequent bus service and transit-related improvements should be made to these corridors as required. **Exhibit 4-7** shows the potential transit emphasis corridors.

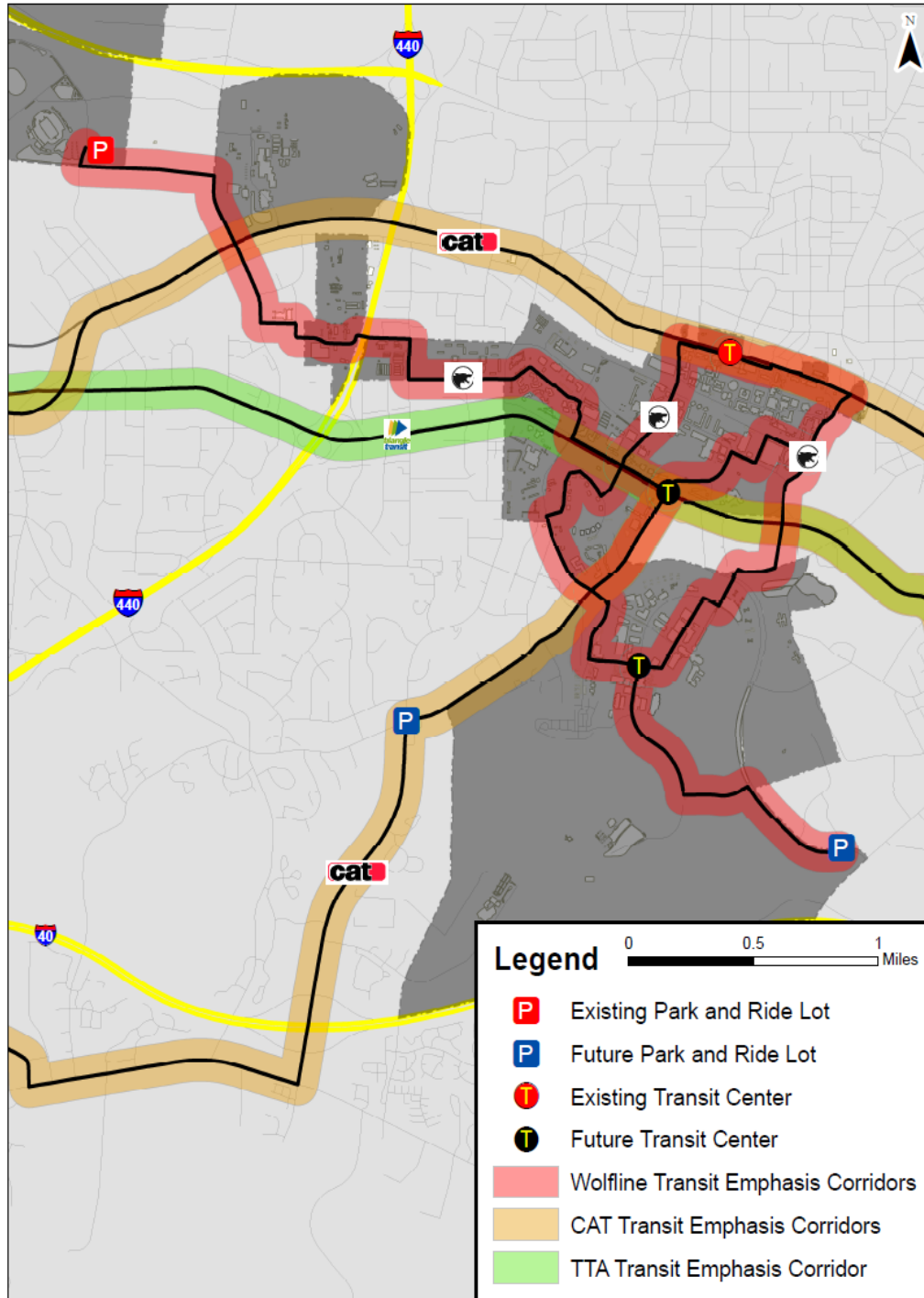
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<sup>7</sup> Transit signal priority gives buses a longer green light or shorter red light to allow them to transverse an intersection more quickly. It differs from traffic signal pre-emption used for emergency vehicles whereby the emergency vehicle takes over the signal and converts it to green.

<sup>8</sup> Queue-jumper lanes are an extension of right-turn only lanes through an intersection. Private vehicles must turn right, but buses are allowed to continue through an intersection to a stop on the farside. This arrangement can allow buses to bypass a line of traffic.



