NCSU TRANSPORTATION MASTER PLAN

Prepared for:

NC STATE UNIVERSITY

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EXECUTIVE SUMMARY

PROJECT OVERVIEW

This Transportation Master Plan was developed for North Carolina State University (NC State) to serve as a guide for transportation planning, management, and policy over the next 5 years. This plan outlines specific action measures and phasing recommendations for an enhanced multimodal campus transportation system with connectivity to future regional transit systems. This report represents a review of the existing parking, transit, transportation demand management (TDM), and bicycle/pedestrian systems. This review of conditions and policies led to recommendations for improvements and changes. The recommendations were developed based on three guiding principles: Park Once, Improve Connections, and Reprioritize Mobility Options. Specifically, a **park once** strategy aims at minimizing vehicular movement on campus or between campuses. **Improving connections** will allow for enhanced mobility on and between the campuses at NC State and will encourage the connection to regional transit. A park once strategy and improving connections will help to achieve the goal of **reprioritizing mobility options** that was put forth in the Campus Capacity and Assessment Study and further explored in this master plan. The reprioritization of mobility options aims at the following: **Pedestrian > Bike > Transit > Vehicle**. These elements will contribute to an enhanced experience for all users of the NC State transportation system by improving the customer experience, planning for future demand, strengthening partnerships, and creating a more fiscally sustainable transportation system.

The plan focuses on three guiding principles:

Park Once

Improve Connections

Reprioritize Mobility Options

Community Outreach

In addition to field observations and data review, a key to understanding the existing system is to engage proactively with the public and system users.

Gallery Walk Public Meetings

Two public meetings were conducted in the beginning of the project to gather student and employee input. The engagement process is described in more detail in the community outreach section of the report, but it included the following outreach activities:

- Gallery Walk Event at Talley Student Center
- Gallery Walk Event at Hunt Library

Coliseum Deck Charrette

A charrette with University stakeholders was conducted to determine the future of the old portion of the Coliseum Deck. The older portion of the deck is nearing the end of its useful life. To offset the loss of parking, a few major ideas came out of the charrette:

- Replace the lost parking in multiple locations around campus. Possibilities for replacement parking include:
  - A portion on the old deck location
  - A deck on Morrill Drive
  - A deck on the SAS Hall Lot (Boney Lot)
  - A deck on the North Hall Lot
- Provide a mix of uses on the site, including potentially another land use and/or a transit hub
- Account for parking “swing space” needs during construction

The charrette process and outcomes are detailed further in the community outreach section of the report.

SUMMARY OF KEY RECOMMENDATIONS

Campus Street Network

A number of projects are in various stages of design and construction that will change the connectivity and overall environment for all modes of travel within and around the University. Additionally, this planning process resulted in new projects that the University should pursue in conjunction with partner agencies. The projects included in this section of the report are:

- Blair Drive and Initiative Way Extensions
- Cates Avenue 2-Way Conversion and Roundabout
- Yarbrough Drive Extension
- Pullen Road/Oval Drive Extension
- Cates Avenue Pedestrian Improvements

- Gorman Street Connector (Cycle Track)
- Avent Ferry Road Corridor Study
- Hillsborough Street Phase 2
- Western Boulevard Tunnel
- Pullen Road Bridge Replacement

Key Street Network Recommendations

1. Build Cates Avenue Two-Way Conversion and Roundabout
2. Build Cates Avenue Pedestrian Improvements
3. Build Pullen Road Bridge Replacement

Parking

An analysis of the existing parking network was completed to identify system-improvement priorities. This included an analysis of existing parking permitting strategies and a Park+ analysis of the existing conditions and 5-year build-out scenarios (based on Park+ analyses developed in the 2016 Fall Semester).

To supplement the analysis, a peer review was conducted of four comparable University parking programs to gain a more thorough understanding of their parking systems, strategies they use, and how their management functions. The major takeaways from the peer review include (1) providing a system where users can access multiple modes of transportation, and (2) considering technology upgrades across parking and transportation systems to improve planning, operations, and management.

A Park+ analysis of 5-year build out scenarios (developed for the 2016 Fall Semester) was used to determine appropriate strategies for managing parking demands and surpluses.

Key Parking Recommendations

1. Determine which parking locations warrant further study from the Coliseum Deck Charrette and conduct a feasibility study to evaluate adding new parking locations
2. Implement a comprehensive shared parking strategy for Centennial Campus
3. Use price and policy to promote a park once environment on campus
4. Implement and leverage license plate recognition (LPR) technology to make data-driven decisions for policy, price, and operations

The following are the three major recommendations that came from the Park+ analysis:

- The addition of a parking structure or structures in the vicinity of North Campus with approximately 1,000 spaces
- When supply and demand allows, prohibit first year students from bringing cars to campus
- Leverage private-sector partnerships to add shared parking supply on Centennial Campus

In addition to the Park+ analysis, a parking permit pricing analysis was completed to show how NC State permit prices compare to Universities across the country as well as local private parking decks. This analysis shows that **NC State permit pricing is on the lower end** for students and employees and should be adjusted over time to support space allocation and demand distribution.

Using the data analysis and peer review outreach, service goals of the recommended parking network were determined. The service goals include adopting a **park once approach** on campus, utilizing enhanced **data analytics** to inform policies and improve user convenience, seeking new and **improved revenue sources** to support the entire transportation system, and maintaining a high level of **customer service** through enhanced offering and management.

Parking recommendations were determined by a combination of peer review and community engagement findings, Park+ analysis, and parking permit pricing analysis. The recommendations are broken into four major categories:

- Demand-Based Recommendations – including the aforementioned North Campus parking needs and shared parking strategies for private development
- Technology Recommendations – including enhanced usage of License Plate Recognition (LPR) technology for virtual permitting and advanced data analysis
- Policy and Permit Recommendations – including addressing the implementation of strategies to move the parking experience to more of a park once philosophy, adjusting permit pricing to manage demand, emphasizing pay-as-you go parking to support more access options, and implementing underclass parking restrictions to manage demands.
- Supportive Strategies – alignment of parking policy and mobility solutions, usage of car share and other mobility options to reduce vehicle dependence, and improvement of wayfinding.

Transit

An analysis of existing conditions of the NC State transit system (Wolfline) was performed with data provided by NC State and by TransLoc. The analysis included a site visit and data analysis. The analysis was focused on the month of March 2017 and statistics were analyzed from TransLoc to determine route performance. Using these statistics and coordination with NC State staff, system improvement priorities were determined and route modification discussions were started.

Planned and under construction infrastructure improvements were included in this project and modifications were made to transit routes based on these known improvements. The planned and under construction improvements include the following:

- Initiative Way and Blair Drive Extensions
- Pullen Road/Oval Drive Extension
- Spring Hill Park and Ride Facility

The improvements above will be completed in the 5-year timeframe of this master plan. All route modifications due to these infrastructure improvements are included in the Years 2-5 recommendations.

A peer review was conducted of three comparable transit programs to gain a more thorough understanding of their transit systems and identify opportunities for the Wolfline system.

The major takeaways from the peer review include: technology and innovation continue to increase, funding can be a challenge, and there is no single solution to providing night service.

Using the data analysis and peer review outreach, service goals of the recommended transit routes were determined. The service goals include improving **service to higher demand destinations/ stops**, improving **quality access and connections**, **simplifying** the service plan, improving service with **coordinated campus transportation projects**, and identifying and leveraging **partnerships**.

ES.1: Wolf Village Transit Hub, NC State

A complete summary of route changes and recommendations are detailed in the transit section of this report.

Key Transit Recommendations

1. Implement routing and schedule changes to increase efficiency
2. Provide additional on-demand night service from 12 AM - 3 AM
3. Create a simplified service plan

Bicycle/ Pedestrian and Transportation Demand Management (TDM)

An analysis of NC State's existing bicycle and pedestrian network, as well as their TDM program (WolfTrails) was conducted with data provided by NC State. Based on conversations with the University and research into the WolfTrails program, a summary of the existing TDM program was compiled. In addition, using performance metrics provided by NC State, an analysis of the TDM program was completed to compare the FY 2016 and FY 2017 data.

Peer reviews were completed for bicycle/pedestrian systems and for University bike share systems. The bicycle/pedestrian systems peer review had three major takeaways, which include (1) establishing student volunteers to spread the TDM program on campus and provide support to cyclists by creating a student-led bicycle shop, (2) removing barriers of entry for active transportation modes, and (3) empowering the TDM program manager.

Additionally, the University bike share peer review had the following major takeaways: (1) the high correlation of success (ridership and financial sustainability) in programs that have been tailored from a "partnership approach," (2) "dockless" systems have the most flexibility and have led to early high ridership numbers, and (3) often, management and maintenance costs can be more than expected.

Key TDM Program Recommendations

1. Require bicycle registration
2. Focus outreach efforts on locations with people taking single-occupancy trips
3. Increase and enhance outreach efforts and evaluate outcomes
4. Provide a campus bike shop
5. Conduct annual mode split surveys

Using the data analysis and peer review outreach, service goals of the bicycle and pedestrian network were determined. The service goals include **improving safety** of bicyclists and pedestrians on and around campus, creating a more **robust Transportation Demand Management (TDM) program,** starting a **culture shift** towards alternative modes of transportation, and **establishing policies** that will guide bicycle and pedestrian facilities for NC State.

The TDM program recommendations focus on making a more robust TDM program that is more prominent in the University community. There are short-term and long-term recommendations to consider.

Additionally, a high-priority bicycle/pedestrian project list was developed based on a list of projects from the Campus Bicycle and Pedestrian Plan (Martin-Alexiou-Bryson, October 2011) that have not yet been completed, supplemented with bicycle and pedestrian projects that will enhance the network.

A complete list of TDM program recommendations and high-priority project recommendations are detailed in the bicycle/pedestrian/TDM section of the report.

Key Bicycle and Pedestrian Recommendations

1. Build multi-use path to connect the campuses along Nazareth Street
2. Construct cycle track on Morrill Drive and Avent Ferry Road
3. Install bike lanes or multi-use path on Pullen Road and the Pullen Road/Oval Drive Extension
4. Provide additional bike storage capacity on campus
5. Evaluate pilot bike share program

1—INTRODUCTION

By almost any measure, these are exciting times at NC State. The institution is experiencing significant growth, campuses are expanding, and groundbreaking education and research is happening across the University community.

Figure 1.1: NC State Campus

Centennial Campus, an early innovator in the development of partnerships between higher education and industry, is embarking on new steps to create the country's next great innovation district. The University is also seated at the heart of a thriving city and region: the Triangle continues to win countless awards as a hub of innovation and a great place to live. Raleigh is starting a bike share program at the same time that NC State evaluates a pilot program for the campus community, and Wake County is in the early stages of a dramatic 10-year plan for enhanced transit across the county, with much of the new service and infrastructure planned near the University.

At the same time, challenges abound, especially related to transportation and mobility: the University's two primary campuses are bisected by a wide, fast, heavily traveled arterial, creating significant barriers to students and employees getting to classes and other destinations. The bicycle and pedestrian environment has significant gaps and other problem areas where users don't feel safe or comfortable. The University community's commuter mode split is still heavily weighted toward driving alone, and many students and employees live and otherwise travel to dispersed locations across the region.

With these conditions as a backdrop, NC State's Transportation Department embarked on a process to develop a new Transportation Master Plan for the University. The plan was informed by previous documents commissioned by the University, including:

- Campus Bicycle and Pedestrian Plan (Martin Alexiou Bryson, 2011)
- Campus Mobility Plan (HDR, 2012)
- Campus Capacity and Assessment Study (Ayers Saint Gross, 2017)

Figure 1.2: NC State Campus

In addition, an intensive public engagement process reached out to stakeholders across the campus community to obtain their input and ideas on transportation and mobility at NC State. Stakeholders involved in this effort included students, employees, and Centennial Campus partner company employees, who were engaged in two targeted events on campus as well as through an online outreach survey.

As a part of a significant peer review process, other relevant higher education institutions across the country were also contacted to obtain information and ideas on successes, lessons learned, and key statistics for use in developing the Transportation Master Plan for NC State.

This report is a five-year plan and thus is a targeted strategy of achievable actions with the potential for immediate impact to the campus community.

The following chapters summarize the existing conditions, peer review findings, public engagement efforts, analyses, and recommendations for transportation and mobility at NC State.

The plan focuses on three guiding principles:

Park Once

Improve Connections

Reprioritize Mobility Options

Figure 1.3: NC State Campus

2—COMMUNITY OUTREACH

PUBLIC FORUM

Map Exercises and Surveys

"Gallery Walk" public engagement events were conducted on Main Campus in Talley Student Center and on Centennial Campus in Hunt Library. The University conducted outreach in advance to students, employees, and Centennial Campus partners to let them know about the public input opportunities. During the public events, participants were asked to complete map exercises and take surveys that pertain to Transit, Parking, and Bike/Pedestrian accommodations.

Campus Meetings

Main Campus	Centennial Campus
Talley Student Center	Hunt Library
March 27th, 2017	March 28th, 2017

Figures 2.1 and 2.2: Public outreach sessions at NC State

Parking

Participants were asked to complete a map exercise at the public workshop about where they park and where they go. Participants were asked to place dots on where they park on a typical day and where their first destination is on a typical day. Different color dots were used for employees, students, Centennial Campus partners, and visitors.

The input map is shown below:

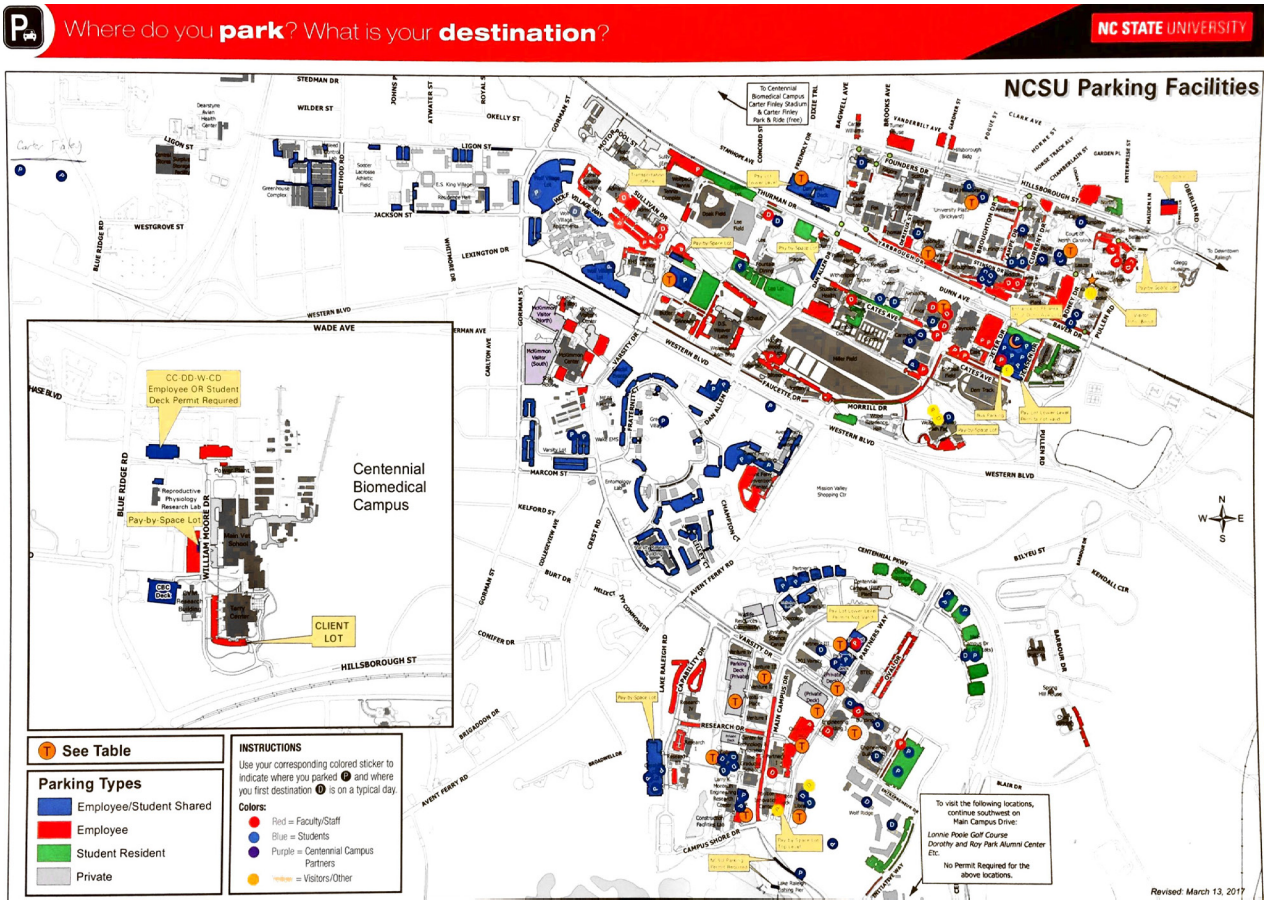


Figure 2.3: Community Outreach Interactive Map — Parking

The following table shows additional dots that were placed for highly used parking decks and destinations:

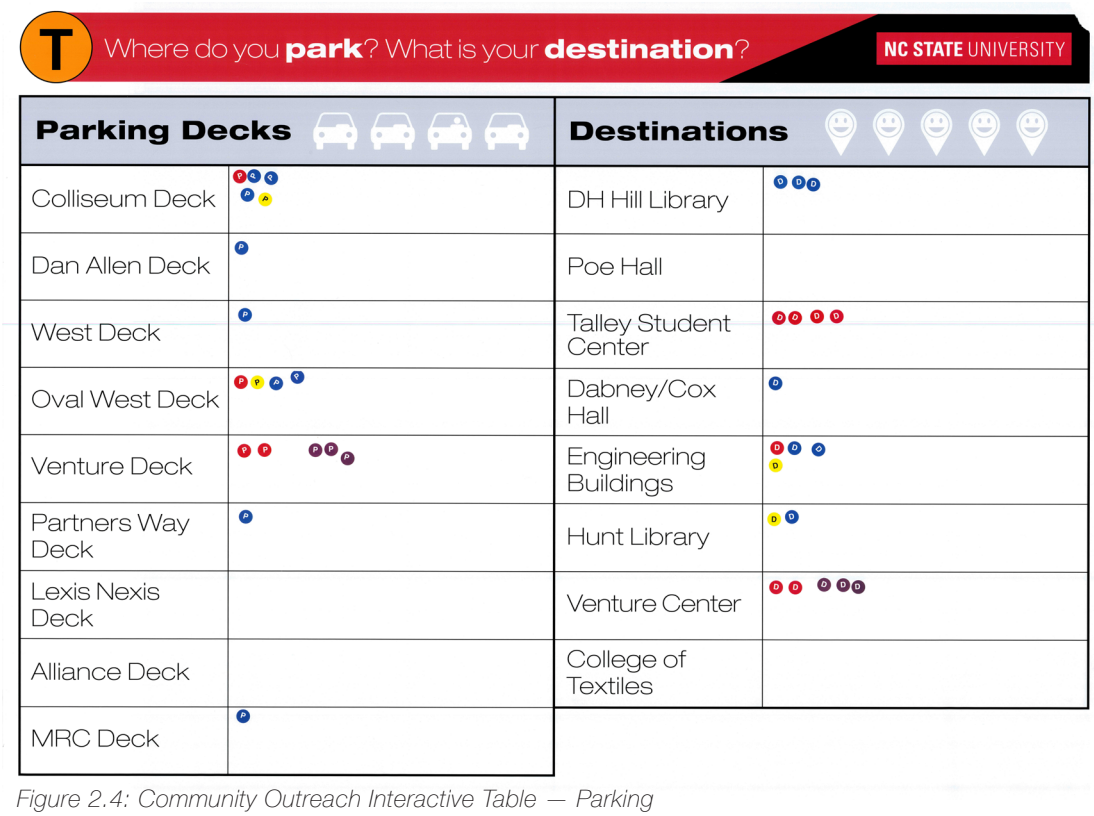


Figure 2.4: Community Outreach Interactive Table — Parking

Approximately 90 participants filled out an on-campus survey and approximately 22 participants filled out an online survey regarding the current parking system and desired improvements. Of the participants, 91 park on campus and the majority of the participants surveyed were students. The results from the survey include:

- Participants park in a variety of lots and decks throughout Main and Centennial Campus. The highest used parking facilities by participants were:
  - Coliseum Deck
  - Oval West Deck
  - Venture Deck
  - Perimeter Lots
  - 'C' parking areas
- On a typical day, most of the participants' first destinations are:
  - Talley
  - Mann Hall
  - College of Textiles
  - Engineering Buildings
  - Venture Center
- Many people are concerned about poor driving habits in parking decks and wish to see better enforcement
- Many participants (mostly students) who don't park on campus want to park in the Coliseum Deck but choose not to buy a pass because they feel that passes are too expensive
- Increase the number of available parking spots
- Decrease the price of a parking permit
- Provide better signage near the McKimmon Center and Joyner Welcome Center to avoid confusion for visitors

- The majority of participants walk to their first destination.