Exhibit 4-7  
Potential Bus Transit Emphasis Corridors

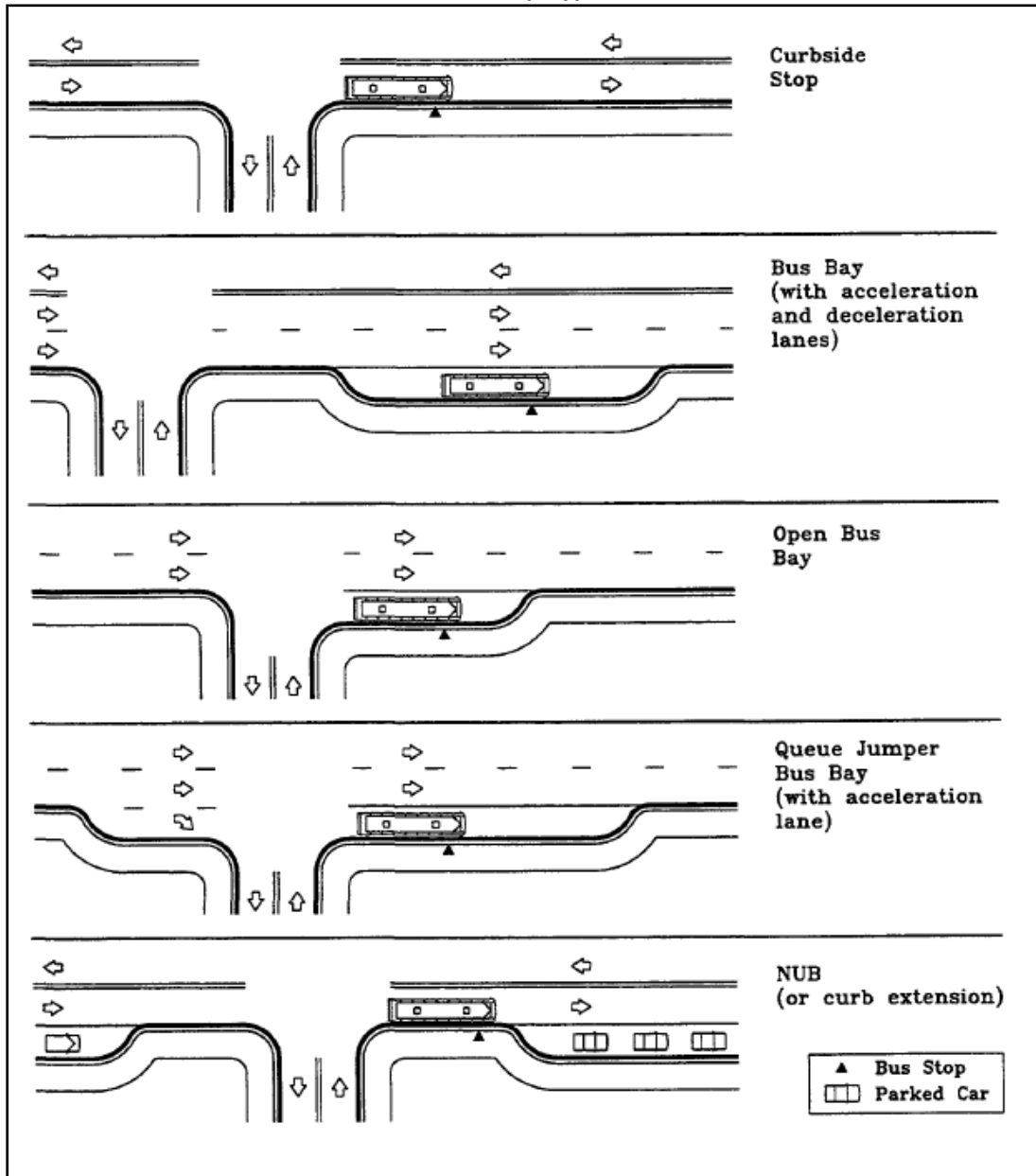


- Pullen Road Corridor – this corridor encompasses Pullen Road, Oval Drive, Main Campus Drive and Partners Way. Few improvements are needed along the NC State roadways other than to acknowledge these roadways as major transit corridors in the master plan and to incorporate transit priority into any new traffic signals that may be constructed. The principal need along this corridor is to ensure that the extension of Pullen Road includes priority for buses. The traffic analysis in Section 3.3.3 indicates that congestion at Pullen & Western is likely so the interchange design should provide for a fast bus route through the area. This is not the responsibility of NC State.
- Cates/Morrill Corridor – this corridor is already heavily used by Wolfline today and is projected to continue to have a high volume of buses. No improvements are identified for this corridor beyond the underpass being designed for the Western Boulevard crossing.
- Centennial Corridor – this corridor stretches from the new Farmers Market P&R to Wolf Village via Centennial Parkway, Main Campus Drive, Research Drive, Capability Drive, Varsity Drive, Fraternity Drive, Dan Allen Drive, Western Boulevard, Varsity Drive, and Wolf Village Way. A variety of routes will use portions of this corridor. Major concerns are to ensure all roadway modifications are sensitive to bus turning radii, stop locations, transit signal priority, and stop locations and amenities. Responsibility for these improvements will be up to the roadway owner, a combination of NC State, City of Raleigh and North Carolina Department of Transportation.
- Carter Finley Corridor – this corridor is an extension to the Centennial Corridor, primarily for game/event days. This corridor is along Ligon, Blue Ridge, and Trinity. On most days, the level of bus service is low, but this corridor is included to emphasize the benefits transit can provide for travel to Carter Finley and the PNC Arena. By providing an exclusive or semi-exclusive lane, transit can provide a real and attractive alternative to sitting in traffic. Major needs are the improved Ligon Tunnel under I-440 and transit signal priority along the route for capital items, but the most needed improvement is a traffic management plan that provides a lane for buses around the congestion point. This lane can be set off through the low-tech method of traffic cones, but will require active police enforcement. It will benefit Wolfline, CAT, and TTA buses and any private shuttles headed to the events.
- Dan Allen Drive/Founders Way – these corridors have been discussed elsewhere, but are shown on this map as part of the complete network.
- Western Boulevard Corridor – this corridor is a potential TTA corridor for commuter bus service between Raleigh and Cary. This corridor is not included in the *Capital Area Bus Transit Development Plan* because the commuter rail service is envisioned to take its place. Should commuter rail be delayed or should more immediate improvements be desired, bus priority can be added along Western west of Avent Ferry. This corridor is noted here because some improvements may involve NC State land, notably the potential for queue-jumpers at Western & Gorman. As the traffic section detailed, this is a highly congested location that will get worse. By providing bus queue-jumpers along Western, the commuter routes serving NC State can travel through the intersection more quickly.

**Exhibit 4-8** shows the types of bus stops that should be considered for the Bus Priority Corridors (and other locations). The “Curbside Stop” is a standard bus stop arrangement that is suitable for most locations on campus. The “Bus Bay” type is appropriate where buses have extended dwell times, such as layover locations where a bus would be blocking traffic for an extended time. It is not appropriate for

a standard stop where the bus does not dwell for a long period of time. The “Queue Jumper” shows how a bus could use the dedicated right-turn lane for other vehicles as a way to bypass congestion at the intersection and reach a farside bus stop bay. Potential locations are along Western Boulevard and Avent Ferry Road. The “Nub” is appropriate where a bus stop is located along a street with on-street parking, such as Main Campus Drive. A Nub provides more room for shelters and eliminates the potential for a car to park illegally in the bus stop zone.