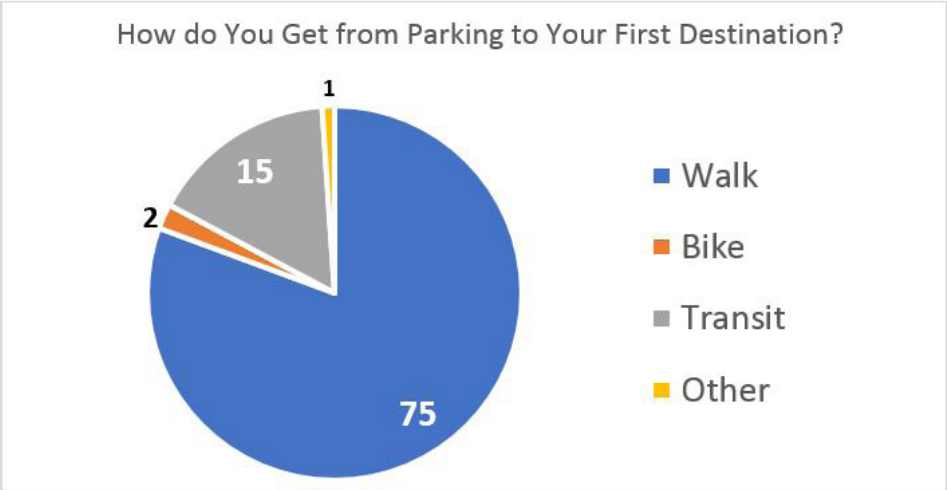


Figure 2.5: Community Outreach Poll Results

- Most of the participants are willing to walk between 5-10 minutes from their car to their destination.

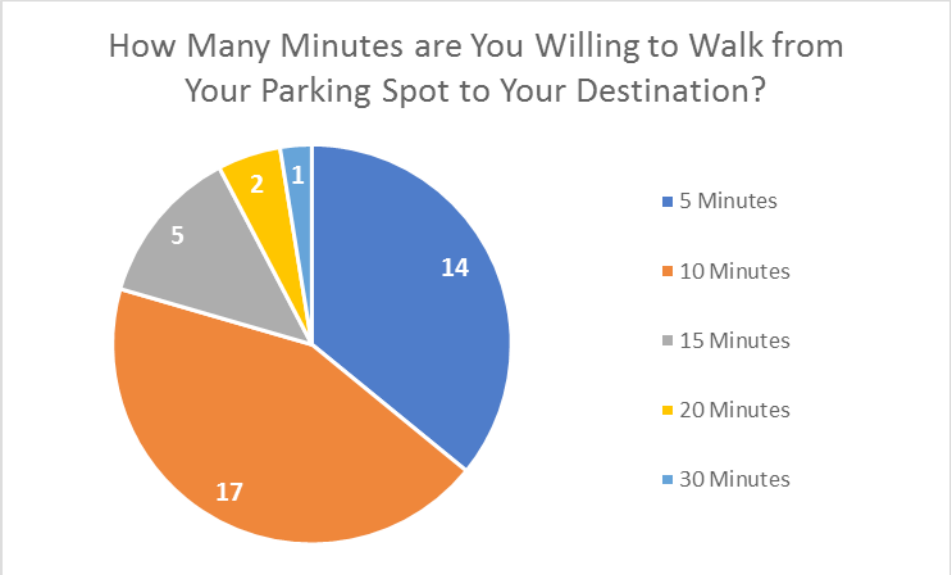


Figure 2.6: Community Outreach Poll Results

All surveys are included in the appendix for reference.

Transit

Participants were asked to complete a map exercise at the public workshop in regard to their transit preferences. Participants were encouraged to draw their ideal Wolfline transit routes for either daytime or nighttime service, and they were asked to place dots on the map where they wanted to see a new transit stop or improvements to a transit stop. The options for new and/or improvements to a transit stop were:

- Stop Only
- Benches Only
- Shelters and Benches

The two input maps are shown below:

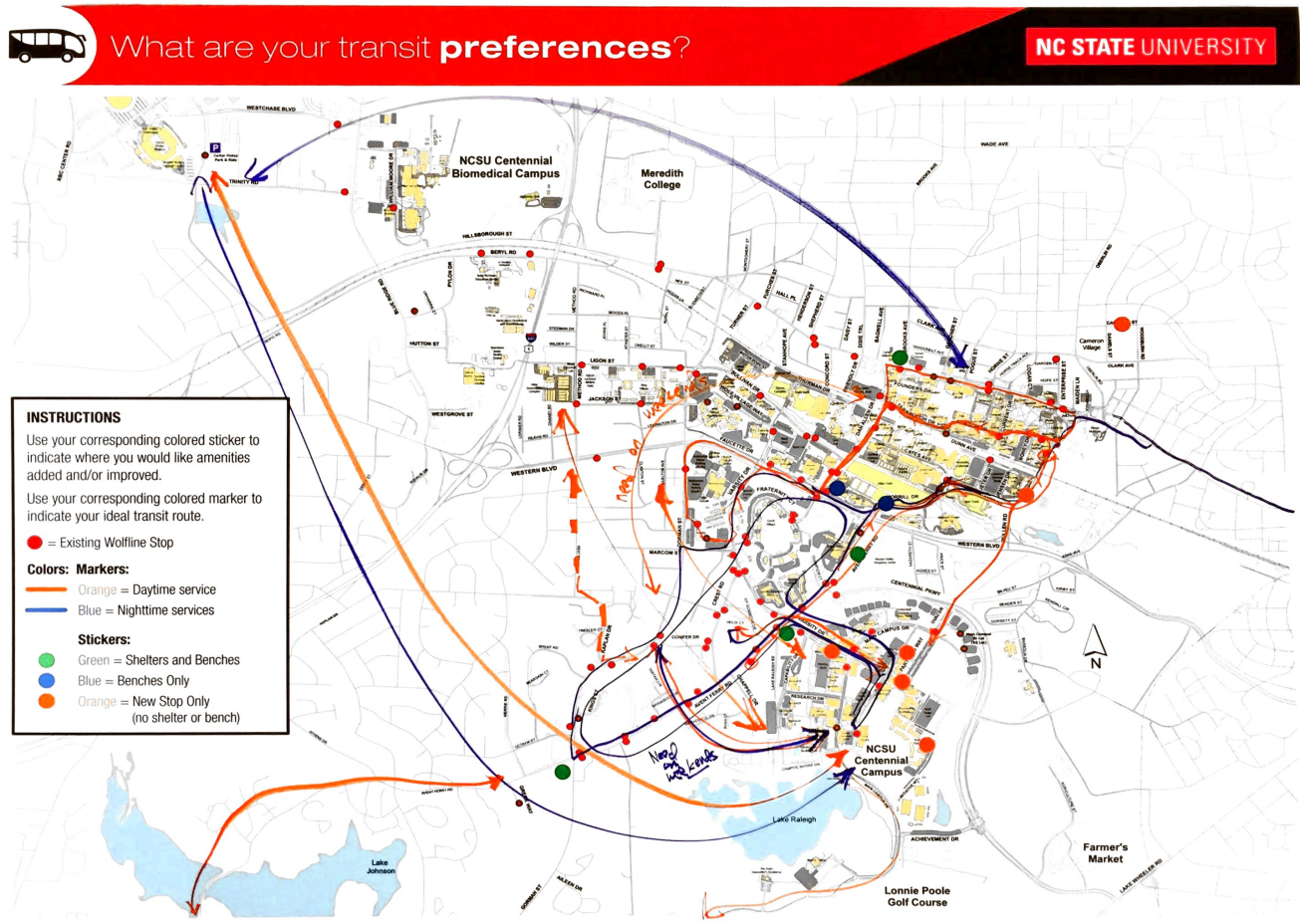


Figure 2.7: Community Outreach Interactive Map — Transit

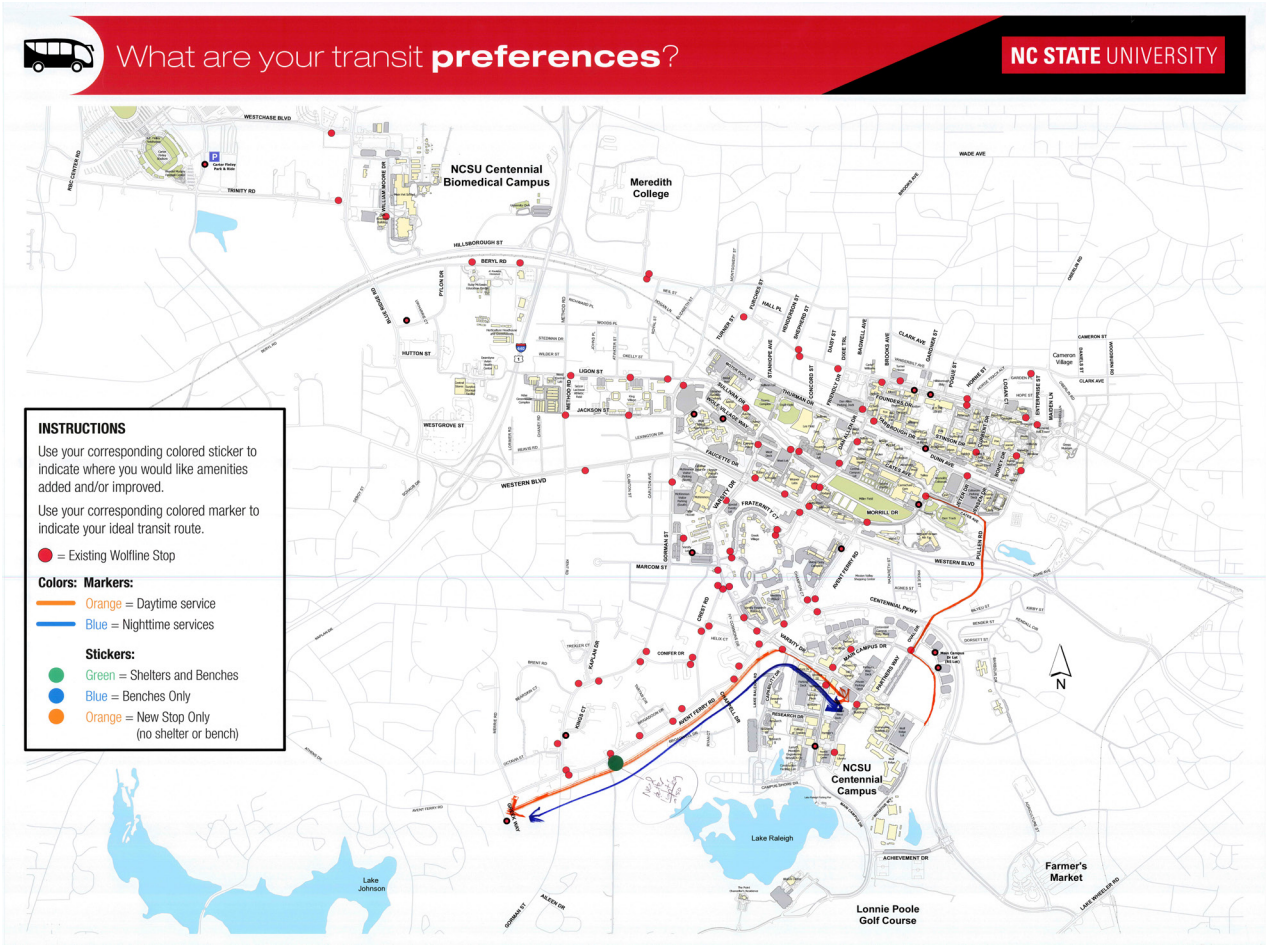


Figure 2.8: Community Outreach Interactive Map — Transit

Participants were also encouraged to fill out a survey about the current transit system and desired improvements; a total of 81 participants took the on-campus survey and approximately 22 participants took the online survey. The results from the survey include the following comments and recommended improvements:

- Increase the frequency of buses running during the day and night
- Most of the participants said they use the Engineering bus (Route #3), Varsity bus (Route #5), Wolflink Shuttle (Route #7), as well as the Southeast Loop bus (Route #8)
- Increase transit frequency during the weekends and provide routes linking Centennial Campus to Avent Ferry Shopping Center, and provide a daytime bus route that stops at Wolf Ridge
- Most participants are willing to walk 5-10 minutes from the bus stop to their destination
- Greater route connectivity between Main Campus and Centennial Campus
- Add a reverse bus route, running counter-clockwise, around Main Campus for shorter travel times
- Bus shelters at College of Textiles on Centennial Campus, at the intersection of Morrill Drive and Cates Avenue, at the intersection of Gorman Street and Kaplan Drive, along Avent Ferry Road, and at Current Drive and Stinson Drive
- Shelters should provide bus route information
- More seating/benches at the Carmichael Gym bus stop

- Most participants want the nighttime transit service to run until 3:00 am

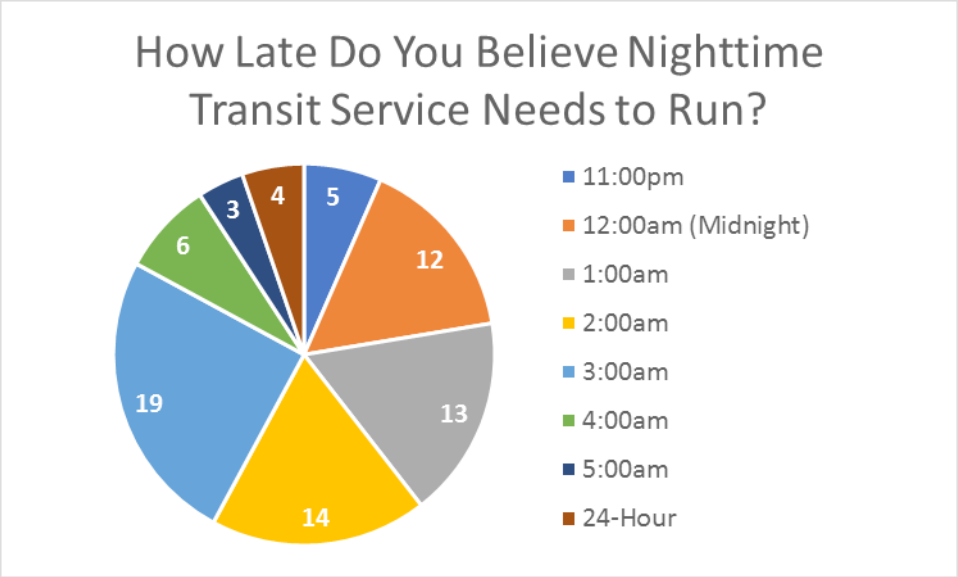


Figure 2.9: Community Outreach Poll Results

- Most participants want night transit provided by a fixed-route transit service

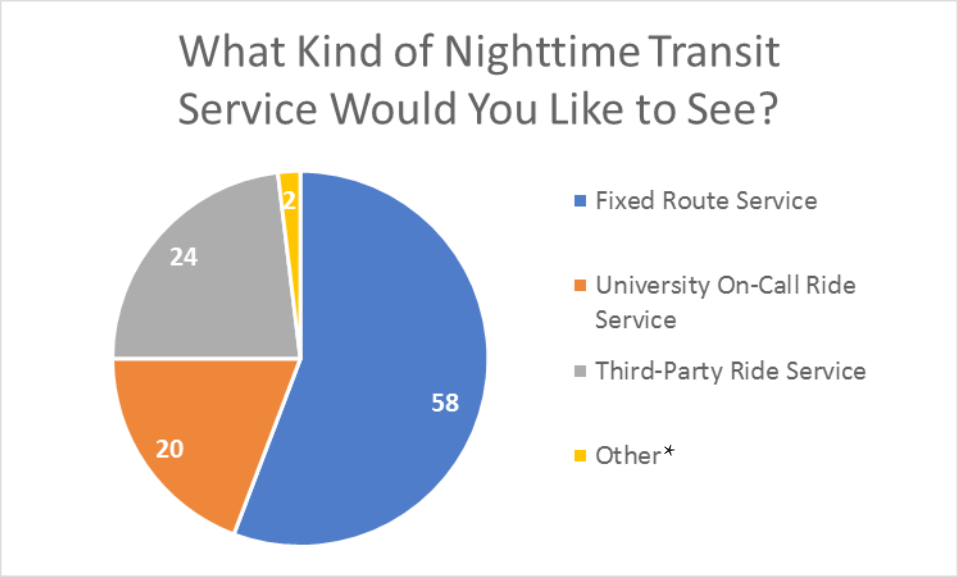


Figure 2.10: Community Outreach Poll Results

**Other—Prefer most cost effective solution, not clear if running big buses almost empty saves money over on-call services.*

Bicycle/Pedestrian

Participants were asked to complete a map exercise at the public workshop in regard to their Bicycle/Pedestrian amenities preferences. Participants were encouraged to draw or place dots where they would like to see new bike or pedestrian facilities. The options for the participants were:

- Signalized Crosswalks
- Grade-Separated Crossings
- Protected Bike Lanes
- Bike Lanes
- Greenways/Bikeways
- Sidewalk/Path Connections
- Bike Racks
- Covered Bike Racks
- Bike Lockers

The input map is shown below:

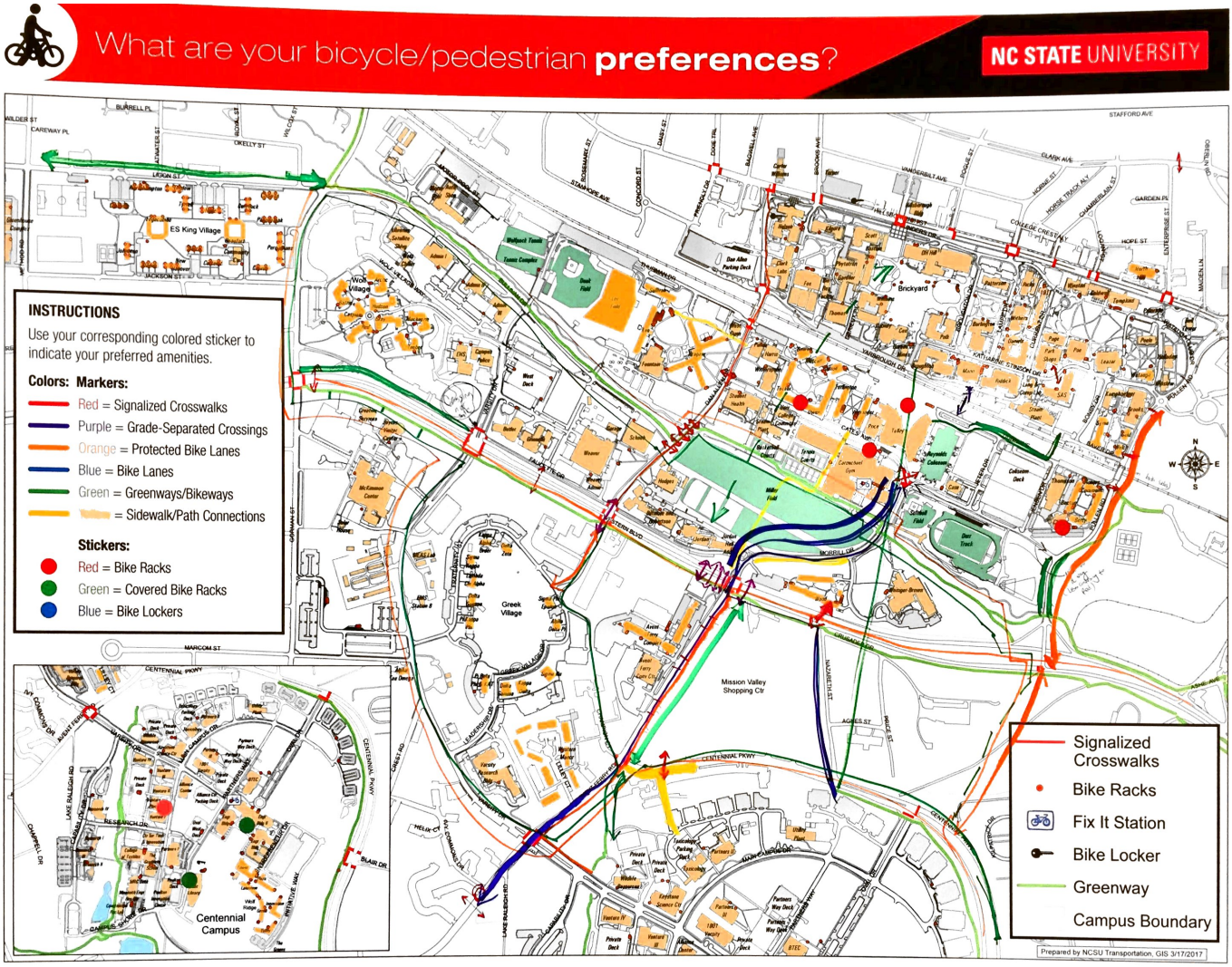


Figure 2.11: Community Outreach Interactive Map — Bicycle/Pedestrian

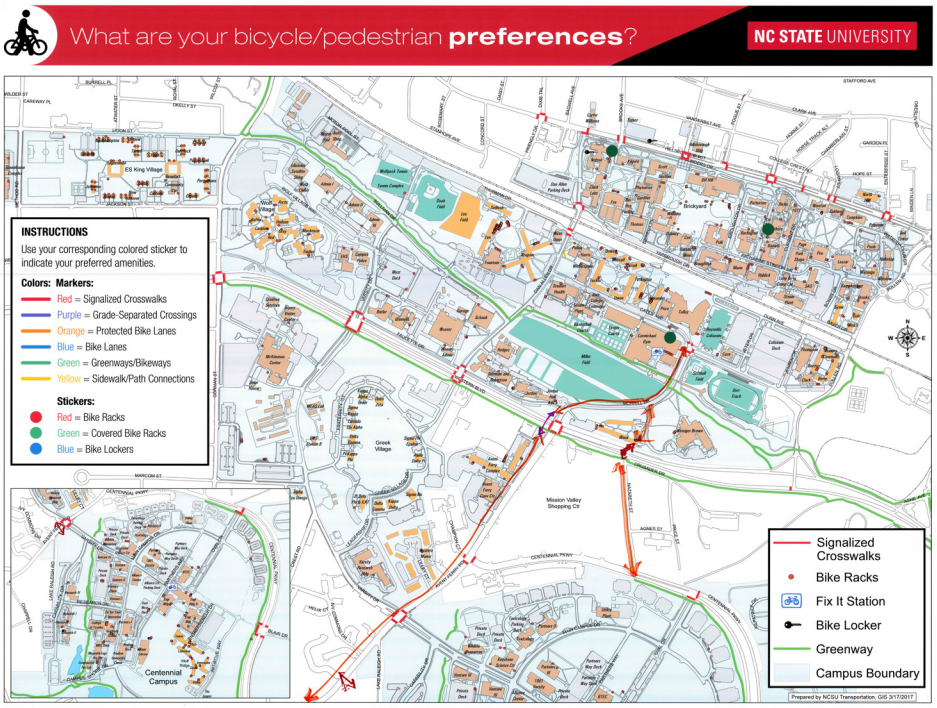


Figure 2.12: Community Outreach Interactive Map — Bicycle/Pedestrian

The following are some of the desired improvements found from the map exercise:

- Grade-separated crossing across Western Boulevard at Avent Ferry Road
- A signalized crosswalk across Western Boulevard at Nazareth Drive
- Bike lanes along Nazareth Drive
- Protected bike lanes along Avent Ferry Road
- Bike lanes along Morrill Drive

Participants were encouraged to fill out a survey either at the public meetings or online. A total of 39 participants filled out an in-person survey and a total of 9 participants filled out an online survey about the current bike/pedestrian system and desired improvements. The results from the survey include:

- Ramps entering and exiting all tunnels for bike route continuity
- More protection for bikers and protected bike lanes throughout campus
- Implement a Campus Bike Share
- Construct a path for pedestrians and cyclists connecting Entrepreneur Drive to Blair Drive at Centennial Parkway
- Protected bike lanes on Dan Allen Drive and Cates Avenue
- Bike/pedestrian path linking Centennial Campus and Main Campus
- Improvements to the facilities at the intersection of Western Blvd. at Avent Ferry Road. One student was hit twice at this intersection by right-turning vehicles. To avoid conflict, participants want a grade-separated crossing
- Place more bike racks on Centennial Campus near the Venture buildings as well as on Main Campus near the McKimmon Center, Carmichael Gym, and at all dorms
- Provide safer, signalized crossings along Dan Allen Drive near Sullivan Drive and Cates Avenue
- Better lighting on pedestrian and bike paths at the tunnel near Reynolds Coliseum and along Morrill Drive and Avent Ferry Road
- Participants were asked to rank the amenities they would like to see on campus. The top four amenities from the survey are:
  - Covered bike racks
  - Greenway/bikeway
  - Protected bike lanes
  - Signalized crosswalks

COLISEUM DECK CHARRETTE | Monday, September 18, 2017

History of the Coliseum Deck

The old portion of the Coliseum Deck was constructed in 1975 and has approximately 1,103 commuter spaces, 150 resident east spaces, and a small portion of pay lot. In 2001, an expansion was constructed that consists of 1,098 spaces and a large portion of pay lot. There are historical issues with the older section of the garage that include a fallen spandrel panel and a durability issue in the precast concrete members that has required ongoing maintenance for a many years. According to Atlas Engineering, with proper maintenance (approximately $150,000/year), the deck could remain in service for a number of years. In year 5, the deck will need major repairs that could cost upwards of $1.2 M, and in year 10 more major repairs are needed that could cost nearly $1.5 M. Given the recommendations of their analysis, it makes fiscal sense to demolish the deck between years 5 – 7 and plan for potential upcoming changes for the University. Due to the typical planning, design, and construction schedule, it is prudent to begin the evaluation of options now to be ready to provide alternative parking options in 5-7 years.

Figure 2.14: Coliseum Deck Charrette, NC State

Coliseum Deck: End of Life Planning			
Year	Annual Cost	Cumulative Cost	Comments
1	$150,000	$150,000	Routine Maintenance
2	$150,000	$300,000	Routine Maintenance
3	$150,000	$450,000	Routine Maintenance
4	$150,000	$600,000	Routine Maintenance
5	$1,200,000	$1,800,000	$700K Major Reparis + $500K Sealant
6	$150,000	$1,950,000	Routine Maintenance
7	$150,000	$2,100,000	Routine Maintenance
8	$150,000	$2,250,000	Routine Maintenance
9	$150,000	$2,400,000	Routine Maintenance
10	$1,500,000	$3,900,000	Major Reparis, if plan is to maintain deck for next 5 years. If not, replace.
11	$200,000	$4,100,000	Routine Maintenance
12	$200,000	$4,300,000	Routine Maintenance
13	$200,000	$4,500,000	Routine Maintenance
14	$200,000	$4,700,000	Routine Maintenance
15	Latest year for demolition		

Figure 2.13: Coliseum Deck End of Life Planning Cost Assessment, Atlas Engineering

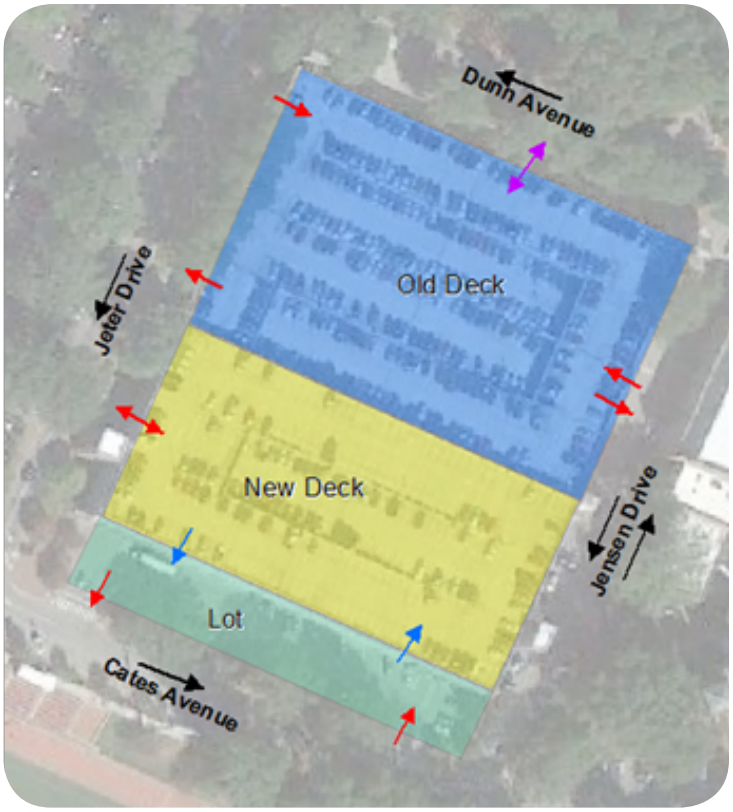


Figure 2.15: Coliseum Deck Layout

Initial Perceptions of the Coliseum Deck

Each stakeholder group was asked to give a brief statement on their perception of the Coliseum Deck.

- **Real Estate** – This location is in the heart of Main Campus and is a huge stress on Pullen Road. Real Estate does not think we need to replace the deck here, it could be replaced with smaller decks in a few locations.
- **Humanities/Social Sciences** – Need to focus on Hillsborough Street and North Campus (possibly on North Hall). They would like to see easily accessible visitor parking for North Campus.
- **Athletics** – Athletics likes having the deck easily accessible for events at Talley, Thompson, Reynolds, soccer/track/softball, and others. They routinely have 2 to 4 simultaneous events. Athletics is concerned that bussing attendees in to games and other events will decrease attendance.
- **DASA/Housing** – They are concerned about access and controlling security with a residence facility on top of a parking deck.
- **Recreation** – The deck provides a place for students to park and go to the gym. Recreation is not concerned about losing the deck, however, they are concerned about the transit hub at Carmichael with the upcoming construction.
- **Campus Enterprises** – Concerned with event parking if the old portion of the Coliseum Deck is not replaced. Campus Enterprises wants to see a real drop off location and a better transit hub location in the area. Additionally, the deck provides a safe location for students to park for night classes and "VIP" parking is important.
- **University Architects Office/Facilities** – This group would like to see a few different deck locations that could replace the spaces lost in the old portion of the Coliseum Deck. They are concerned about traffic along Pullen and would like to see the new deck locations in places that have access along Western Boulevard or Hillsborough Street. Additionally, grad students use the deck for night classes and it's a "life-saver" for them. Currently, the Coliseum Deck carriageway is used by oversized vehicles. These include school buses, off-campus apartment shuttles, and NC State shuttles.
- **Transportation** – Lots of maintenance has been expended on the old piece already. The facility is big enough to oversell significantly, which is good for revenue.
- **Environmental Health and Public Safety** – Transportation is a receipts entity, and it costs approximately $25,000 per space to replace parking—we need to keep this in mind. We should also seek help from the City where appropriate.

Figure 2.16: Coliseum Deck Charrette

Campus Capacity and Assessment Study

The Campus Capacity and Assessment Study (CCAS) is a process that provides multiple lenses to help us deliver the highest and best use of University Resources. The guiding principles of the CCAS include the following:

- Strengthen Identity and Brand
- Enhance Stewardship of Campus Resources
- Connect the Campus
- Re-prioritize Circulation (Pedestrian > Bike > Transit > Vehicle)
- Promote Vibrancy

Specifically, to re-prioritize circulation, the following strategies are suggested:

- Eliminate/reduce surface parking in the campus core
- Keep vehicular access and parking at campus edges

The CCAS put forth one potential scenario as shown below on Figure 2.17. This potential scenario notes that Talley and the surrounding area is the student life hub for the entire campus and recommends replacing the old portion of the Coliseum Deck with a residential use and provide a new parking location on Morrill Drive close to Western Boulevard.

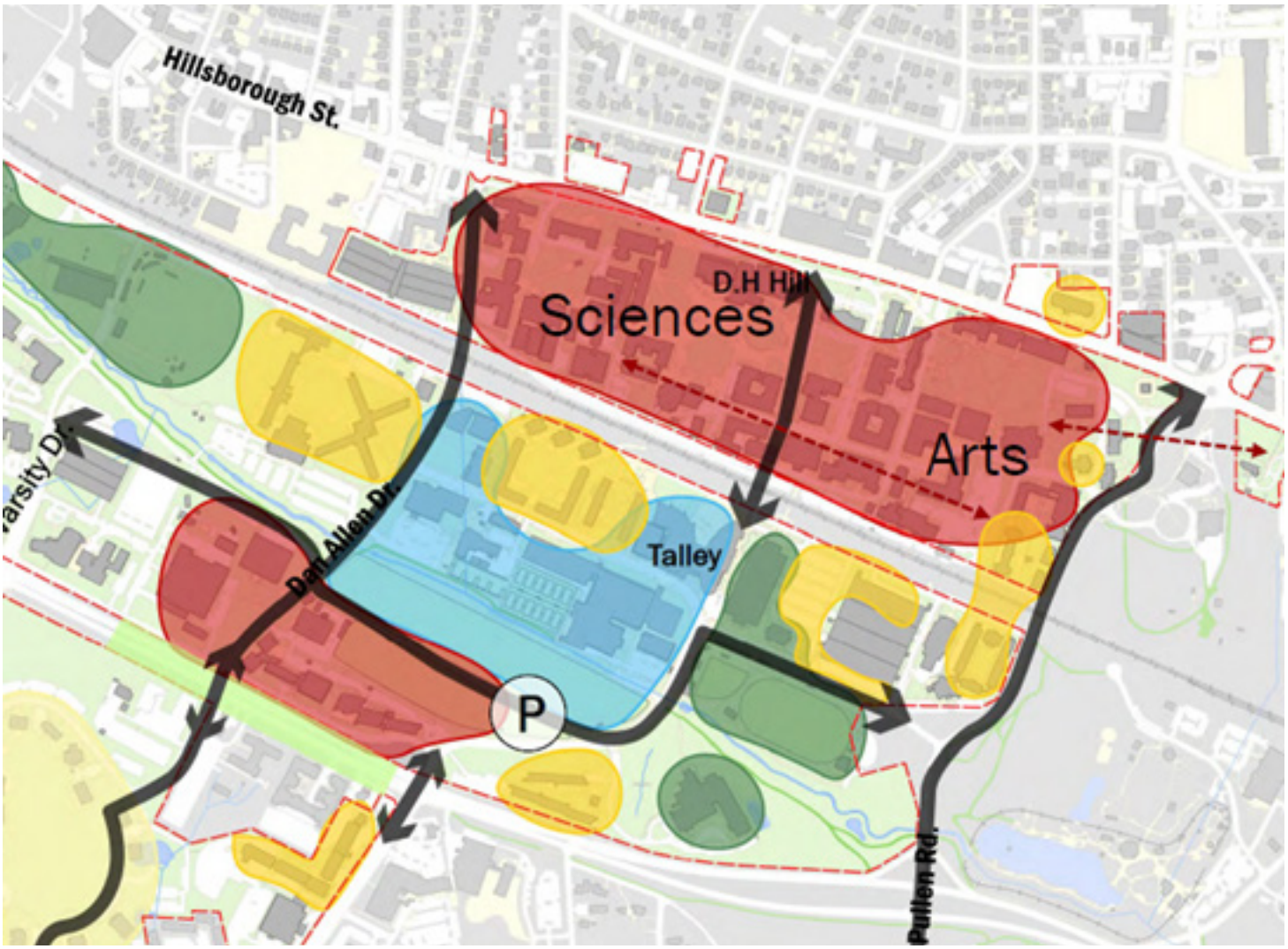


Figure 2.17: CCAS Potential Scenario, Ayers Saint Gross

Prioritization Exercise

The group was asked to determine what metrics should be used to evaluate the proposed alternatives. Based on an open discussion the following metrics were chosen:

- Cost/Revenue
- Time/Phasing
- Parking Supply/Event Parking
- Transit/Mobility
- Land Use Relationships/Street Experience

The group was then asked to place a pink sticky note on their number 1 priority, a yellow sticky note on their number 2 priority, and a blue sticky note on their number 3 priority. Shown in the exhibit below is how the group prioritized the metrics. It was determined that **cost/revenue** and **transit/mobility** were the top priority for evaluating proposed alternatives.

Figure 2.18: Priority Metrics Exercise

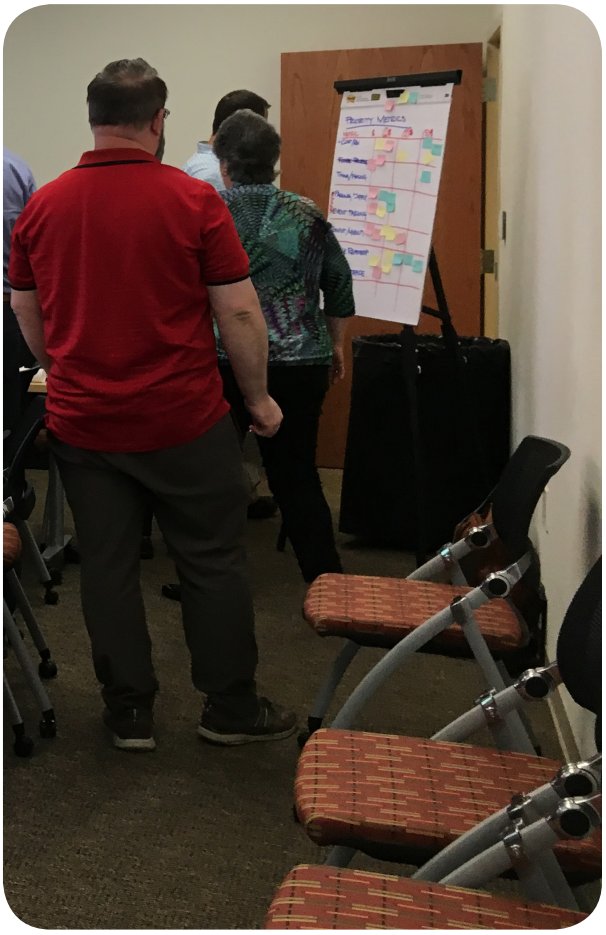


Figure 2.19: Coliseum Deck Charrette

Parking Deck Precedents

A variety of parking deck precedents were discussed to keep the group focused on what could be done in the footprint of the old portion of the coliseum deck.

Figure 2.20: Parking Deck with Building, Ram's Head Deck, Chapel Hill, NC

Figure 2.21: Parking Deck with a Transit Hub, Clackamas, OR

The following images show options for what could potentially fit on the footprint of the old portion of the Coliseum Deck.

Figure 2.22: A portion of the Stanhope Building and parking structure on the Old Portion of the Coliseum Deck, Google Earth

Figure 2.23: Arizona State University Towers and parking structure on the Old Portion of the Coliseum Deck, Google Earth

Breakout Groups

The attendees were split into two breakout groups and were asked to develop a few proposed scenarios. The exhibits below show some of the alternatives that were explored.

Team 1

Figure 2.24: Proposed Scenarios Exercise

This team believed the old portion of the Coliseum Deck should not be rebuilt where it is and instead looked at the possibility of providing additional parking decks in a variety of locations:

- Intramural Fields on Morrill Drive
- Soccer Practice Fields on Morrill Drive
- West Lot
- SAS Lot (Boney Lot)
- Various location along or north of Hillsborough Street

Additionally, the team looked at the possibility of a transit hub location in the existing surface lot on the Cates Avenue side of the parking deck.

University Recreation discussed that having a parking deck on the practice or intramural fields would not be preferred, but they could work around it. They are more concerned with the Morrill Drive transit hub that is to the east of Carmichael Gym. The gym has planned expansion starting in May 2018 and this will significantly disrupt the existing transit hub.

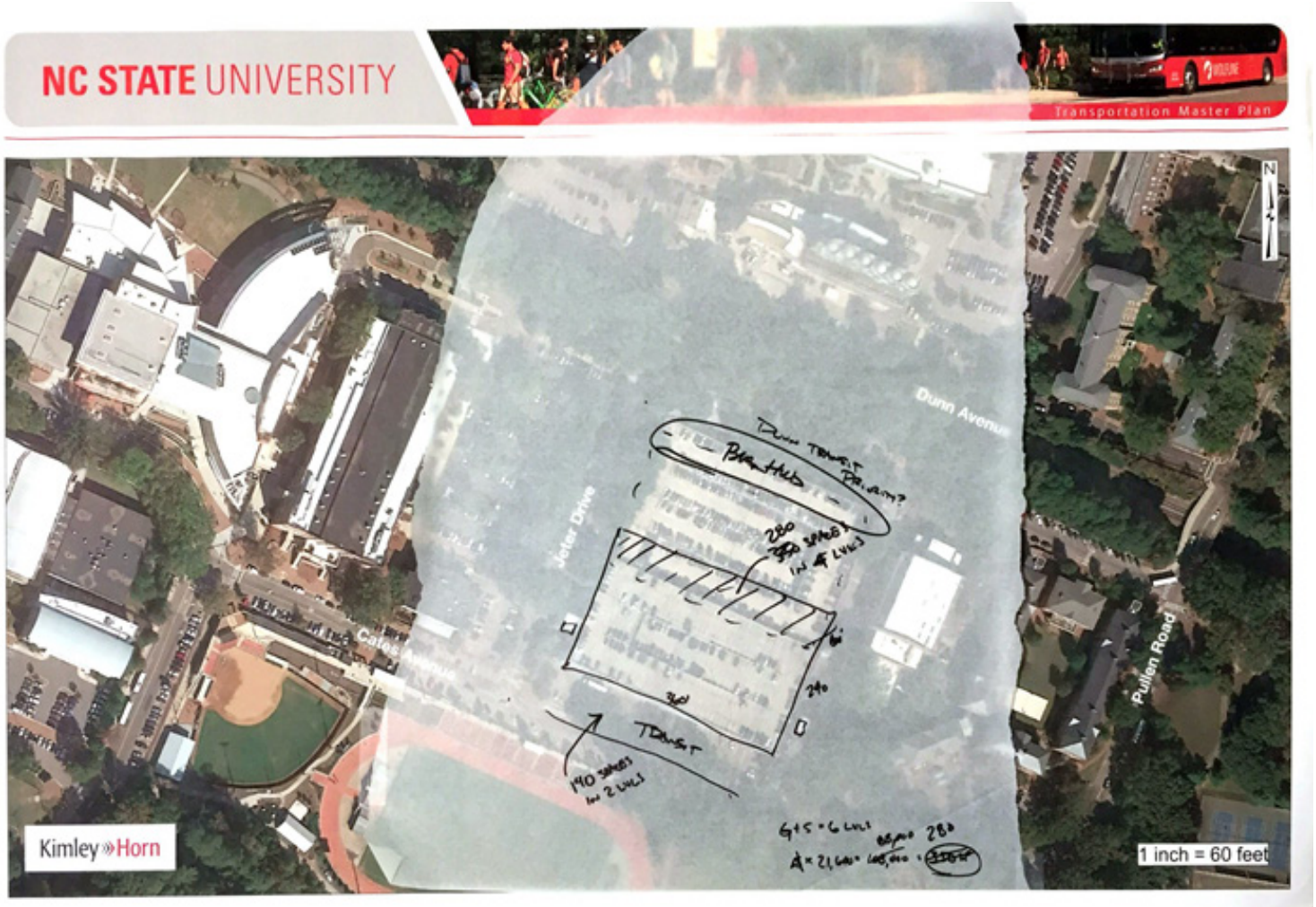


Figure 2.25: Proposed Scenarios Exercise

The scenario shown above could accommodate transit, additional parking, and a new land use on the Coliseum Deck location. This scenario shows the new portion of the Coliseum Deck being expanded out 60 feet to the north and would provide approximately 280 spaces in four levels. Additionally, the scenario shows a transit hub location on the Cates Avenue side of the parking deck with 2 levels of parking above. These two levels could provide approximately 140 spaces potentially in an efficient manor by connecting to the existing (newer) portion of the deck. This scenario could provide almost 40% of the 1,100 spaces lost with the old portion of the Coliseum Deck being demolished. Additionally, it would provide a large footprint in the old deck location that could allow for a new land use.

In addition to the transit hub with parking above on Cates Avenue, this group discussed the possibility of a transit hub on the Dunn Avenue side of the deck. The group did not have a strong consensus on whether the Dunn Avenue or Cates Avenue location is preferred for a transit hub.

Team 2

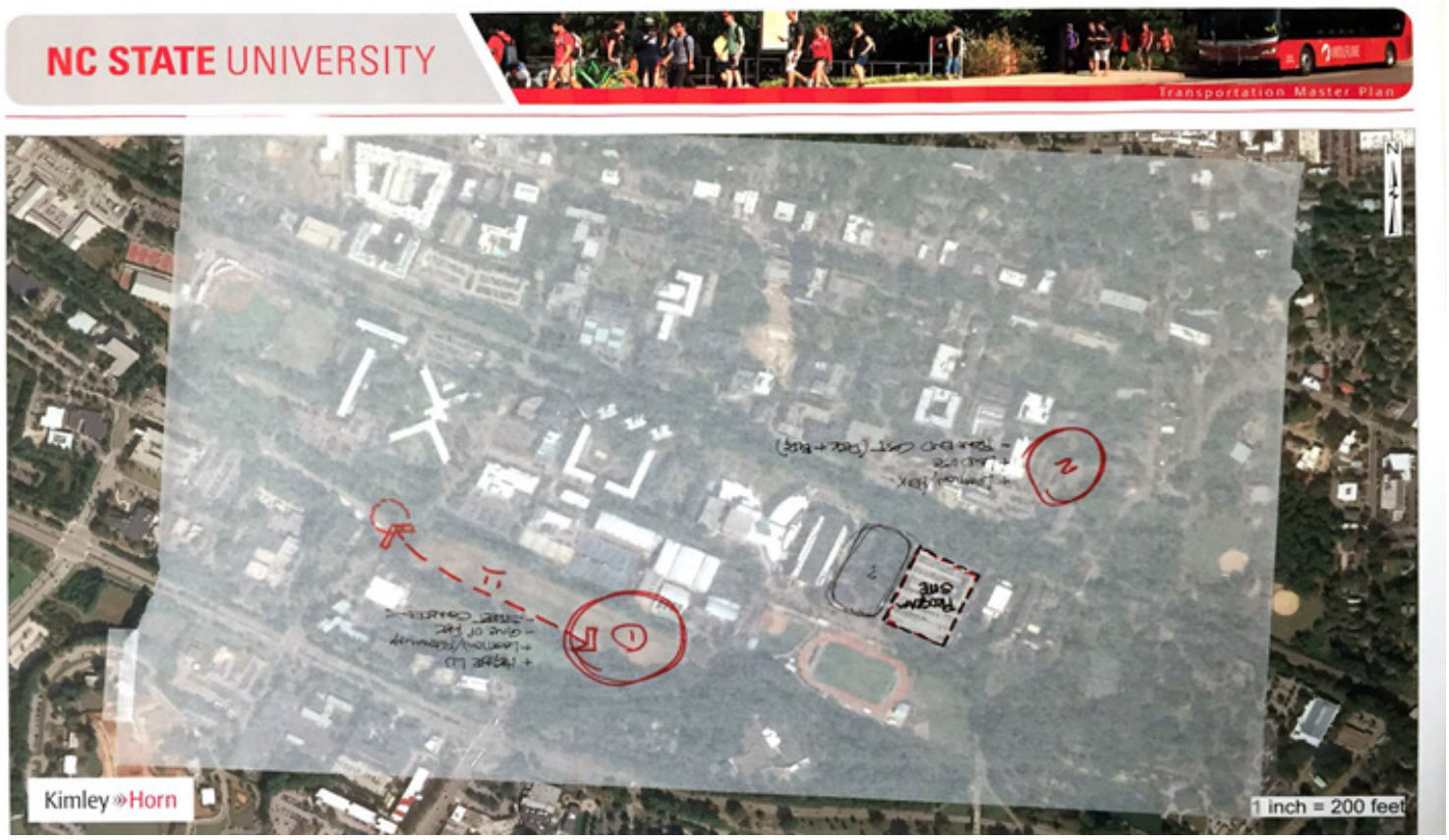


Figure 2.26: Proposed Scenarios Exercise

The scenario shown above provides a few locations that a new parking deck was considered. The first scenario considered was a new parking deck on the intramural fields or soccer practice fields on Morrill Drive. This group acknowledged that this deck would likely need to be constructed with a new east-west roadway connection from Morrill Drive to Dan Allen Drive. The pros and cons of the deck in this location are listed below:

Pros:

- Higher land use potential than existing athletic facilities
- Location and proximity to hub of student life
- Optimal access to major thoroughfares

Cons:

- Relocation of intramural fields or soccer practice fields
- New street connections would be needed and there is concern about a large volume of traffic on the new street connection

Additionally, this group looked at a potential parking deck on the SAS Hall lot (Boney lot), potentially combined with a building. The pros and cons of the deck in this location are listed below:

Pros:

- Location and proximity to North Campus (significant unmet parking demand)
- Land use compatibility with planned program

Cons:

- Front end cost of deck and building
- Smaller site in comparison to the other locations

Conclusion and Findings

The stakeholder groups came to an agreement that the older portion of the Coliseum Deck should not be fully replaced in the same footprint. To offset the loss of parking, a few major ideas came out of the charrette:

- Replace the lost parking in a few locations around campus – ideas generated included:
  - Possibly a portion on the old deck location
  - Possibly in a deck on Morrill Drive
  - Possibly in a deck on the SAS Hall lot
  - Possibly in a deck on the North Hall lot

To provide a higher and better use for this area, the following ideas were discussed:

- Incorporate a transit hub into the Coliseum Deck
  - Either along Dunn Avenue or Cates Avenue
- Add another land use in the location of the old deck
  - Potentially a residence hall, academic building, student life building, or others

The group came to the consensus that NC State should not replace the older section of the Coliseum Deck in the same footprint and a new land use should be considered on the north side of the footprint. The group agreed incorporating a transit hub is a good idea, but how and where it will be incorporated still needs to be decided. Additionally, the group agreed that there is a need to phase projects to consider swing space during construction (e.g. constructing new parking facilities before demolition of the old deck, if possible).

An initial feasibility study of a parking deck located on Morrill Drive, or the SAS Hall lot (Boney lot), or in the vicinity of Hillsborough Street should be performed to determine the capacity of parking that might be possible in each location. Based on that information, the balance of parking (if any) to be replaced on the Coliseum parking deck site can be determined. In addition, a planning study should be performed to consider other possible land uses and transit hub options on the Coliseum Deck site to understand access, grades, capacity, etc. Once the parking supply information is understood at each alternate parking deck location, the land use alternatives can be compared using the metrics developed as a team with cost/revenue and transit/mobility weighted the highest.

After the feasibility studies are completed, the stakeholder group should reconvene and discuss the findings.

Figure 2.27: Coliseum Deck Charrette

3—CAMPUS STREET NETWORK

While the street network on the NC State campus is relatively well-established and well-connected, a number of projects are in various stages of design and construction that will change the connectivity and overall environment for all modes of travel within and around the University campus. These projects are generally being funded by the University, the City of Raleigh, and the North Carolina Department of Transportation, and are further detailed below.

Key Street Network Recommendations

1. Build Cates Avenue Two-Way Conversion and Roundabout
2. Build Cates Avenue Pedestrian Improvements
3. Build Pullen Road Bridge Replacement

NC STATE PROJECTS

Blair Drive and Initiative Way Extensions

The Blair Drive and Initiative Way extension project currently under construction will extend Initiative Way from the existing intersection with Blair Drive to the north to complete the Initiative Way/Main Campus Drive loop around Centennial Campus. In addition, the project will extend the short section of Blair Drive on Centennial Campus to the east to connect with the intersection of Centennial Parkway at Blair Drive. This project will provide a greater level of connectivity on Centennial Campus for bicycles, pedestrians, transit, and vehicular traffic. This project is anticipated to be completed by September 2017.

Figure 3.1: Blair Drive and Initiative Way Extensions, Roadway Design by McKim and Creed

Cates Avenue Two-Way Conversion and Roundabout

It is proposed to reopen Cates Avenue to two-way traffic and modify the intersection of Cates Avenue and Pullen Road to accommodate the two-way traffic. Two alternatives were explored for the intersection of Pullen Road at Cates Avenue—a roundabout and a traffic signal. Based on a brief analysis of both alternatives, it was determined that either alternative should accommodate the proposed conversion, but both alternatives should be studied in further detail. It is recommended to move forward with the roundabout alternative as it is a traffic calming measure consistent with the Pullen Road at Stinson Avenue roundabout and Pullen Road at Hillsborough Street roundabout farther to the north. Additionally, this conversion will provide more options for transit and vehicular traffic.

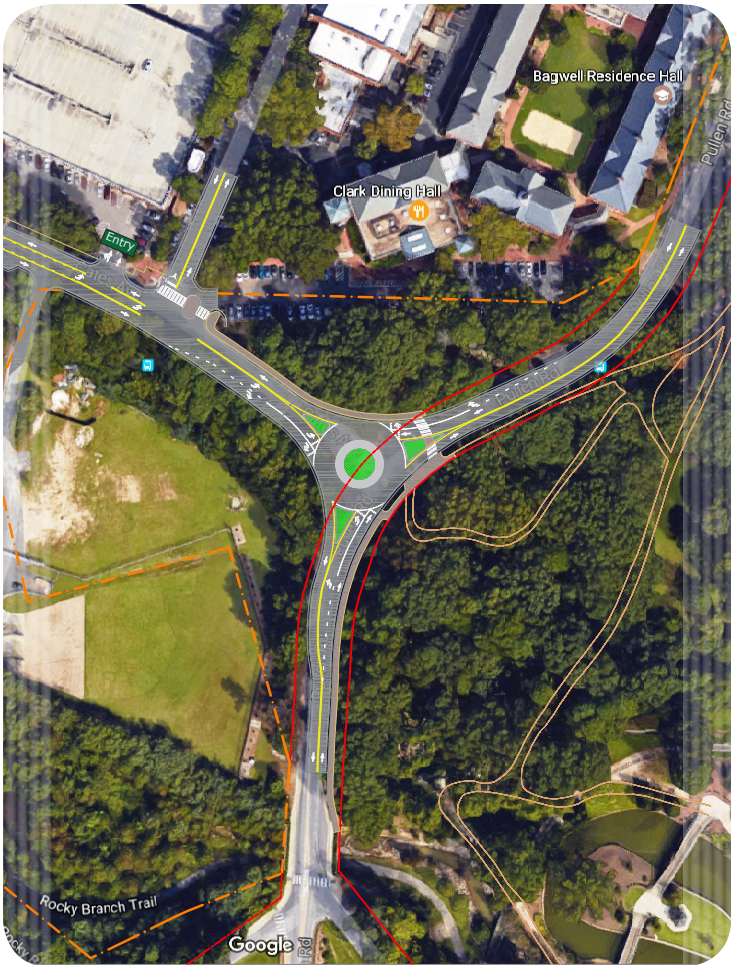


Figure 3.2: Cates Avenue Roundabout Exhibit, NC State Transportation

Yarbrough Drive Extension

A master plan was completed for Yarbrough Drive in 2013 that proposed significant changes to this corridor north of and parallel to the NC Railroad tracks. The master plan proposes to extend Yarbrough Drive to the east and provide service access behind the steam plant. This extension would have benefits for all modes, and in particular would provide more flexibility for east-west transit routing through North Campus. This project was anticipated to cost approximately $5.5M based on first quarter 2013 construction costs. This total does not include design services, contractor fees, contingencies, and escalation. It should be noted that the extension of Yarbrough Drive is in the NC Railroad right-of-way. Considering all of these factors, it is unlikely that this project will be complete in the five-year time frame of this Transportation Master Plan. It is recommended that the extension of Yarbrough Drive should be considered in future long-range planning for this portion of campus.

Cates Avenue Pedestrian Improvements

As reflected in the Campus Capacity and Assessment Study and this Master Plan's Bike and Pedestrian section, it is recommended to convert Cates Avenue between Dan Allen Drive and Morrill Drive to a pedestrian only walkway in the future. However, it is not anticipated that this will happen in five years and this conversion to a pedestrian only walkway should be considered in future long-range planning. As a temporary improvement, it is recommended to convert all parking from perpendicular to parallel on Cates Avenue and provide wider sidewalks on both sides of Cates Avenue.

Figure 3.3: Yarbrough Drive Master Plan, O'Brien/Atkins and Associates, PA and Ramey Kemp

CITY OF RALEIGH PROJECTS

The City of Raleigh has ongoing projects that will impact the transportation network on NC State's campus. These projects include the following:

Pullen Road/Oval Drive Extension

The City of Raleigh, the Catholic Diocese of Raleigh, and the University are sharing in the cost to extend Pullen Road from the intersection at Western Boulevard to a new roundabout at Bilyeu Street. The project will also include an extension of Oval Drive from Centennial Parkway to the proposed roundabout, creating a new connection between Main Campus and Centennial Campus. The cross-section of the proposed streets will include a planted median, bike lanes, a 6-foot sidewalk on the east side, and a 10-foot multi-use path on the west side. This project will provide an important connection for transit, bikes, and pedestrians. This connection will allow some transit routes to bypass the intersection of Western Boulevard at Avent Ferry Road and move directly from Main Campus to Centennial Campus. Additionally, with the bike and pedestrian improvements on the Pullen Road extension and the proposed improvements put forth in this master plan, it is anticipated that this corridor will be highly used by bicyclists and pedestrians traveling between Main Campus and Centennial Campus. The project design was kicked off in March 2016 and construction is anticipated to be completed by the end of 2018.

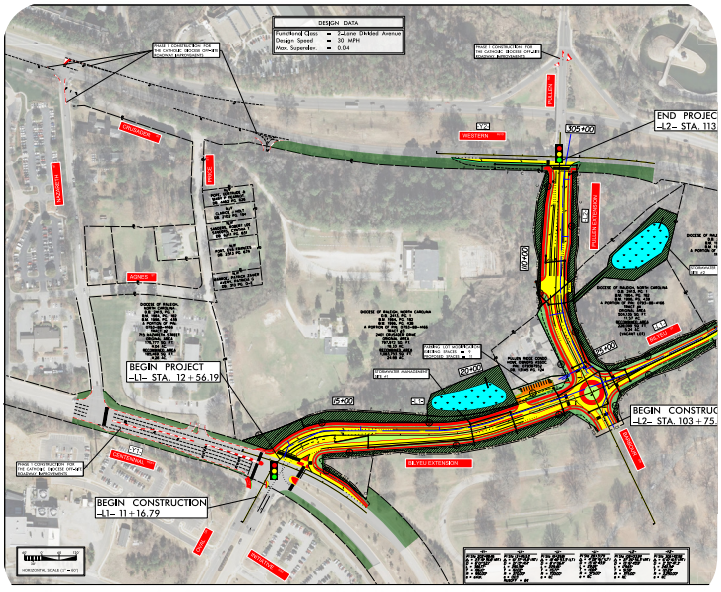


Figure 3.4: Pullen Road Extension, Ramey Kemp

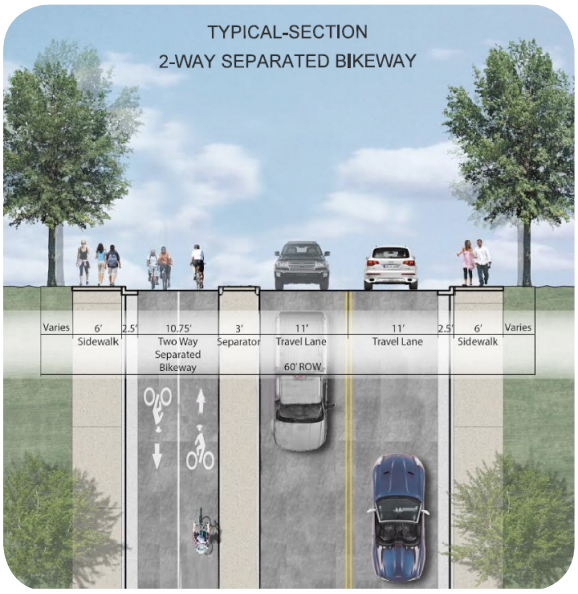


Figure 3.5: Gorman Street Connector, ALTA Planning + Design

Gorman Street Connector (Cycle Track)

The goal of this project is to improve bicycle and pedestrian connectivity on Gorman Street between the existing Rocky Branch Trail at Ligon Street/Sullivan Drive and the Reedy Creek Trail at Hillsborough Street/Clark Avenue. This facility will provide the final connection on the East Coast Greenway between Umstead Park in the west, Crabtree Valley Mall in the north, and downtown Raleigh. The project design includes a two-way separated cycle track facility on Gorman Street and bicycle and pedestrian improvements at major intersections. This project will provide a fully protected cycling commuting route from areas around NC State. This project is anticipated to be completed by late 2018.

Blue Ridge Road Bicycle and Pedestrian Improvements

The City of Raleigh is looking to complete bicycle and pedestrian improvements on Blue Ridge Road from Trinity Road to Reedy Creek Road. This project is in the vicinity of the College of Veterinary Medicine and the Centennial Biomedical Campus and can help provide better bicycle and pedestrian connections for students and employees at this campus. The project objective is to fill bicycle and sidewalk gaps on Blue Ridge Road. This project did not earn Locally Administered Project Program (LAPP) grant funding for 2018, therefore the timeline for completion of this project is unknown.

Avent Ferry Road Corridor Study

The corridor study will develop a community-generated vision for the character of the corridor's public realm and adjacent land uses. The corridor study was kicked off on March 27, 2017 and is expected to conclude by June 2018. The corridor study will consider multimodal recommendations including transit, bicycle, and pedestrian enhancements. Avent Ferry Road connects a high volume of residents to NC State. This project could provide safe accommodations for bicycles, pedestrians, and transit vehicles to travel to and from NC State.

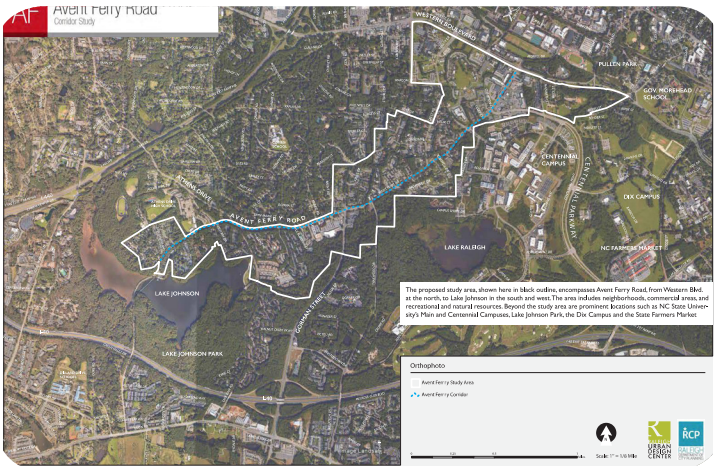


Figure 3.6: Avent Ferry Road Corridor Study Report, ColeJenest & Stone

Hillsborough Street Revitalization Phase II

Phase II of the Hillsborough Street Revitalization project is reconstructing 0.5 miles of Hillsborough Street from Rosemary/ Shepherd Street to Gardner Street, continuing the remaking of the street that began at Pullen Road and has resulted in significant redevelopment on the corridor. The project includes removing traffic signals and adding three roundabouts, and is intended to transform this section of Hillsborough Street from a congested three-lane street to a safer two-lane avenue. This project will create a more pedestrian-friendly environment, enhance motorist safety, and support revitalization efforts. Hillsborough Street acts as a barrier to the north side of Main Campus. The bike and pedestrian improvements will allow students and employees to safely access businesses and residential developments along and north of Hillsborough Street. The project is expected to be completed in summer 2018.

NCDOT PROJECTS

Western Boulevard Tunnel (EB-5718)

Figure 3.7: Western Boulevard Crossing Study, Stantec

This NCDOT project proposes a bicycle and pedestrian tunnel immediately west of the Western Boulevard at Avent Ferry Road/Morrill Drive intersection. This project will provide a safe crossing for bicycles and pedestrians moving across Western Boulevard. In addition to the bicycle and pedestrian improvements outlined in this master plan, this tunnel will provide a crucial connection for bicycle and pedestrian movement between Main Campus and Centennial Campus. This project is included in the NCDOT 2018 – 2027 STIP and is proposed to be constructed in 2023. The University should continue to work with the City as this project develops and consider potential transit options in the tunnel as well, particularly as smaller (and potentially autonomous) transit vehicles become more prevalent and viable.