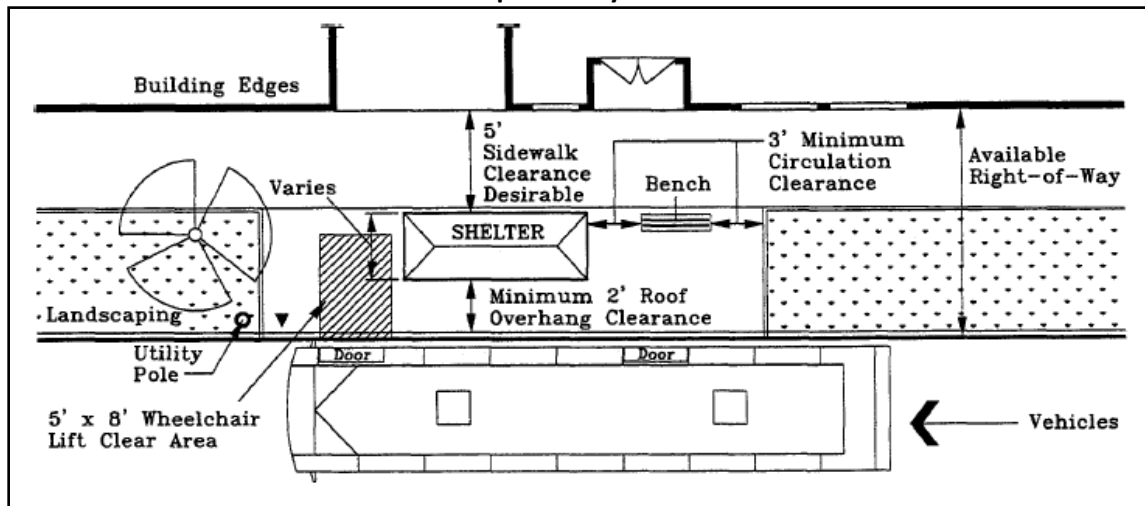
**Exhibit 4-8  
Bus Stop Types**



Source: TCRP Report 19: Guidelines for the Location and Design of Bus Stops, 1996

Exhibit 4-9 shows the arrangement of amenities at the bus stop. Important items to note are that the bus stop sign (indicated by the small triangle) should be located at the far end of the bus stop zone. It signals to the patrons where they should wait, and tells the bus operator where he/she should stop the bus. The ADA landing pad is located at the stop location for the front door of the bus, and a shelter and bench, if provided, are located behind the ADA pad. Exhibit 4-8 shows how these elements would be arrayed for the various bus bay types by matching up the location of the bus and bus stop sign.

Exhibit 4-9  
Bus Stop Amenity Placement



Source: TCRP Report 19: Guidelines for the Location and Design of Bus Stops, 1996

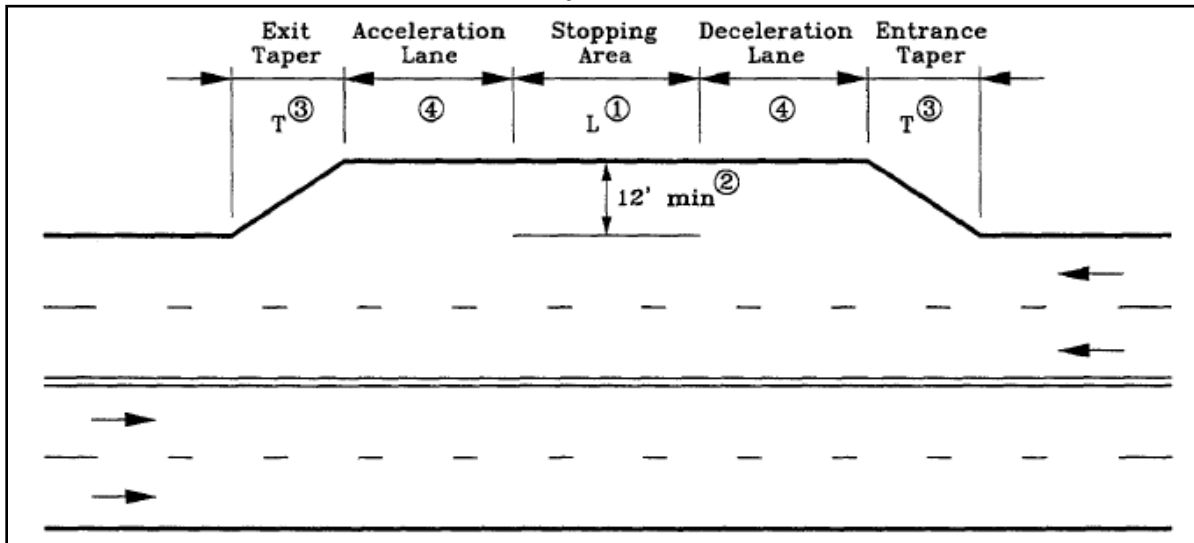
For situations where a Bus Bay is warranted, Exhibit 4-10 shows the dimensions that are required. The TCRP Report 19<sup>9</sup>, from which these drawings are taken, provides more details on the exceptions and calculations of the dimensions. For a 60-foot articulated bus, which is recommended for several routes, the Stopping Area is 70-feet; the other dimensions are based upon the speed of the surrounding roadway. For the typical low-speed roadway found on campus, the minimum bay width is 10 feet and the minimum tapers are 5:1 for the entrance taper (50 feet for a 10-foot bay) and 3:1 for the exit taper (30 feet); no deceleration/acceleration lanes are required on low-speed roadways.