Pullen Road Bridge Replacement over Western Boulevard (B-5675)

This NCDOT project proposes reconstruction of the aging Pullen Road bridge over Western Boulevard. This project is not included in the NCDOT 2018 – 2027 STIP but is expected to be in future versions of the STIP. Additionally, with BRT proposed on Western Boulevard in the next 10 years, this interchange could move up in priority if rebuilt as a part of the Wake Transit BRT project. The bridge replacement project may include reconstruction of the half interchange into a fully grade-separated interchange, but that would require additional funding that has not been identified at this time. Transit considerations should be a high priority for the reconstruction of this interchange, since BRT is proposed on Western Boulevard, a separate north-south frequent network route is proposed in the Wake Transit plan, and the interchange will be an important Wolfline connection as well. In addition, bicycle and pedestrian enhancements are recommended to be included since this will be a critical connection for these modes. Continue to monitor and engage with NCDOT and the City of Raleigh as this project progresses.

4—PARKING

INTRODUCTION

NC State currently has an extensive network of parking facilities and a variety of permitting strategies on all of their campuses. The goal of this project is to identify ways to create a more strategic and efficient parking system for the University.

The planning process included the following tasks:

Existing Conditions: Existing conditions of the parking system were analyzed to identify system-improvement priorities. This included an analysis of existing parking permitting strategies and a Park+ existing conditions analysis. The Park+ analysis was conducted in the 2016 Fall Semester, preceding this study.

Peer Review: A peer review of comparable universities who have innovative parking strategies was conducted. Several universities were identified that have a similar campus structure and could therefore be used to identify opportunities for improvement to the parking system.

Analysis: A summary of the Park+ Analysis completed for NC State is provided in this section. The Park+ analysis was conducted in the 2016 Fall Semester, preceding this study. The model was not recalibrated for this effort, since parking demand on campus did not change discernibly. That analysis looked at parking conditions today and into the future, and evaluated a number of recommendations intended to manage parking demand. Additionally, an analysis of permit pricing for a variety of universities and local private parking was performed to see how NC State permit prices compared.

Key Parking Recommendations

1. Determine which parking locations warrant further study from the Coliseum Deck Charrette and conduct a feasibility study to evaluate adding new parking locations
2. Implement a comprehensive shared parking strategy for Centennial Campus
3. Use price and policy to promote a park once environment on campus
4. Use license plate recognition (LPR) technology to make data-driven decisions for policy, price, and operations

Recommendations: A comprehensive list of recommendations were developed to guide the University when determining parking strategies, policies, and technologies for the future.

EXISTING CONDITIONS

Existing Parking Conditions

NC State provides a variety of parking options on campus, including parking decks near academic areas, fringe parking lots, pay lots, resident parking lots near dorms, and employee parking lots throughout all campuses. Centennial Campus partners generally have their own self-managed parking facilities. The variety of parking options provides a lot of flexibility for students and employees, but this does create issues of using cars to get around campus and between campuses, rather than parking once and using the suite of mobility options to access other parts of campus.

NC State has made recent parking permit changes that were implemented in Fall 2017 to help promote a park once philosophy. A **park once** strategy aims at minimizing vehicular movement on campus or between campuses. A park once strategy will help to achieve the goal of **reprioritizing mobility options** that was put forth in the Campus Capacity and Assessment Study and further explored in this master plan. The reprioritization of mobility options aims at the following: **Pedestrian > Bike > Transit > Vehicle**. To do this, the University has implemented a more strategic parking permitting strategy that generally prohibits students from parking in one place and driving to another facility with their permit. Phase I of this strategy achieves this goal by limiting students from moving their cars around. The permitting strategy can be seen with the differences in the following images of the 2016-2017 Parking Permit Map (Figure 4.1) and 2017-2018 Parking Permit Map (Figure 4.2). Specifically, the Perimeter (P) Permit has been broken into three distinct zones in the 2017 map —Resident Wolf Village (RV), Greek Village (GV), and Fringe (F). Phase 2, which is planned to be implemented in 2018, will similarly restrict employees ability to move their cars.

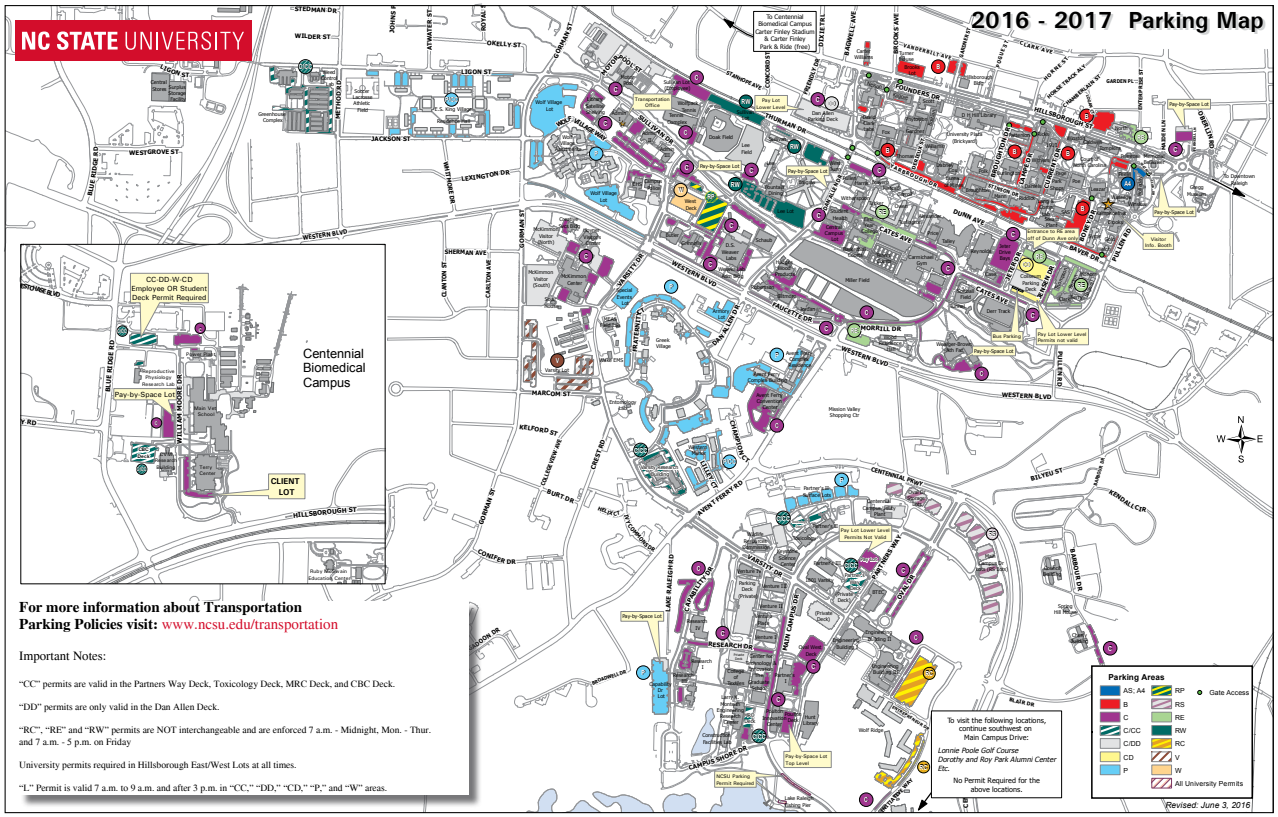


Figure 4.1: NC State Parking Permit Map 2016-17

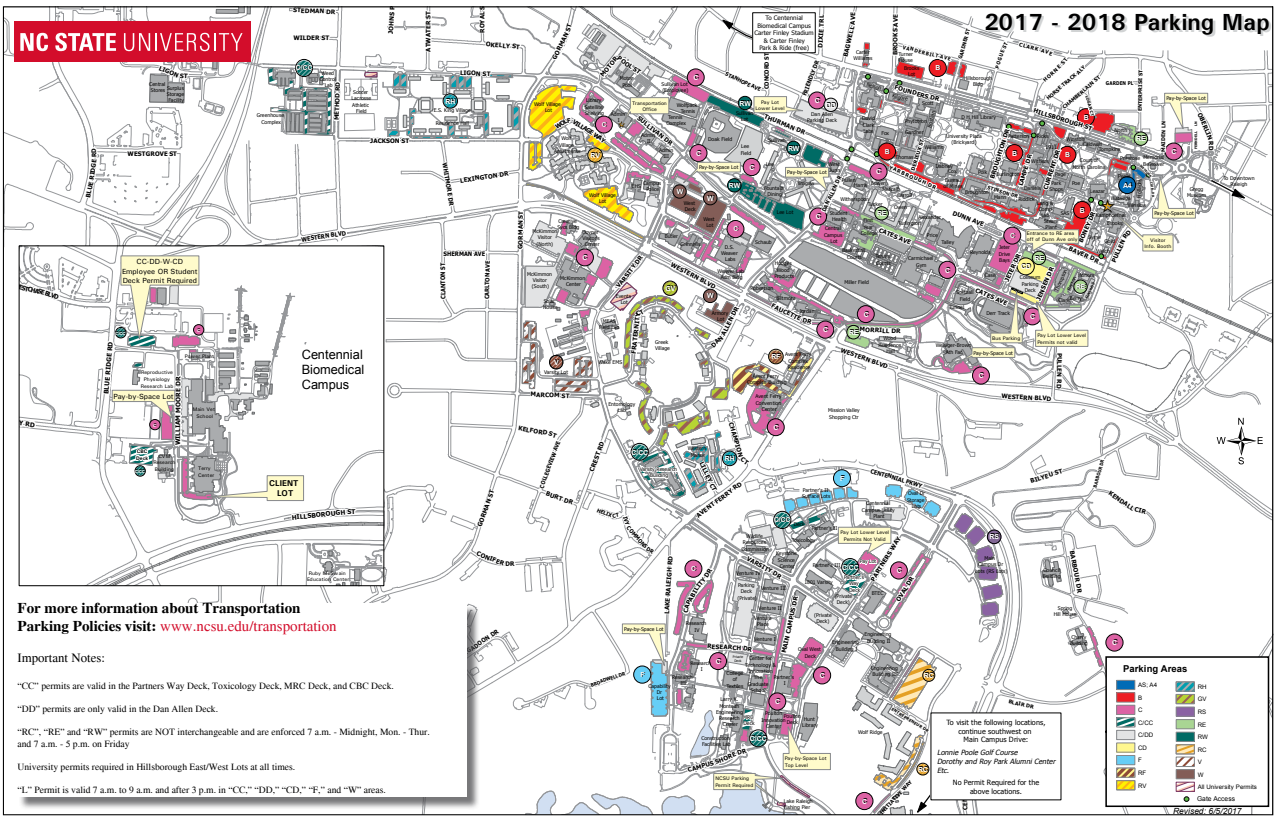


Figure 4.2: NC State Parking Permit Map 2017-18

Existing Conditions Park+ Analysis

NC State performed an analysis of the existing parking and future development projections in the 2016 Fall semester, incorporating several strategies to manage parking demand and reduce parking deficiencies in key areas throughout campus. Table 4.1 summarizes the parking demand, supply, and projected surplus or deficit for the base year of 2016. The assumptions used in building the Park+ model included land use data provided by the University, based on spring 2016 configurations, as well as parking inventory, location, permit, usage, and peak utilization as provided by the University. Mode-split information was also included and derived from a 2015 campus-wide survey and allocated by user type, along with walking tolerances based upon discussions with project staff and the NC State walking distance map online (that have been confirmed to be consistent with industry standard conditions).

In the base year, while the overall campus has a general surplus, there are localized areas where demand significantly exceeds the available supply of parking spaces. This is seen throughout the North Campus, as well as several specific facilities in the Central and Centennial Campus areas, as shown in the Base Year Model Results displayed in Figure 4.3.

Campus Area	Demand	Supply	Surplus/ Deficit	Percent Occupied
Total Campus Wide Parking	16,642	23,077	6,435	72%
Campus-Wide Total w/o Corp. Parking	14,506	20,049	5,543	72%
North Campus	3,559	3,030	-529	117%
Central Campus	5,611	8,323	2,712	67%
South Campus	1,512	2,652	1,140	57%
West Campus	754	1,130	376	67%
Centennial Campus Total	5,198	7,807	2,604	67%
Centennial Campus Univ. Parking	3,062	4,779	1,717	64%
Centennial Campus Corp Parking	2,136	3,028	887	71%

Table 4.1: Model Summary, Base Year (2016)

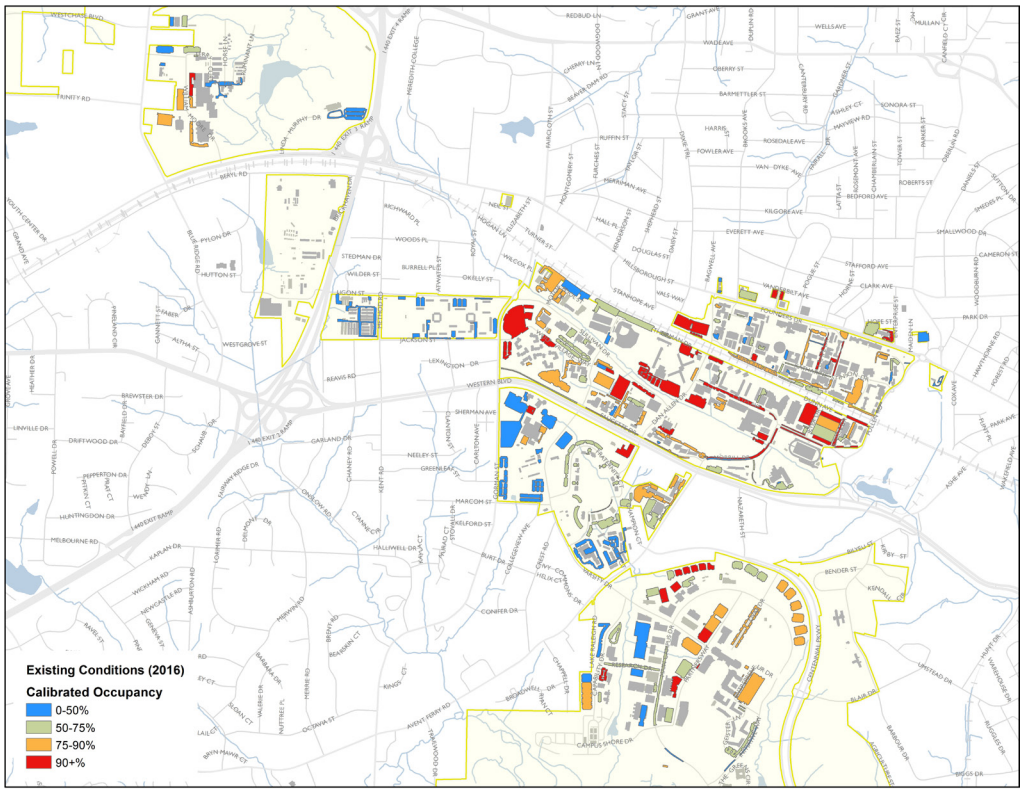


Figure 4.3: Model Results, Base Year (2016)

PEER REVIEW

Parking Peer Review Summary

A review of four comparable parking programs was conducted to gain a more thorough understanding of their parking systems, what strategies they use, and how it works. The comparable parking programs were researched and interviewed to gain this information. The peer review included phone interviews with Florida State University (FSU), Stanford University, Texas A&M University, and the University of Wisconsin-Madison. Questions were broken out into seven categories to fully understand the transportation and parking systems of the universities:

- Program overview
- Parking management strategies
- Transit and shuttling operations and management
- Parking operations and program features
- Transportation demand management
- Sustainability
- Future thinking recommendations

Key Takeaways

Several key takeaways from the peer review can be utilized by NC State in the development of parking strategies and policies.

Incorporate Parking as Part of the Larger Transportation Network

Options include accommodations for single-occupant vehicles, as well as emphasis on buses, bicycles, pedestrians, carpools, and other modes to reduce parking demands and improve mobility and access. Florida State University provides several means for students and employees to move about campus such as transit, Zipcar, taxis, and pedicabs. One innovative option FSU provides is a student-developed ridesharing app called Turns which allows students to post or join carpools to and from campus.

Figure 4.4: Cycle Track, University of Wisconsin, Madison

NC State has options like Zipcar, the new bike sharing program and ridesharing services that should be leveraged and strategically expanded to continue to support a more holistic mobility system.

To expand the multimodal network, most of the contacted universities also connect to the surrounding city or other transportation networks. Stanford University, for instance, runs transit for the public and University affiliated hospital network.

Consider Implementing Technology Upgrades

Transit and parking smartphone applications such as Transloc (which NC State already utilizes) are being utilized to enhance the user experience. Technology upgrades to enforcement and data collection practices have also become more prominent.

Many of the comparable parking programs have or are looking to implement License Plate Recognition (LPR) technology to replace traditional enforcement methods. LPR allows parking officers to more accurately and efficiently monitor parking behaviors on the campus and make necessary changes more easily. NC State is actively moving toward LPR enforcement.

Recognize that Parking is Just One Choice in a Suite of Access and Mobility Options

The comparable parking programs reviewed recognize the importance of providing a range of mobility options for customers beyond parking. The programs recognize that providing alternative modes needs to be balanced with providing a range of permit, carpool, pay-as-you-go options in lieu of permits, and other vehicle parking options, and implementing transportation demand management (TDM) strategies. NC State has a very wide array of mobility services on campus and should continue to leverage and expand these options to promote better decision-making and develop a holistic multimodal/park once campus.

See Appendix B for more information on the questions discussed during the phone interviews as well as a comprehensive table of the Peer Review Comparisons.

Figure 4.5: Morrill Drive, NC State

ANALYSIS

The following service goals were identified to guide the analysis and recommendations.

Service Goals

1. Adopt a park once approach on campus, with corresponding policies and restrictions
2. Utilize enhanced data analytics to inform policies and improve user convenience
3. Seek new and improved revenue sources to support the entire transportation system
4. Maintain a high level of customer service through enhanced offering and management

Park+ Analysis

The following is a summary of the Park+ analysis completed for NC State in the 2016 Fall semester. For each of the scenarios analyzed, a five-year build-out based on known and projected development assumptions was utilized to model demands. These projections include a growth of approximately 2,000 students; 202 new beds in Case Commons and fraternity housing; a 40,000-square-foot addition to the Carmichael Gym; approximately 436,000 square feet of additional classrooms, labs and research facilities, and office space to Engineering 4 (EB Oval) and Plant Sciences buildings; an anticipated 500,000 square feet of private office, residential, and retail space in the Centennial Campus area; along with corresponding losses and additions to the parking supply campus-wide. Table 4.2 provides a summary of the modeled conditions incorporating the projected build-outs and incorporating the projected increased supply of private parking spaces corresponding to the private developments.

Parking demand associated with future build-out in the North Campus area is projected to continue exceeding capacity by increasing from 117% to 127% utilization. It is anticipated that Centennial Campus will exceed effective capacity, even with additional private sector supply, increasing from 67% to 86% utilization, with University managed parking at 94% utilization. Effective capacity is an industry-accepted occupancy threshold for parking facilities that indicates the efficiency of the system. Based on industry standards, the primary threshold is 85% of the total capacity of the parking system and/or certain areas within the system. For example, when observed or projected occupancies are under this threshold, users can typically locate spaces easily. When observed or projected occupancies are at or above this threshold, users cannot typically find available parking easily.[1]

Campus Area	Demand	Supply	Surplus/ Deficit	Percent Occupied
Total Campus Wide Parking	**20,352**	**24,554**	**4,202**	**83%**
Campus-Wide Total Without Corporate Parking	**17,127**	**20,326**	**3,199**	**84%**
North Campus	3,843	3,030	-813	127%
Central Campus	6,107	8,300	2,193	74%
South Campus	1,596	2,652	1,056	60%
West Campus	814	1,130	316	72%
Centennial Campus Total	7,992	9,307	1,315	86%
Centennial Campus University Parking	4,767	5,079*	312*	94%
Centennial Campus Corporate Parking	3,225	4,228**	1,003**	76%

Table 4.2: Park+ Model Summary, 5-Year Build-Out (2021)

*Includes 300 spaces from Plant-Sciences deck

** Includes a 1,200-space corporate deck

To effectively manage these anticipated increases in demand, several scenarios were analyzed including:

- No First-Year Student Parking
- Permit Reallocation
- Shared Parking on Centennial Campus
- New Parking
- Preferred Recommendations

1: "Parking 101: A parking primer: A publication of the International Parking Institute," International Parking Institute, 2015, "Shared Parking, second edition," Urban Land Institute

5-Year Development (2021) Scenario

The Park+ model (developed in Fall Semester 2016) used the growth projections mentioned on the previous page.

The results of this scenario indicated that the surplus on campus was nearly cut in half, with a surplus of 3,920 spaces. North Campus had a deficiency of 813 spaces. The 300 space parking garage on Centennial Campus absorbed the demand for the new academic uses on Centennial Campus leaving a 521 space latent demand. The results of this scenario are detailed in Table 4.3 and shown on Figure 4.6 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	3,843 spaces	3,030 spaces	-813	127%
Central Campus	6,107 spaces	8,300 spaces	2,193	74%
South Campus	1,596 spaces	2,652 spaces	1,056	60%
Centennial Campus	7,992 spaces	9,307 spaces	1,315	86%
West Campus	814 spaces	1,130 spaces	316	72%
Campus Wide	20,352 spaces	24,554 spaces	4,202	83%

Table 4.3: Park+ Model Summary, 5-Year Build-Out (2021)

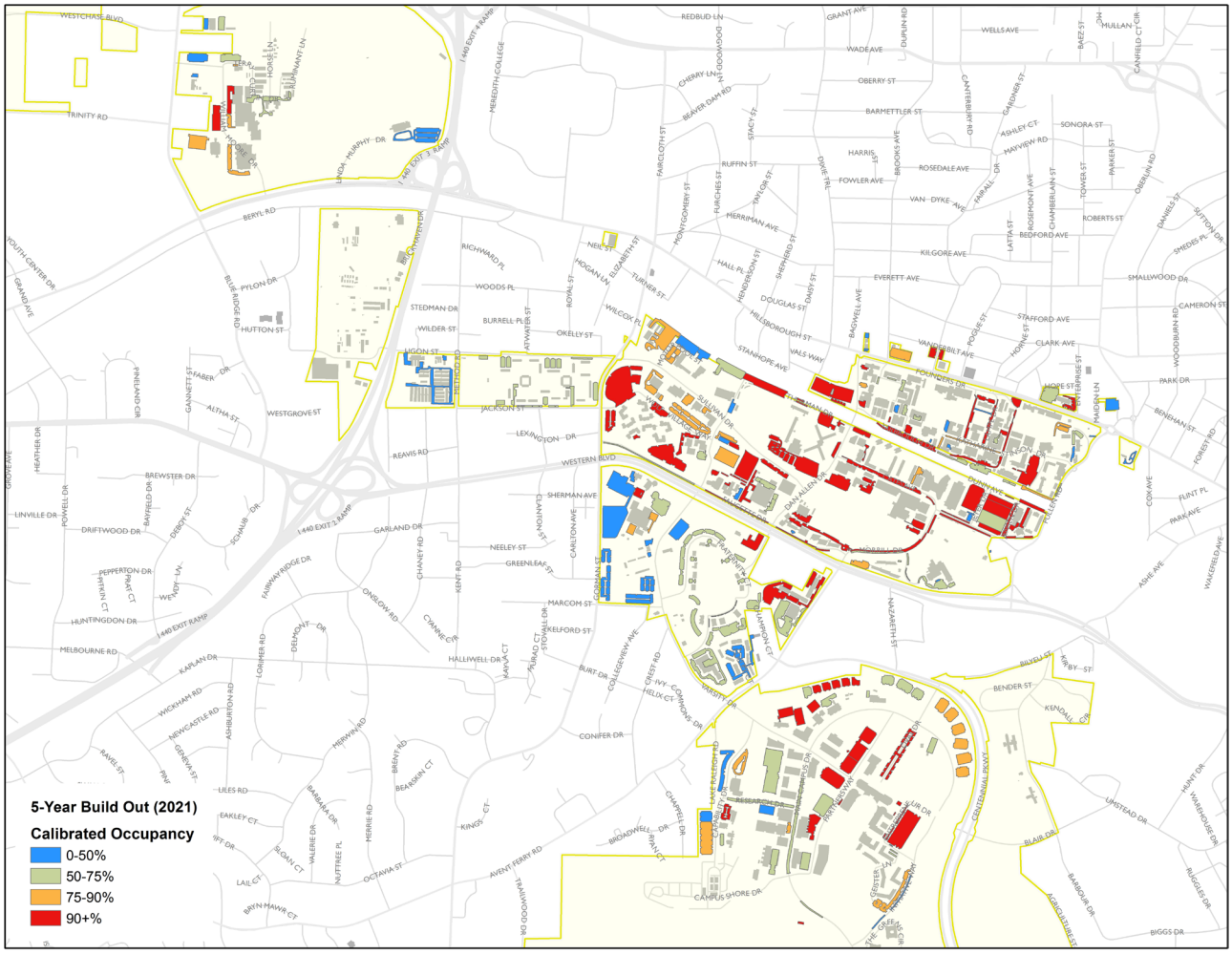


Figure 4.6: Model Results, 5-Year Build-Out (2021)

Proposed Policy: No First-Year Student Parking Scenario

Using the data from the previous scenario (5-Year Projections), the next scenario looks at first-year parking restrictions where first-year students are not permitted to park on campus. Results indicated that there was still a campus wide surplus of 5,248 spaces, a latent demand of 468 spaces, and North Campus has a deficiency of -564 spaces. The results of this scenario are detailed in Table 4.4 and shown on Figure 4.7 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	3,594 spaces	3,030 spaces	-564	118%
Central Campus	5,680 spaces	8,300 spaces	2,620	68%
South Campus	1,496 spaces	2,652 spaces	1,156	56%
Centennial Campus	7,764 spaces	9,307 spaces	1,543	83%
West Campus	772 spaces	1,130 spaces	358	69%
Campus Wide	19,306 spaces	24,554 spaces	5,248	79%

Table 4.4: Park+ Model Summary, 5-Year Build-Out with Permits Prohibited for First-Year Students (2021)

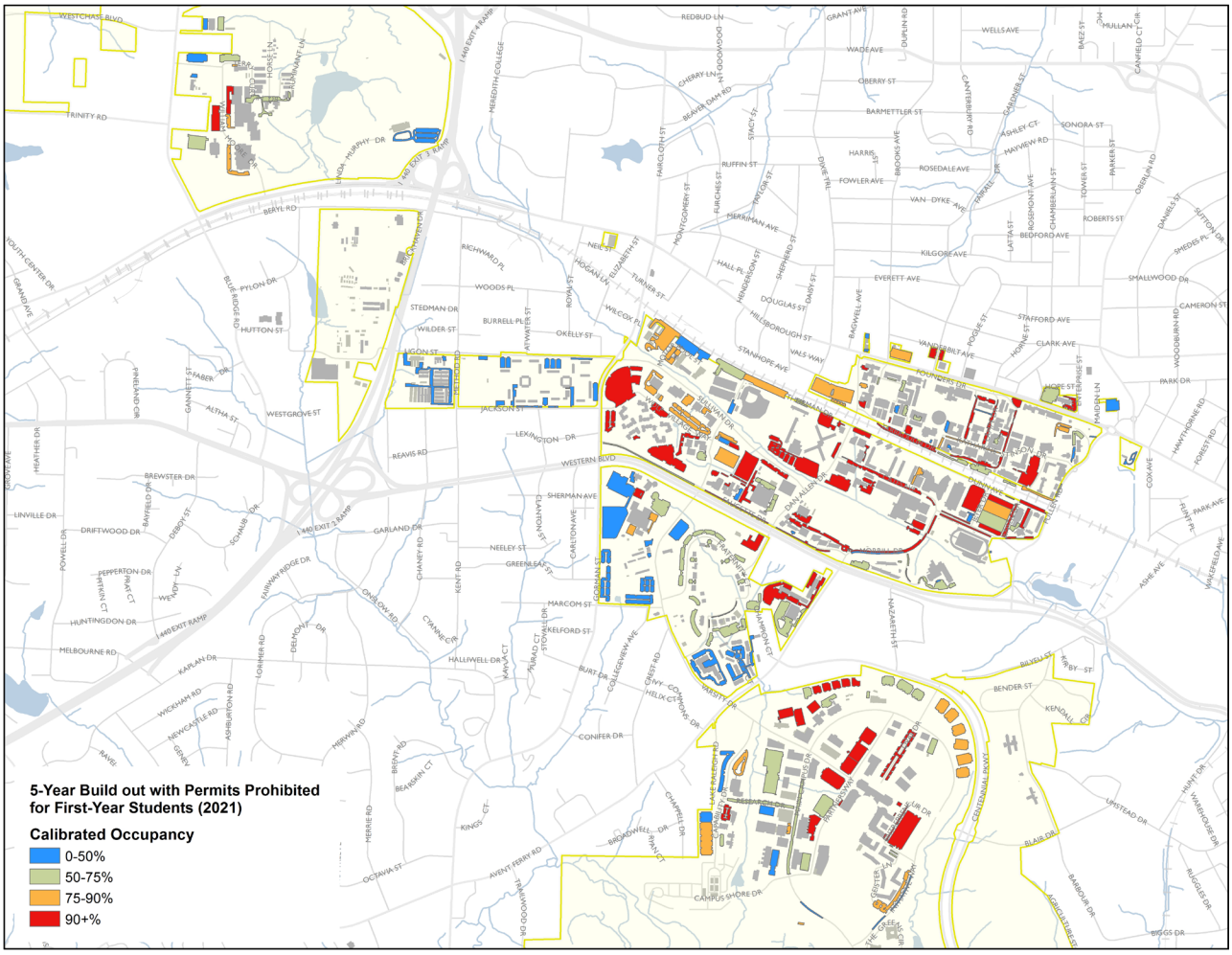


Figure 4.7: Model Results, 5-Yr Build-Out with Permits Prohibited for First-Year Students (2021)

Proposed Policy: Permit Reallocation (2021) Scenario

Using the data from the 5-Year Projections scenario, the next scenario looks at reallocating permit types to allow for the most appropriate user type in regard to location. Based on the model analysis, North Campus has a deficiency of -1,339, more than double the previous scenario. Both Central and South Campus had surpluses, however less than the previous scenario. Centennial Campus was almost at effective capacity in this scenario. The overall campus operates with a met demand of 18,802 spaces and a latent demand of 2,676 spaces. The results of this scenario are detailed in Table 4.5 and shown on Figure 4.8 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	4,369 spaces	3,030 spaces	-1,339	144%
Central Campus	6,308 spaces	8,300 spaces	1,992	76%
South Campus	1,674 spaces	2,652 spaces	978	63%
Centennial Campus	7,525 spaces	9,307 spaces	1,782	81%
West Campus	882 spaces	1,130 spaces	248	78%
Campus Wide	20,758 spaces	24,554 spaces	3,796	85%

Table 4.5: Park+ Model Summary, 5-Year Build-Out with Permit Reallocations (2021)

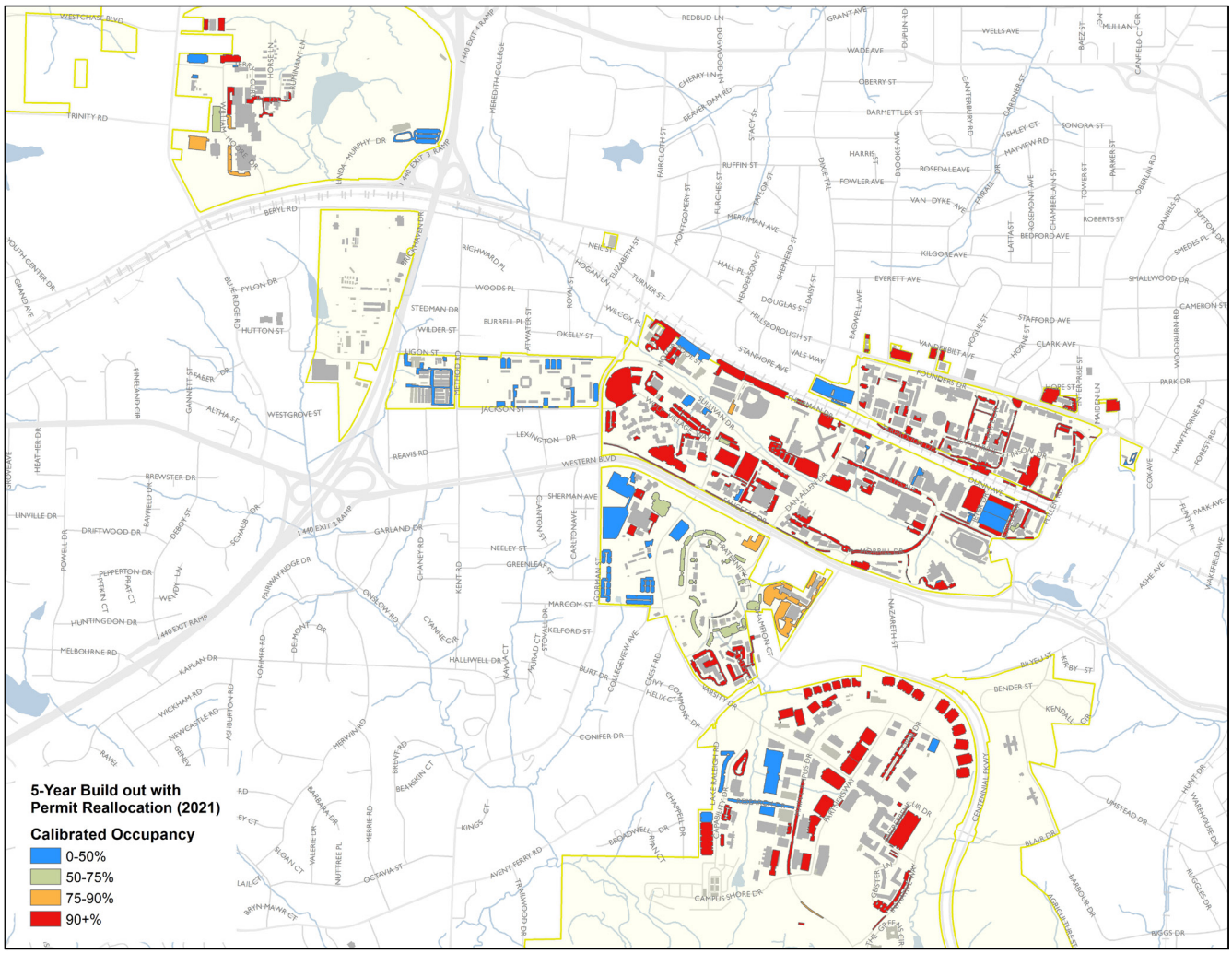


Figure 4.8: Model Results, 5-Yr Build-Out with Permit Reallocation (2021)

Policy Change: Shared Parking on Centennial Campus (2021) Scenario

This scenario included the implementation of shared parking on Centennial Campus, allowing academic and private uses to share spaces. While the policy change did not impact overall supply/ demand numbers, the parking on Centennial Campus achieved a much better balance, as shown in the map below. The overall campus operates with a met demand of 20,322 spaces and a latent demand of 30 spaces. The results of this scenario are detailed in Table 4.6 and shown on Figure 4.9 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	3,843 spaces	3,030 spaces	-813	127%
Central Campus	6,107 spaces	8,300 spaces	2,193	74%
South Campus	1,596 spaces	2,652 spaces	1,056	60%
Centennial Campus	7,992 spaces	9,307 spaces	1,315	86%
West Campus	814 spaces	1,130 spaces	316	68%
Campus Wide	20,352 spaces	24,554 spaces	4,202	83%

Table 4.6: Park+ Model Summary, 5-Year Build-Out with Additional Private Supply (2021)

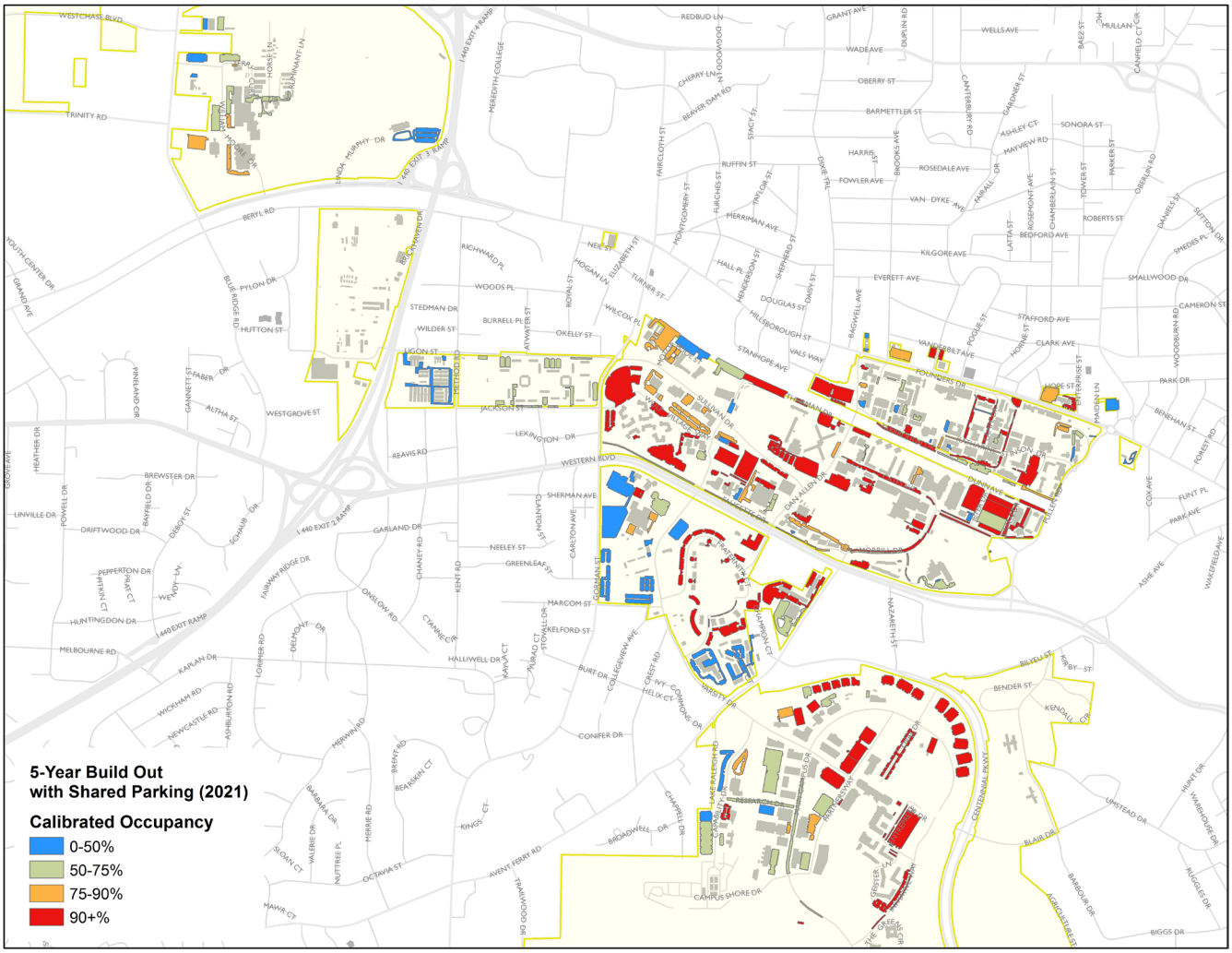


Figure 4.9: Model Results, 5-Yr Build-Out with Additional Private Supply (2021)

New Parking (2021) Scenario

This scenario included the implementation of a new parking structure on the site of the current North Hall student residence. This garage included 1,000 proposed spaces that would serve North campus demands and leverage public demands along Hillsborough Street to help pay for the parking garage. The overall campus operates with a met demand of 19,924 spaces and a latent demand of 428 spaces. The results of this scenario are detailed in Table 4.7 and shown on Figure 4.10 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	3,777 spaces	3,809 spaces	32	99%
Central Campus	6,107 spaces	8,300 spaces	2,193	74%
South Campus	1,596 spaces	2,652 spaces	1,056	60%
Centennial Campus	7,992 spaces	9,307 spaces	1,315	86%
West Campus	814 spaces	1,130 spaces	316	78%
Campus Wide	20,352 spaces	25,333 spaces	4,981	80%

Table 4.7: Park+ Model Summary, 5-Year Build-Out with New Parking (2021)

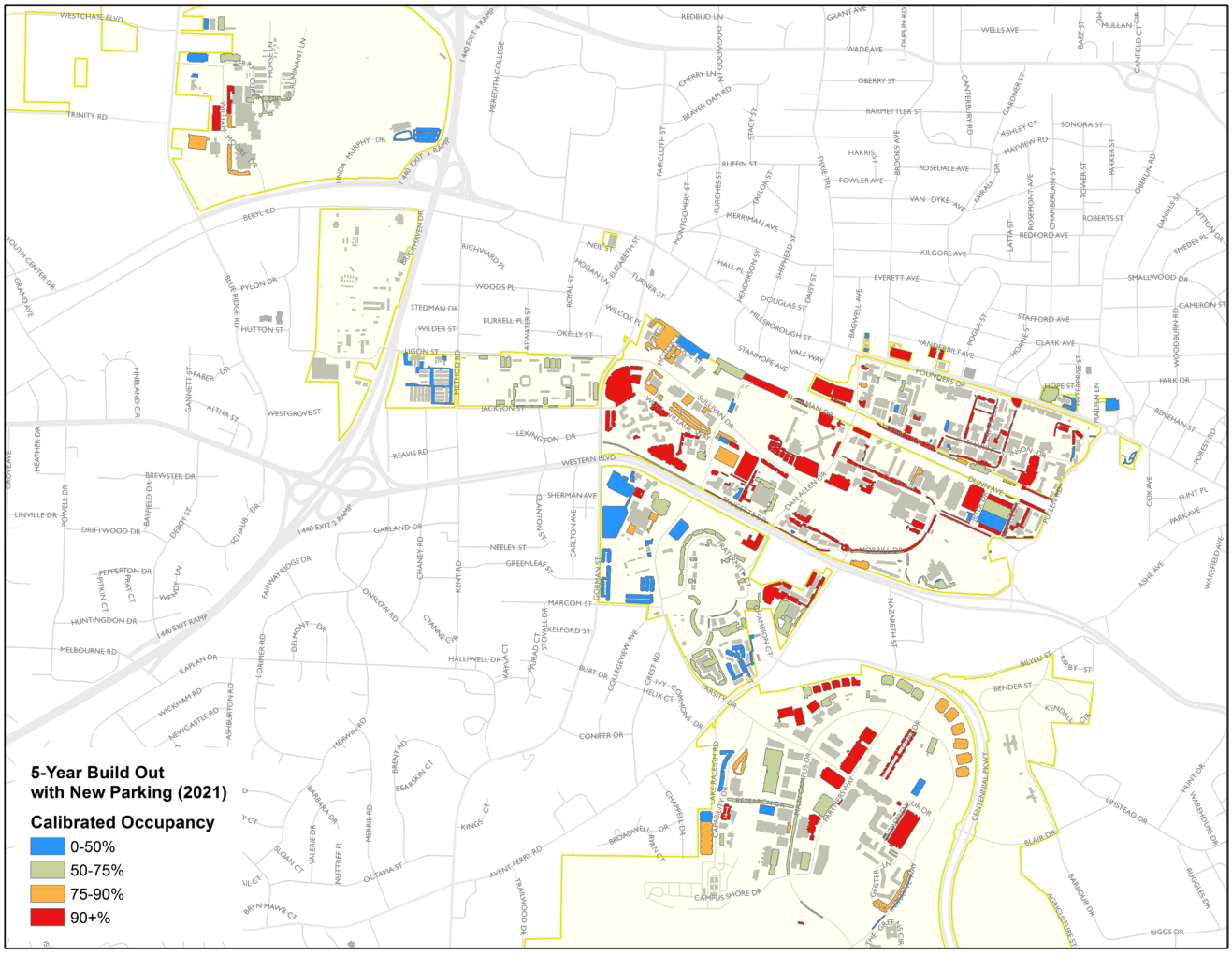


Figure 4.10: Model Results, 5-Yr Build-Out with New Parking (2021)

Preferred Recommendations (2021) Scenario

The final scenarios looked at the combination of several of the previous individual recommendations, including:

- New Parking at North Hall site
- Shared Parking on Centennial Campus between private and academic uses
- First-year parking restriction policy

The overall campus operates with a met demand of 19,286 spaces and a latent demand of 20 spaces. The results of this scenario are detailed in Table 4.8 and shown on Figure 4.11 below.