Adopting these standards will require a number of changes around campus. For example, the Wolf Village stop has the bus bay located past the shelters. This arrangement results in buses bypassing riders in the shelter before the bus stops. The shelters and bus stop sign should be relocated to the far end of the bus bays. Several bus bays on the Centennial Biomedical Campus may be unwarranted since they are not at bus layover locations. Should they be retained, their dimensions should increase to those noted above. The current bus bays are too small, which results in bus operators not using them, or only partially pulling into the bay, defeating the purpose of getting the bus out of the travel lane. These are only examples; a comprehensive review of the stops should be made as part of the update to the Physical Master Plan.

<sup>9</sup> TCRP publications are available free online at [www.tcrponline.org](http://www.tcrponline.org).



Exhibit 4-10  
Bus Bay Dimensions



Source: TCRP Report 19: Guidelines for the Location and Design of Bus Stops, 1996

#### 4.6.2 Fixed Guideway<sup>10</sup> Corridors

At some point in the future, demand may rise to the level that a higher capacity technology is warranted. It may also be desired for other reasons besides just ridership – such as to capitalize on a corporate partner’s research or to create a distinct identity for the university in the country. To that end, potential corridors were evaluated.

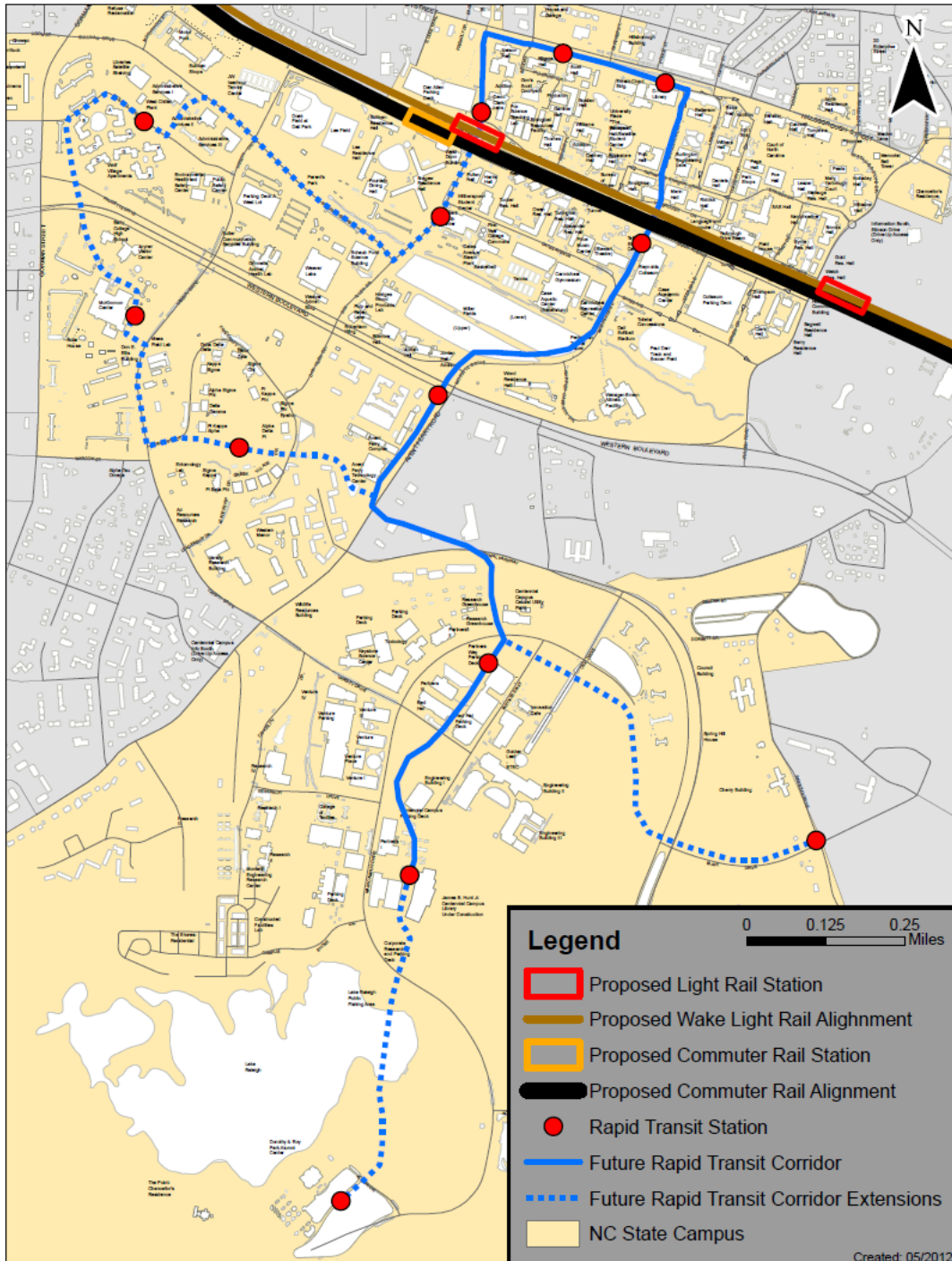
The key objective for any high capacity corridor is to connect locations with the highest demand. For NC State, there are two connections that rise to the top – connecting DH Hill Library to the Hunt Library and their surrounding areas, and to connect the commuter rail and light rail stations to Centennial Campus. The Physical Master Plan meets the first objective, but with the current rail plans, the rail stations moved and are no longer located on the Physical Master Plan corridor.