Campus Area	Demand	Supply	Surplus/ Deficit	Utilization Ratio
North Campus	3,594 spaces	3,809 spaces	215	94%
Central Campus	5,608 spaces	8,300 spaces	2,620	68%
South Campus	1,496 spaces	2,652 spaces	1,156	56%
Centennial Campus	7,764 spaces	9,307 spaces	1,543	83%
West Campus	772 spaces	1,130 spaces	358	78%
Campus Wide	19,306 spaces	25,333 spaces	6,027	76%

Table 4.8: Park+ Model Summary, 5-Year Build-Out with Preferred Recommendation (2021)

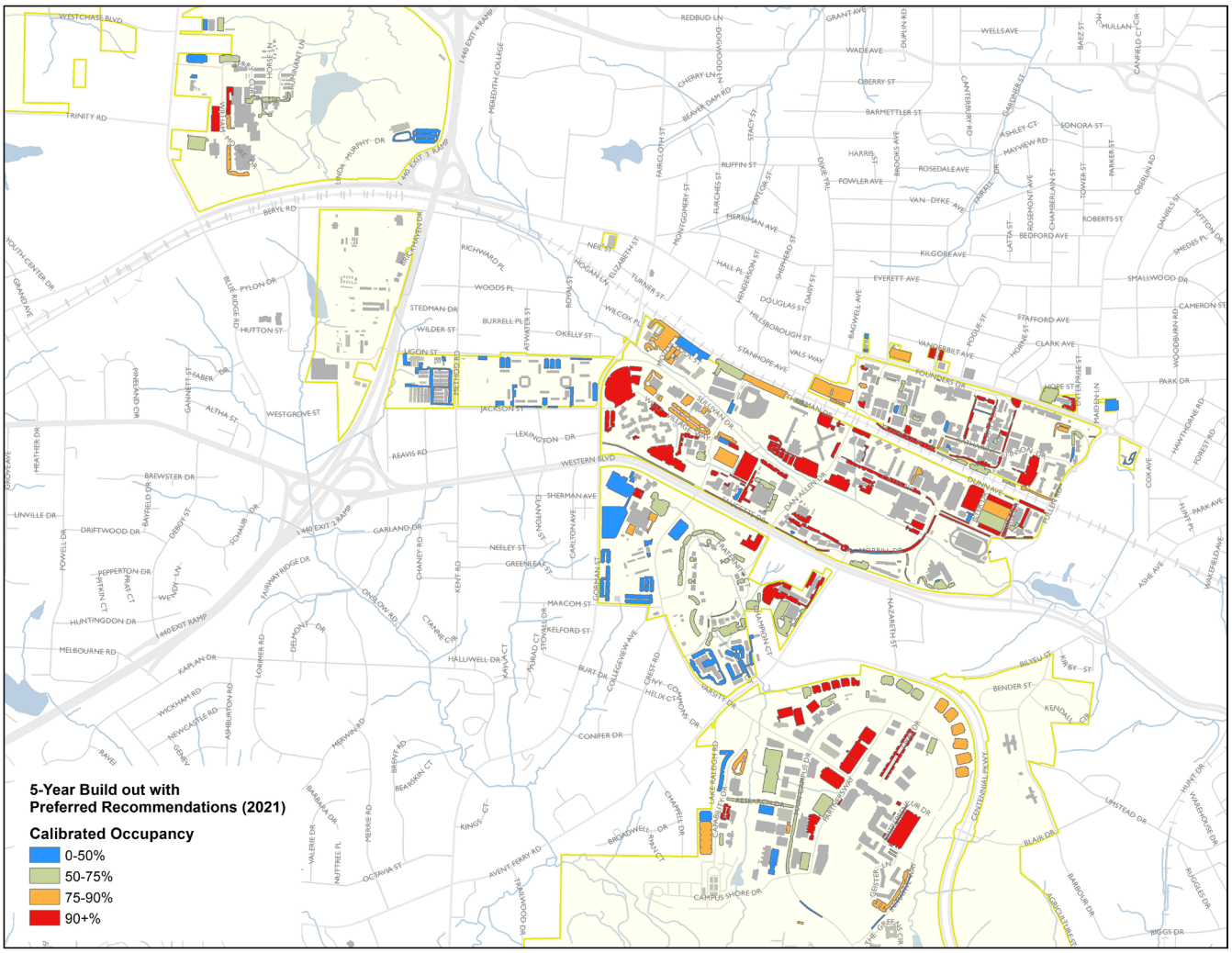


Figure 4.11: Model Results, 5-Yr Build-Out with Preferred Recommendation (2021)

Overall System

As summarized in Table 4.9, the combined scenario of preferred recommendations provides the most efficient use of parking assets campus-wide. This scenario includes the construction of an approximately 1,000-space parking deck to serve the overutilized North Campus area and leverage public parking revenues from Hillsborough Street. The recommended scenario also includes the use of shared parking agreements in the Centennial Campus area, including academic spaces in the nested private parking garage, as well as first-year student parking restrictions. However, as demonstrated in Figure 4.11, localized instances of over-utilization could remain throughout campus, and would need to be addressed on an ongoing basis with data-driven policy and permit decisions.

The recommendations from the Park+ analyses are included in the recommendations section.

Scenario	Demand	Supply	Surplus /Deficit	Utilization Ratio
Base-Year (2016)	16,642 spaces	23,077 spaces	6,435	72%
5-Yr Build Out (2021)	20,352 spaces	24,554 spaces	4,202	83%
First-Year Parking Restrictions	19,306 spaces	24,554 spaces	5,248	79%
Permit Reallocation	20,758 spaces	24,554 spaces	3,796	85%
Shared Parking on Centennial Campus	20,352 spaces	24,554 spaces	4,202	83%
New Parking Garage on North Campus	20,352 spaces	25,333 spaces	4,981	80%
Combined Scenario of Preferred Recommendations	19,306 spaces	25,333 spaces	6,027	76%

Table 4.9: Model Summary by Scenario, Campus-Wide (2021)

Parking Permit Pricing Analysis

A review of comparable parking permit prices was conducted with peer institutions and with local private parking facilities near NC State.

Permit Type	Notes	NC State	Non-ACC Comparable Parking Programs		
			Stanford	Texas A&M	University of Wisconsin-Madison
Student	Resident, varies by location	$235-$370	$312.50-$860 per academic year	$291-471	$718-$1235
	Commuter, varies by location	$120-$370			
Employee	Assigned Space	$1215	NA	$567-743 varies by location	$1218-1735 varies by location
	Permanent Employee, varies by location	$120-480	$375-$1032	$291-471	$718-$1235

Table 4.10: Permit Rates from Non-ACC Comparable Parking Programs

Permit Type	Notes	NC State	ACC Comparable Parking Programs				
			Florida State	University of Virginia	UNC	Georgia Tech	Clemson University*
Student	Resident, varies by location	$235-$370	$8.90 per credit hour	$240-$576	$170-$440.25 per academic year	$795	$162
	Commuter, varies by location	$120-$370		$240-$540	$227-$768 per year		
Employee	Assigned Space	$1215	NA	NA	$717-$2286 based on salary & location	$1545	NA
	Permanent Employee, varies by location	$120-480	$124.92-$250	$576-$1140	$331-$1246 based on salary	$795	$83-$400 based on salary

Table 4.11: Permit Rates from ACC Comparable Parking Programs

*Clemson University is in a rural location with no structural parking. Therefore, it is less comparable than other universities.

Permit Type	Notes	NC State	Local Comparable Parking Facilities		
			University Towers	Valentine Commons	City Center Deck
Anyone	Resident/Commuter	$120-$370	$800/9 months $450/semester	$65/month	$110/month

Table 4.12: Local parking permit rates comparison

Parking permit rate recommendations are summarized in the recommendations section below.

RECOMMENDATIONS

Recommendations presented here are based on an analysis of existing parking and transportation conditions at NC State Transportation that included:

- Community outreach
- Reviews of comparable parking program strategies and best management practices
- Park+ modeling of existing and projected parking demand
- Discussions with staff and campus stakeholders
- Reviews of peer institution and adjacent private parking rates

Recommendations are compiled into four groups:

Demand-Based Recommendations

Consider a New Parking Structure on North Campus

Park+ analysis of current and projected future parking demands indicates a deficit of over 800 spaces on North Campus. In addition to policy, pricing, and programming, latent demand should be mitigated with additional parking supply. Specifically, this plan recommends NC State:

- Conduct a thorough parking structure feasibility study for North campus that evaluates parking demand from University and public uses, and different allocation of users (i.e. employees and public) in a potential North Campus area structure.
- Examine sites for the potential addition of a parking structure in the vicinity of North Campus with approximately 1,000 spaces. This addition of parking will help offset spaces that could be lost with the demolition of the old portion of the Coliseum Deck.
- Explore partnerships that reserve a portion of the parking spaces in the structure for City of Raleigh public use by patrons of the Hillsborough Street commercial corridor especially during times of lower University demand.

Figure 4.12: Coliseum Deck, NC State

Leverage Private Sector Partnerships to Add Shared Parking on Centennial Campus

Park+ analysis indicates the need of nearly 1,000 additional parking spaces on the Centennial Campus site with the construction of the Engineering 4 (EB Oval) and Plant Sciences buildings. This plan recommends NC State:

- Define and execute a strategy for managing shared parking, including establishing leasing, partnership, and management/ maintenance agreements with public and private entities, allocating shared parking resources, establishing customer service amenities, and using parking system technology for enforcement and operations management of shared parking resources.
- Explore the possibility of immediately sharing existing private parking resources on Centennial Campus.
- Capitalize on development of private parking within Centennial Campus to add parking spaces to serve University academic demand by establishing a more flexible agreement to allow access to spaces in these parking facilities.
- Consider assessing an impact fee on private development on Centennial Campus in lieu of the private entities providing parking and in conjunction with a University-private shared parking relationship. The fees would be used for implementation of new shared parking spaces. This public-private partnership would both incentivize growth on this campus and help NC State Transportation to finance new parking facilities.

Technology Recommendations

Implement License Plate Recognition (LPR) and Virtual Permitting

Automating parking data collection and maintenance can greatly assist in actively managing parking demand and pricing. Virtual permits reduce capital and administrative costs and make permit validation more convenient for users by eliminating physical permits.

Mobile-mounted and gate-mounted LPR systems can be used for automated permit validation and enforcement. These technologies provide data metrics associated with parking occupancy, parking duration, movement of vehicles within the system, and other key metrics that assist with active management of parking supply

relative to demand. This data collection will aid in making data driven decisions, including setting pricing levels, managing parking supply relative to demand fluctuations, benchmarking, and other active parking management and operational strategies.

The goal is to streamline and improve parking operations and management by adopting a virtual permit environment with the license plate as the primary credential.

This plan recommends NC State Transportation:

- Implement LPR-based permitting and enforcement in Fall 2018. This would include procuring LPR vehicles for all campuses and integrating the data from that system into the existing Ames management system.
- Implement virtual permitting by Fall 2018.
- Include LPR-based credentialing on parking facility entrances and exits tied to existing and future Parking and Revenue Control System (PARCS) systems, as well as pay-by-license-plate kiosks and phone apps for pay-as-you-go users.
- Integrate LPR-based enforcement efforts with existing and future PARCS, as well as back-end management systems to ensure optimal use of data for management, operations, planning, and policy development.
- Develop a data collection and maintenance process that utilizes data from the LPR system to evaluate parking occupancy, parking duration, vehicle movement within the system, and other key metrics. This data stream will be critical to analyzing future changes to the program and setting pricing levels for permit and pay-as-you-go parking supply.
- Restrict back-in parking, but provide a supplemental plate option, and enforce.

Policy and Permit Recommendations

Institute a Park Once Approach

Vehicles hunting for parking spaces at NC State and circulating between campuses leads to internal campus traffic congestion. This plan recommends NC State Transportation adopt a park once approach that works to minimize campus vehicular movement. Specifically, this plan recommends NC State Transportation:

- Collect and review parking operations data metrics associated with demand, mode share, and customer experience.
- Break out permits by zone to prevent moving around campus.
- Draw on collected data to set permit and pay-as-you-go policies and pricing to concentrate and re-balance the location of parking demand.
- Provide varied commute and circulation options, such as enhanced transit, shuttle, pedestrian, and bicycle facilities that increase comfort, convenience, and connectivity.
- Develop and execute a campaign (incorporated with the TDM program) aimed at employees to promote the park once approach, including the reasons, motives, and importance of the park once approach, and to provide resources that will assist employees with connecting to their destinations after their car is parked.

NC State implemented a park once strategy aimed at students in the Fall of 2017. Phase 2 will focus on employees and is anticipated to be implemented in the Fall of 2018.

Use Permit Pricing Tiers to Manage Parking Demand and Incentivize the Use of Alternative Modes

NC State Transportation has been working in recent years to develop location-based and zone-specific permits. Recent changes reallocated fringe parking, like the Wolf Village Lot and Centennial Campus Wolf Ridge facilities, to student residential parking. Additionally, the recent transition to semester-based permits has aided in encouraging flexible and multimodal commuting behavior (i.e. not driving and parking every day). Despite these active demand management measures, further active management of parking demand through pricing is recommended.

Employee permit designations outside of the “AS” Assigned Space designation permit can end up hunting in numerous facilities for an available space. Permits that grant access to parking facilities in disparate areas also run counter to a park once philosophy as they encourage employees to drive between campus destinations. Universities such as Arizona State University (facility-based) and Oregon State University (zone-based) take a deliberate approach to concentrating parking demand in certain areas through tiered pricing and location-based parking permits where users are restricted to certain facilities or to limited areas for available parking. The University of Florida has several employee parking tiers that consolidate parking, as well as premium permit types (priced accordingly) that allows for parking anywhere on campus. These

strategies are paired with coordinating shuttling and other mobility services to circulate users around campus while their vehicles remain parked.

Specifically, this plan recommends NC State Transportation:

- Actively track and monitor parking occupancy and wait lists (with LPR coupled with the current back-end management system) and annually review and adjust permit pricing tiers and pay-as-you-go parking facilities to closely tie price with demand.
- Evaluate student permit pricing on an annual basis relative to market value to not overly incentivize students to purchase parking permits.
- Develop permit pricing tiers for employees tied to specific parking facilities that reduce parking flexibility and vehicle movement during peak demand while still retaining convenience.
- Reallocate employee permits to more of a zone structure that prohibits movement between campuses and emphasizes coordinated use of campus mobility options for workday trips within Campus.

Place a Greater Emphasis on Pay-As-You-Go Parking

As the permit recommendations discussed in the previous section are implemented, forcing motorists to make more thoughtful decisions about their commute choice, it will be critical for NC State Transportation to provide reasonable parking options for those who decide to drive to Campus on an as-needed basis. This plan recommends that NC State Transportation provide more pay-as-you-go parking options by mixing it with traditional permit parking.

The provision of pay-as-you-go parking options increases customer flexibility and offers a viable way to continue generating parking revenue as traditional parking permit prices increase and more travelers switch to alternate options. Pay-as-you-go parking offers greater flexibility since travelers are not locked into long-term parking permit contracts, but instead can drive and park only when they want or need to. On other days, these travelers are free to use other modes of transportation.

Arizona State University uses hourly parking in fringe lots and centrally located (and predominantly permit) parking structures to provide more flexible options for customers who may want to drive and park on some days and take alternative modes on others. Their back-end management platform is used to allocate pay-as-you-go

Figure 4.13: Colorado State University Pay-As-You-Go Lot

spaces on a daily and hourly basis in real-time. Due to this active management and the provision and promotion of pay-as-you-go parking options, parking occupancies are more balanced across ASU's four campuses, and revenue per space has increased.

This plan recommends the following strategies for the pay-as-you-go parking component of the transportation system:

- Immediately rebrand the program from Visitor/Hourly Parking to Pay-As-You-Go Parking as a means of better informing patrons of the program's intention.
- Develop a communication strategy that emphasizes the flexibility of this option so patrons are more aware of it as a viable choice. Those wishing to park on campus without a parking permit are encouraged to use the pay-as-you-go parking option.
- Move towards providing predominantly mobile and license plate-based payment options for all pay-as-you-go parking
- Consider converting more spaces in permit parking areas such as parking garages with large swings in peak and non-peak demands, on-street parking on Centennial Campus, on-street parking on Cates Avenue, and resident east parking on Dunn Avenue to pay-as-you-go parking spaces
- Provide better advertising and wayfinding for pay-as-you-go parking on campus
- Conduct an annual review of spaces on each campus that are accessible to pay-as-you-go parking.
- Use existing back-end management system analytics and early semester calibrations to define daily and hourly loading of pay-as-you-go parking spaces, and balance supply in mixed permit and pay-as-you-go parking facilities

Consider Increasing Rates for Student and Employee Permits

An assessment of comparable parking programs both within and outside the Atlantic Coast Conference (ACC) indicates that the annual rate of NC State's student and employee permits is on the lower end of comparable schools.

Specifically, this plan recommends:

- NC State Transportation should continue annually reviewing permit rates with adjustments tied to demand and occupancy data collected through access and LPR technology. Parking facilities and "zones" of campus with high demand could be priced more aggressively than those with lower demand, thus encouraging balancing of demand throughout the system.
- NC State Transportation should consider increasing permit prices across the board to be more aligned with comparable parking programs.

Restrict First-Year Student Parking

Park+ analysis of parking demand indicates that approximately 10% of the parking demand on campus could be reduced by implementing a restriction on first-year student parking.

On-campus underclassmen student residents who purchase permits for parking in various "R" designated resident lots present a significant opportunity for parking demand reductions. Since first-year students typically live in on-campus dorms, their need for close, convenient parking for frequent trips is not as high as other groups. Since incoming first-year students do not have ingrained expectations about parking on campus, they represent an appropriate way to reduce overall parking demand, assuming there is proper communications and messaging.

Implementation of this restriction should be timed with demand emerging for the spaces currently occupied by first-year students to avoid a sudden drop in revenue.

On many urban university campuses around the country, incoming first years and sophomores are discouraged or prohibited from parking on campus. At Stanford University, for instance, students are not permitted to bring cars to campus for the duration of their first year (Fall through Spring semesters).

Specifically, this plan recommends:

- As demand increases for parking facilities where first-year students currently park, consider prohibiting incoming first years living on campus from purchasing a permit to park (i.e. any of the "R" Resident permit types).
- Under this scenario, permit all first years to access pay-as-you-go parking options, particularly relevant for first years who live off campus (e.g. commuter students) and would like to park.
- Develop specific incentives and support practices for students with parking restrictions, including access to car share services, reduced transit costs, premium service to different parts of NC State's campus, and enhanced cycling options such as access to LimeBike bike share.
- Undertake a deliberate, proactive messaging campaign to announce policy changes and transportation and parking options to incoming students.

Actively Manage Event Parking and Access

Event parking poses a significant challenge for University parking and transportation systems as resources are strained beyond capacity, and many events cause demand overlap with normal daily class and campus schedules. Proactive coordination across different university entities like athletics and housing is essential to event parking and access management.

This plan recommends NC State Transportation assume a more active role in planning for parking for events by:

- Continuing coordinated strategy with campus colleagues who facilitate events to plan for event types including sporting events, on-campus student move-in, commencement, performing arts events, and others.
- Proactively projecting demand and the displacement of student and employee parking to provide the appropriate accommodations.
- Leveraging mobile LPR and existing back-end management system analytics to spatially manage event parking demand in real-time, and distribute traffic congestion through dynamic pricing.