**Exhibit 4-11** shows the potential corridors to reserve for a rapid transit system. Shown in solid is the principal corridor – in many respects the same as the current corridor. The difference is to extend the line to the west to Dan Allen to connect with the future commuter rail and light rail stations. The southern portion of the corridor has also been moved into the “extension” category – a long-long term need. The extension south across Lake Raleigh is not anticipated to generate enough demand to warrant the extension, but could be a strong differentiator if the university wanted to add this amenity to the convention center being planned. The eastern extension is to an area where the current master plan does not indicate enough density to warrant this service, but if the plans change, the extension may be worthwhile.

<sup>10</sup> Fixed guideway is a generic term that applies to any transit technology operating along an exclusive right-of-way. Rail systems of any form fall into this category since only trains can use; bus corridors can if they are reserved for the exclusive operation of buses.



Exhibit 4-11  
Potential Rapid Transit Corridors



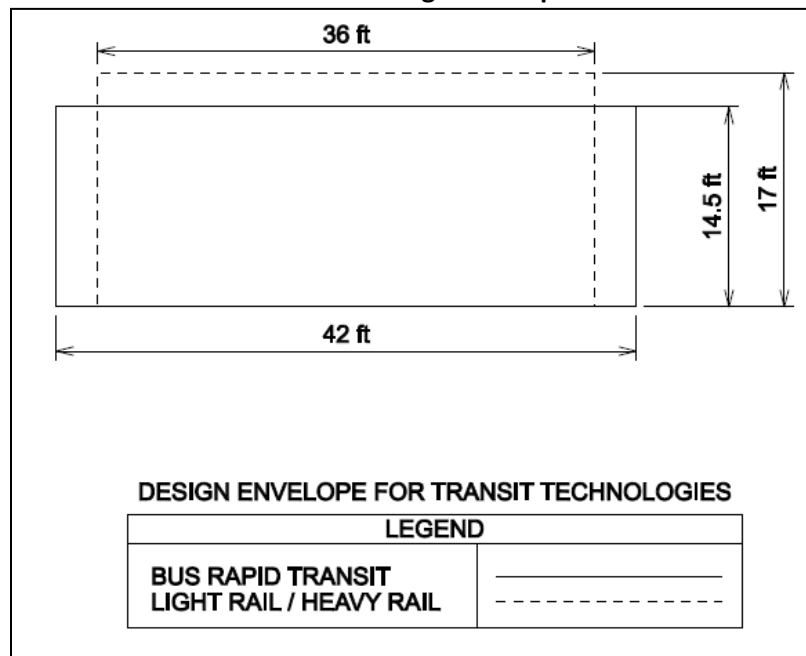
**Future Rapid Transit Corridor Reservation**

The other extension is through the Wolf Village area, a location of high demand on the current Wolfline service. Also on the alignment is McKimmon Center and Greek Village. McKimmon Center attracts a large number of visitors from outside the university and the potential exists that these visitors may arrive by rail. Greek Village is growing in population and may generate additional demand.

The layout can be a two-way operation, or could operate as a one-way loop. Should the university continue to desire a monorail technology, such a loop arrangement works best because it avoids the need to have time-consuming switches to direct vehicles into one direction or another. This type of layout also works well with the newer PRT technologies, which offer the potential for point-to-point service.

The right-of-way reservation should be sufficient to allow for multiple technologies to provide maximum flexibility. **Exhibit 4-12** shows the desired clearance envelope. A horizontal clearance of 42 feet is sufficient to allow for a bus technology that permits two-way operation and room to pass a disabled bus, while a 36-foot width is sufficient for rail technologies. Any corridor reservation on campus should be between these widths. A vertical clearance is also shown. The bus and rail technologies can pass below buildings, and some of the rail technologies are even capable of entering buildings – the monorail at the Disney Contemporary Resort is a famous example where the vehicle goes inside. The vertical clearance of 17 feet is sufficient for a light rail vehicle with its overhead catenary. Narrower clearance widths are possible for both technologies for limited service – for example, the bus vertical clearance can be as low as 11 feet at, say, a transit center in the ground floor of a parking deck, but the clearance envelopes shown below should be the general reservation.

**Exhibit 4-12  
Corridor Design Envelope**



## 5 Financial Summary

The cost implications of the recommended changes will be dependent upon the cost structure of the existing operating contract with First Transit and the new structure for the replacement contract beginning in AY 2017-18. Remuneration in the existing contract is a combination of a fixed cost and a cost per hour of service. An analysis of the contract terms has not been made since the magnitude of some of the changes may trigger adjustments in the cost structure. The sections below present the changes in the operating hours of service, with operating cost implications based upon the operating cost per hour reported in the National Transit Database for 2010, the last available year. Capital costs are estimated for those facilities for which NC State would have responsibility based upon similar costs from around the country.

### 5.1 Operating Costs

Operating costs are highly dependent upon the hours of service operated. **Exhibit 5-1** provides the changes in the operating hours for each of the three time periods. Costs are shown for three general categories of service changes: headway adjustments to existing routes to accommodate overloads; other schedule changes to adjust span of service; and implementation of new routes.

For the first two years, 17.90 hours of service would be added daily in the Fall and Spring by the end of the two year period. Some of these additions would occur in the first year with the remainder in the second year. At the 2010 NTD cost/hour of \$78.77, this amounts to an additional cost of \$1,410 per day by the end of the second year. This cost/day is an average reflecting the number of days each route is individually in service. Total annual incremental hours, which considers the lower summer service levels, for the first two years are 3,453, with an estimated annual cost of \$272,000. By the end of the full 10 years, the incremental cost of Wolfline service will increase by \$3.0 million. This increase is in constant 2010 dollars.

**Exhibit 5-1**  
**Changes in Service Hours and Estimated Costs**

	Category	Daily Hours			Annual Hours		
		1-2 Years	3-5 Years	6-10 Years	1-2 Years	3-5 Years	6-10 Years
	Headway Adjustments	43.4	86.3	(39.6)	7,800	17,347	(7,616)
	Other Schedule Changes	(34.5)	16.5	25.6	(6,516)	2,640	3,496
	New Routes	9.0	23.0	63.5	2,169	4,876	13,584
	Increment	17.9	125.8	49.5	3,453	24,863	9,463
<b>ESTIMATED OPERATING COSTS</b>							
@ 2010 NTD	\$78.77	\$ 1,410	\$ 9,910	\$ 3,900	\$ 272,000	\$ 1,958,000	\$ 745,000
	cumulative increment		\$ 11,320	\$ 15,220		\$ 2,230,000	\$ 2,975,000

## 5.2 Capital Costs

### 5.2.1 Bus Costs

Capital costs are of two types – buses, which are included in the operating contract, and other items. Since the bus contractor owns the vehicles, the contractor includes a cost in the contract to cover these expenses. The charge should reflect the cost of the vehicles if new and the salvage value of the vehicles at the end of the contract. For used vehicles, the costs should be based upon the value of the vehicles at the start of the contract.

Under the current contract, First Transit supplied a mix of new vehicles and used vehicles, with the used vehicles being specified to be replaced as part of the contract renewal. A similar arrangement could be entered into for the additional vehicles required over the next 10 years. As a large national contractor, First Transit or any similar operator, could draw from vehicles elsewhere in the country from contracts expiring or otherwise surplus. An alternate approach would be for NC State to purchase its own vehicles for use on the Wolfline service.

Because the approach has not been determined, a specific cost estimate cannot be developed for the bus expenses. In general, articulated buses cost about 50 percent more than a full sized bus. In 2011, according to the American Public Transportation Association Transit Vehicle Database, a full sized bus (all vehicles greater than 27.5 feet in length in their database) cost \$480,000 and articulated buses cost \$730,000. Separate costs were not calculated in the database for 30-foot buses, but based upon earlier data, 30-foot vehicles cost about 15 percent less than a full size bus, or about \$400,000.

### 5.2.2 Other Capital Costs

For other capital items, NC State has three categories of expenses – new transit centers; new park & ride lots; and the pedestrian tunnel under Western Boulevard. The last item may not be solely the responsibility of the NC State since it also benefits a roadway on the NCDOT system.

For the transit centers, the cost from around the country is about \$600,000 per bay. With five routes serving the Centennial Transit Center, assuming each route has one bus bay assigned to it, the cost would be about \$3 million. This cost can vary depending upon whether it is a stand alone facility or the bottom floor of a parking deck or other structure.

Three park & ride lots are called for in the 2012 *Campus Mobility Plan*. The Carter Finley P&R is assumed to be at no cost since it could use a portion of the existing parking lot. For the other park & rides, costs for similar facilities range from \$3000 per space to \$6500 per space, with a reasonable range of \$4-5000 per space, which includes all construction costs for the park & ride, including the bus loading area. The Farmers Market P&R is estimated based upon sharing 88 of the current spaces and only constructing the additional spaces; costs for the Southwest P&R include \$500,000 for land acquisition based upon the assessed value of parcels in the area. Since the Farmers Market is state owned land, no land costs were included. Estimated costs are:



- Farmers Market – 150 new spaces; \$600,000 to \$750,000
- Southwest – 650 spaces; \$3.0 million to \$3.7 million

The transit/pedestrian tunnel under Western Boulevard is estimated to cost between \$1.5 to \$2.5 million depending upon whether a single underpass or dual underpass is constructed. The design study underway will identify alternatives and their costs in more detail.

The new traffic signal on Centennial Campus at Varsity and either Capability Dr or Main Campus Dr is estimated to be \$50,000 to \$70,000. Costs are higher if more decorative poles are used.

Other miscellaneous improvements include additional bus shelters. These shelters cost \$15,000 to \$20,000 fully installed depending upon shelter size and the level of design and customization. Large, custom built shelters such as in many downtowns can cost much more, upwards of \$100,000 or higher. NC State has not installed this type of shelter.

### 5.3 Potential Funding Sources

As noted, NC State University does not, nor should not, bear the full amount of these additional costs. The operating expenses should mostly be borne by an increase in student fees. For the first two years, the additional \$272,000 in operating costs per year amounts to about \$6 per year per student, assuming student fees pay for 80 percent of the cost. For Years 3-5, the estimated increase in student fees would be about another \$43 by 2017 and for Years 6-10, another \$16 increase would be required by 2022. This \$65 increase is a similar size to the \$61 increase over the past 10 years.

As a general public transit service, Wolfline is eligible to apply for and receive other federal and state funds that are available for any transit system. These funds pass through the City of Raleigh as the designated recipient of the funds, but Wolfline is eligible to receive an allocation of the funds. The current federal transportation program is in flux since SAFETEA-LU expired several years ago and Congress has been unable to pass a replacement program. Under the current rules, the Raleigh-Cary metropolitan area is likely to receive next year an increase in the formula funds based upon the increase in population that has occurred since 2000. Such an increase, should it occur, offers Wolfline the potential to apply for these funds without resulting in another recipient receiving less funding. This potential is not assured, however, until the transportation budget for FY 2013 is set.

Another federal program that is competitive based is the Congestion Mitigation and Air Quality (CMAQ) program. These funds are available for capital expenses and some operating expenses for improvements that reduce congestion. Potential projects for Wolfline include:

- Western/Avent Ferry Tunnel
- Farmers Market P&R and new express route
- Southwest P&R and new express route
- Commuter Rail Shuttle

CMAQ could pay for a portion of the cost to construct the tunnel and lots, and could pay for a portion of the operating expense for the new express routes for a three-year period. CMAQ money cannot be

used for longer than three years for operating expenses. NC State would need to apply for these funds through the Capital Area Metropolitan Planning Organization (CAMPO).

The new sales tax dedicated to transit is another potential funding source. This source is uncertain since it requires two actions that have not yet occurred – the Wake County Commissioners must place the tax increase on the ballot; and the voters of Wake County must approve the tax increase. Durham County has already approved this half-cent increase, but its prospects for 2012 are uncertain in Wake County. Should this tax be implemented, Wolfline would be able to benefit from it according to the same rules that apply to CAT, TTA, and CTran.