Supportive Strategies

Technology, policy, pricing, and other strategies to manage, decrease, and concentrate parking demand must be coupled with convenient, accessible, and attractive alternative commute and circulation options. This section presents some critical supportive strategies.

Align Parking and Multimodal Circulation Options

For a park once approach to work at NC State, other modes must be available and integrated into the parking and transportation system. This includes providing convenient access to reliable car share, ride share, bike share, shuttle, and transit service, as well as comfortable and connected walking and biking routes.

Recommendations to support this strategy can be found in the bicycle, pedestrian, and transportation demand management (TDM) section of this report.

Figure 4.14: LimeBike, NC State

Institute Departmental Car Share

Departments currently procure vehicles for their employees to make trips to other parts of campus. The University seeks to reduce departmental capital costs for these vehicles, as many go unused for portions of the day and week, and reduce the number of vehicles on campus.

This plan recommends NC State Transportation:

- Eliminate the model of departments procuring department-specific vehicles in favor of a broader shared model (with exceptions for specialized vehicle needs). This could mean NC State Transportation expands its relationship with Zipcar to include employee-specific shared vehicles (vans and sedans) for department use to replace the existing single-use departmental vehicle inventory. The cost of accessing these vehicles could be pooled between several departments, and the vehicles could be made available to employees free of charge. The vehicles should be under the purview of the Facilities Division.
- Work with departments to determine actual vehicle usage to plan for the appropriate shared fleet.
- Work with the Facilities Division to evaluate the department use and siting of shared fleet maintenance and departmental vehicles long-term.
- Some departments may require specific vehicles such as maintenance vehicles.

Provide Wayfinding

Connected infrastructure and mobile technology is transforming the way data is collected and parking and transportation systems are operated and maintained. As NC State sees greater adoption of intelligent parking systems technology, more user and financial data will become available.

NC State has an existing wayfinding and navigation system that utilizes online information and signage throughout campus. The system does an excellent job of navigating motorists once they are on campus. However, today's customers are accustomed to accessing commute, travel, and payment information and options with mobile phones instantly and in real time. If shared in real-time with students, employees, and visitors, data can serve as a resource for users to make informed transportation and mobility decisions based on their needs and priorities.

This plan recommends that NC State Transportation leverage internal and external technology and computer engineering resources to either:

- Create and manage a stand-alone app of mobility resources and information for travelers to, from, and around NC State, with features such as parking locations, inventory, real-time occupancy, bicycle parking and bike share information, traffic and weather conditions, transit routes and real time vehicle location, mobile parking payments, account information, trip planning, and others.
- Develop and provide data sources for outside vendors or mapping providers for inclusion in existing mapping platforms. Sidewalk Labs and Google Maps are currently initiating parking information in the existing Google Maps platform. NC State would need to provide static and dynamic data from its existing parking revenue control technologies and data management technologies. This data stream could then be uploaded into the mapping platform and become available to any Google Maps consumer who is looking for navigational information in and around the NC State campuses. Under this approach, NC State would be able to reach a much broader audience (its estimated that Google Maps serves more than 90 billion users monthly).

5—TRANSIT

INTRODUCTION

NC State currently operates the Wolfline Transit System ("Wolfline") that provides fixed-route bus service to Main Campus, Centennial Campus, off-campus residential, and various other campus community destinations. A key component of enhancing overall campus mobility is achieved through identifying short- and mid-term improvements to the existing Wolfline system that will improve the quality of service to riders, cost effectiveness of the investment, and ease of operations for the University.

The planning process included the following tasks:

Existing Conditions: Existing conditions of the Wolfline system routes were documented. This process included a site visit.

Peer Review: A peer review of university transit systems that offered a similar transit service to the Wolfline was completed to identify opportunities for Wolfline service improvements. Where there were additional types of services that were being provided by a peer system but not currently provided by Wolfline, the comparison served as a reference for potential future Wolfline services.

Analysis: Current route performances were analyzed to identify system-improvement priorities. Analysis included, transit data analysis and coordination with the NC State Transit staff to screen various elements including cost and operations issues.

Recommendations: The route modification recommendations were developed based on the five service goals and categorized as either short-term (Year 1) or mid-term (Year 2 to 5) solutions. The system recommendations and individual alignment recommendations were defined for the weekday, weeknight, and weekend service routes. Additionally, the transit plan recognizes the importance of partnerships and the coordination between NC State, the City of Raleigh, GoTriangle, and Wake County to ensure the continued success and sustainable operation of the Wolfline service.

Key Transit Recommendations

1. Implement routing and schedule changes to increase efficiency
2. Provide additional on-demand night service from 12 AM - 3 AM
3. Create a simplified service plan

EXISTING CONDITIONS

Summary of Existing System

NC State's Wolfline bus service is provided for the employees and students of NC State and is open to the public, and operates fare-free to riders. The existing service consists of 10 daytime routes and five evening/weekend routes. The daytime routes serve class-to-class trips as well as class-to-home trips, serving Main Campus, Centennial Campus, Biomedical Campus, and several residential areas. The night and weekend routes serve the same areas but one weekend/nighttime route (Wolfprowl) also provides access to Downtown Raleigh. Routes use internal campus roads (e.g., Varsity Drive, Morrill Drive, Dan Allen Drive, and Founders Drive) and other local roadways to provide connections to the surrounding areas via Avent Ferry Road, Western Boulevard, and Hillsborough Street. Daytime routes generally operate between 7:00 AM and 10:00 PM. Nighttime routes continue from 10:00 PM to approximately 3:00 AM, with slight variations to the schedule on the weekends.

The analysis of the existing Wolfline service identified various shortcomings in both the existing service and operational characteristics. Service issues include high demand that is not accommodated during peak hours, consistently low ridership on some routes, and unmet on-time performance for all routes. The service currently operates with route schedules that overlap between weekday, weeknight, and weekend routes. Operational issues arise from congestion along main corridors where there are high volumes of transit and vehicular traffic. In addition to roadway capacity, congestion is also caused by queue delay at key intersections heavily used by buses, cars, and pedestrians.

Figure 5.1: Wolfline Bus, provided by NC State Transportation Department

PEER REVIEW

Transit Peer Review Summary

A peer review of comparable university transit systems was conducted to gain an understanding of transit operations and strategies that have been successful and that may be applicable to NC State. The peer review included phone interviews with Arizona State University (ASU), University of Texas at Austin (UT), and University of Maryland, College Park (UMD) to gain further insights into transit operations relevant to NC State. Comparisons and summaries of transit system characteristics were developed for up to eight similar university transit systems (including the three universities that were interviewed). The university transit systems used for comparison include:

- Arizona State University
- Duke University
- East Carolina University
- University of Texas at Austin
- University of Maryland, College Park
- Rutgers University
- The Ohio State University
- University of South Florida

The goal of the peer review was to identify best practices and potential strategies for select issues (i.e. type of nighttime service, use of shuttles or on-demand service, private residential shuttle on campus, etc.).

The phone interviews and comparisons specifically focused on several key themes:

- Short/long-term priorities
- Challenges and successes
- Technology and innovation
- Regional connections and partnerships
- Service adjustments/route modification processes
- Night service
- Service between campuses and major destinations (including park and ride locations and transit hubs)
- Multimodal connectivity and opportunities (including transfers)
- Performance indicators

See Appendix B for more information on the questions discussed during the phone interviews as well as a comprehensive table of the Peer Review Comparisons.

Key Takeaways

There are several key takeaways from the peer review that can be utilized by NC State in the development of service goals and changes to service.

Transit and Multimodal Options Increase Campus Connectivity

A common challenge among the peer systems is determining how best to incorporate transit into the complex, urban fabric of a university setting. All three peer universities interviewed expressed that transit on campus can be challenging with traffic or other multimodal options competing for space or usage. While several of the systems used for comparison have successful campus-to-campus connectivity (e.g., Arizona State University (ASU) connects several campuses that are separated by 45 minutes or more), internal circulation of transit remains an issue. ASU and University of Texas at Austin (UT) stated that they have seen an increase of walking and biking for intercampus travel at the expense of transit circulators. The University of Maryland (UMD) expressed that due to high levels of pedestrian traffic and resulting vehicle congestion, transit can be a poor option for traveling between classes; however, UMD is looking at expanding circulators for key areas. Emphasis continues to be on removing vehicles from the core and providing multimodal connections to key locations. ASU and UMD are focusing on expanding park and ride locations and providing increased service.

Another takeaway is the development of relationships with surrounding residential apartment complexes. Both UMD and ASU regularly communicate with off-campus apartment complexes to coordinate transit service to campus. UMD has contracts with multiple apartment complexes that provide funds in return for transit service. ASU also coordinates transit service to avoid the use of private shuttles.

Several of the peers continue to have strong relationships with local transit providers similar to NC State. ASU, UT, and UMD provide connections to other local and regional transit service.

Technology and Innovation Continue to Increase

Technology upgrades continue to be an emphasis. For example, smartphone apps continue to be used to enhance and promote transit use. ASU uses apps to provide real time info, such as the location and number of riders on each vehicle. Several systems are also including Wi-Fi and charging ports to enhance the experience. However, most NC State routes are not long enough to warrant the use of Wi-Fi.

One of the most significant benefits of technology is the increase in communication. UT is particularly effective in generating awareness of the system for students and employees. They have developed a communication plan to better focus efforts to the student body. They utilize a combination of email, social media, and print materials.

Several other peers are continuously looking at new vehicles and technologies. For instance, ASU is looking at the potential of an electric fleet as well as autonomous vehicles.

One of the biggest takeaways is the importance of ridership data and its use to drive decisions. Similar to NC State, ASU has automatic passenger counters that allow for the collection of valuable, accurate data. ASU combines this ridership data with operating costs to create a cost-per-ride-metric used to evaluate routes.

Funding Can Be a Challenge

Each of the three universities interviewed during the peer review mentioned that funding is a continued challenge. Many of the peer systems use a combination of student fees and parking permits. UMD uses apartment contracts as mentioned above. ASU is considering implementing a carbon impact fee to generate revenue.

Night Service Differs

The focus on late night service differs from peer to peer. At ASU, night service is not extensive and most shuttles end service before 11:30 PM. At UT, the E-bus route runs until 3:00 AM Thursday through Saturday, connecting the campus to the entertainment district in one stop. Other night service at UT includes shuttles that run until 11:00 PM. UMD offers an evening fixed-route service from 5:30 PM to 3:00 AM, 7 days a week, as well as an on-demand night service (NITE Ride) that operates from 5:30 PM to 7:30 AM year-round. Ridership for a typical evening is around 7,000 riders between evening fixed service and NITE Ride with some nights reaching up to 9,500 riders. NITE Ride is provided directly by the University and is an effective point-to-point service (providing 60 to 70 riders per night in the fall and spring and up to 150 riders in the summer when it is less restricted). NITE Ride is flexible, providing service to everywhere on the main campus and the University property that is just off campus, allowing more students to take advantage of the service. Figure 5.2 shows the service boundary for UMD NITE Ride. UMD has further increased the effectiveness of NITE Ride by implementing an online app-based dispatching system that allows riders to call a ride via a website or the app.

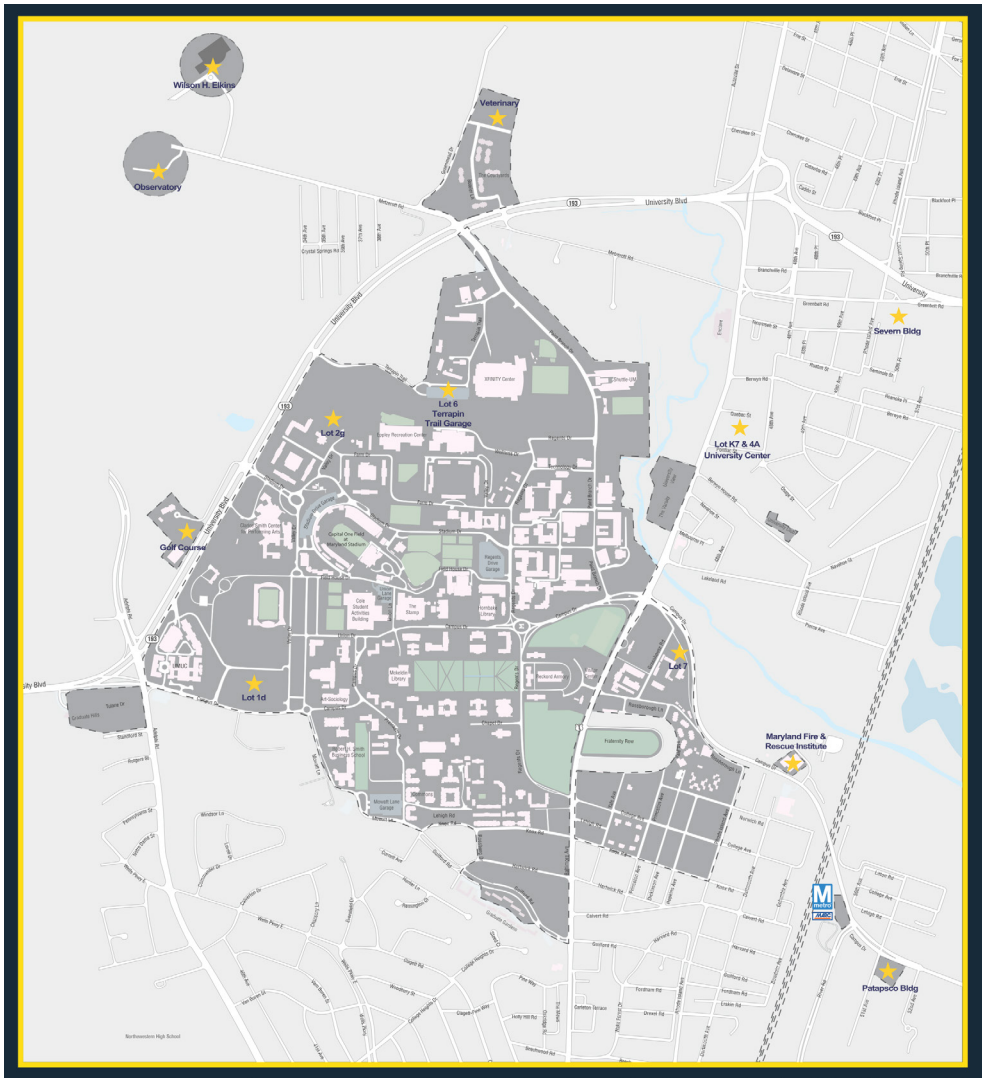


Figure 5.2: University of Maryland NITE Ride Service, UMD Department of Transportation Services

ANALYSIS

The following service goals were identified to guide the analysis and recommendations.

Service Goals

1. Improve service to higher demand destinations/stops
2. Improve quality access and connection to academic areas, housing developments, and parking facilities
3. Simplify service plan
4. Improve service with coordinated campus transportation projects
5. Identify and leverage partnerships

Route Performance

The existing Wolfline routes were evaluated based on six performance metrics; ridership, capacity, passenger miles traveled, passengers per service hour, passengers per service mile, and service reliability. NC State currently utilizes these metrics to measure the general performance of the system and to assess how routes are operating in comparison to each other. The following is a summary analysis of transit route performance and ridership based on March 2017 data.

Average Weekday Ridership

Average weekday ridership provides information on ridership by route. In March 2017, the average weekday ridership was approximately 2,000 riders per route. Route 1 had the highest ridership (3,725 riders) followed by Routes 8 and 3 (3,245 and 3,196 riders, respectively). Route 1 connects Main Campus to residential areas and a shopping center located south of the campus, serving many class-to-home trips. Routes 8 and 3 accommodate class-to-class trips from Main Campus to Centennial Campus. Route 11 had the lowest average weekday ridership (254 riders) followed by Routes 6 and 2 (449 and 750 riders, respectively). Routes 11 and 2 provide connection between the E.S. King Village residential area to Centennial Campus and areas just north of Main Campus. Route 6 provides an important connection between Main Campus and the Biomedical Campus. Additionally, this route provides a connection to the Carter Finley park and ride.

For all nighttime routes, the average nightly ridership was just below 100 riders per route with the Night Wolf having the highest ridership (147 riders) and Wolfprowl having the lowest ridership (43 riders). The Wolfprowl route only operates three nights per week (Thursday-Saturday) and is the only route to provide service to Downtown Raleigh. Night Wolf, Werewolf Shuttle, and Centennial Night provides service that is similar to the daytime Routes 1 and 9, Route 7, and Route 8, respectively.

Table 5.1 and Figure 5.3 illustrate the average weekday ridership based on the existing Wolfline Routes.

Average Weekday Ridership					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
	3,725	750	3,196	1,263	449
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	2,106	3,245	2,645	991	254

Average Weekday Ridership				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
	147	43	133	60

Table 5.1. Average Weekly Ridership Summary

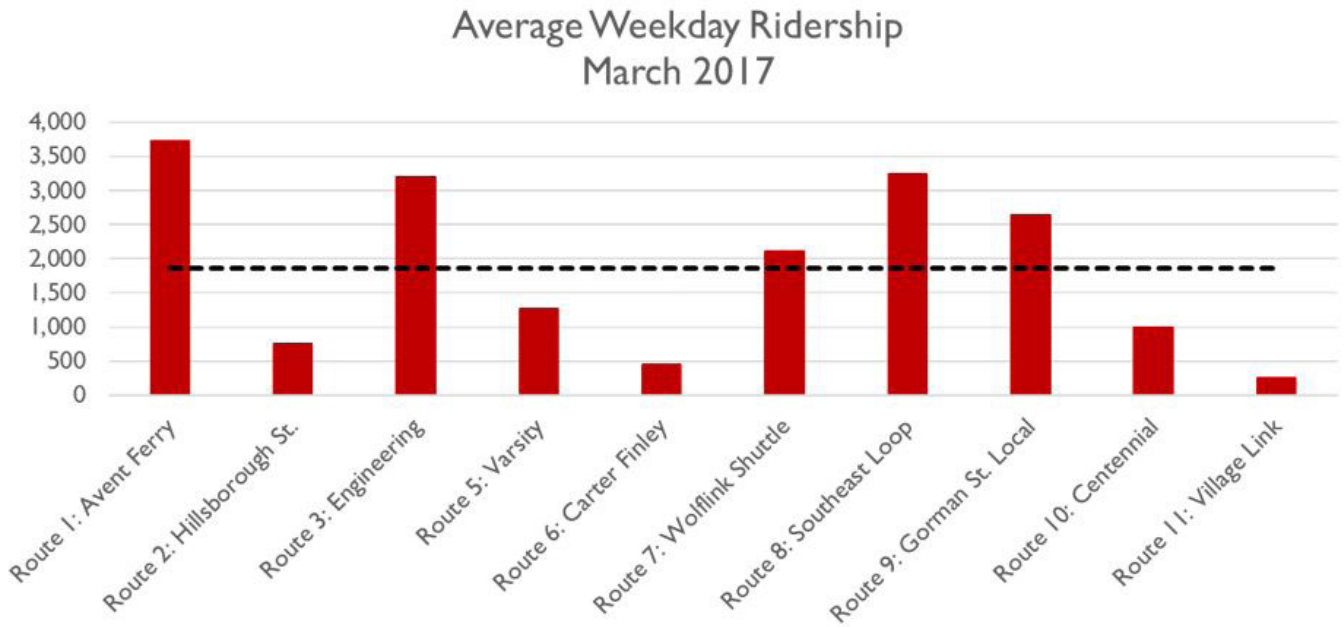


Figure 5.3: Average Weekly Ridership Summary

Weekday Capacity

Weekday capacity measures the route's ridership and service performance per trip, and provides an indication whether the route operates at an appropriate frequency (headway). Capacity was measured on three levels: all seats occupied (100% occupied), some standees (125% occupied), and crush load (> 150% occupied). Routes that have high ridership (> 3,000 riders) but rarely reach their crush load and occasionally reach 100% capacity are likely operating at an appropriate headway. For example, in March 2017, Route 3 operated at crush load for only 1% of trips and operated at 100% capacity for 13% of trips; this indicates that Route 3 operates effectively during peak hour. In contrast, the following routes operated most frequently at crush load: Route 1 (12% of trips), Route 7 (9% of trips), and Route 8 (7% of trips).

Routes that operate at crush load for more than 1% of trips are indicating a potential need for increased headways, additional vehicle capacity, or other needs to address peak ridership conditions. On the other end of the spectrum, routes that never reach or exceed 100% vehicle seating capacity indicate potential service inefficiencies associated with excess capacity. These include routes 2, 6, and 11.

For all night routes, 100% capacity was rarely met and only one route, Centennial Night, reached crush load for 1% of its trips. Night Wolf and Centennial Night did reach capacity during 2% and 1% of their trips, respectively, but Wolfprowl and Werewolf Shuttle never reached full occupancy.

Table 5.2 and Figure 5.4 illustrate the weekday capacity based on the existing Wolfline routes.

Weekday Capacity					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
All Seats Occupied	22%	0%	13%	4%	0%
(Some Standees)	(15%)	(0%)	(3%)	(1%)	(0%)
{Crush Load}	{12%}	{0%}	{1%}	{0%}	{0%}
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	19%	19%	14%	14%	0%
	(13%)	(12%)	(8%)	(8%)	(0%)
	{9%}	{7%}	{5%}	{4%}	{0%}

Weekday Capacity				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
All Seats Occupied	2%	0%	1%	0%
(Some Standees)	(0%)	(0%)	(1%)	(0%)
{Crush Load}	{0%}	{0%}	{1%}	{0%}

Table 5.2: Weekday Capacity Summary

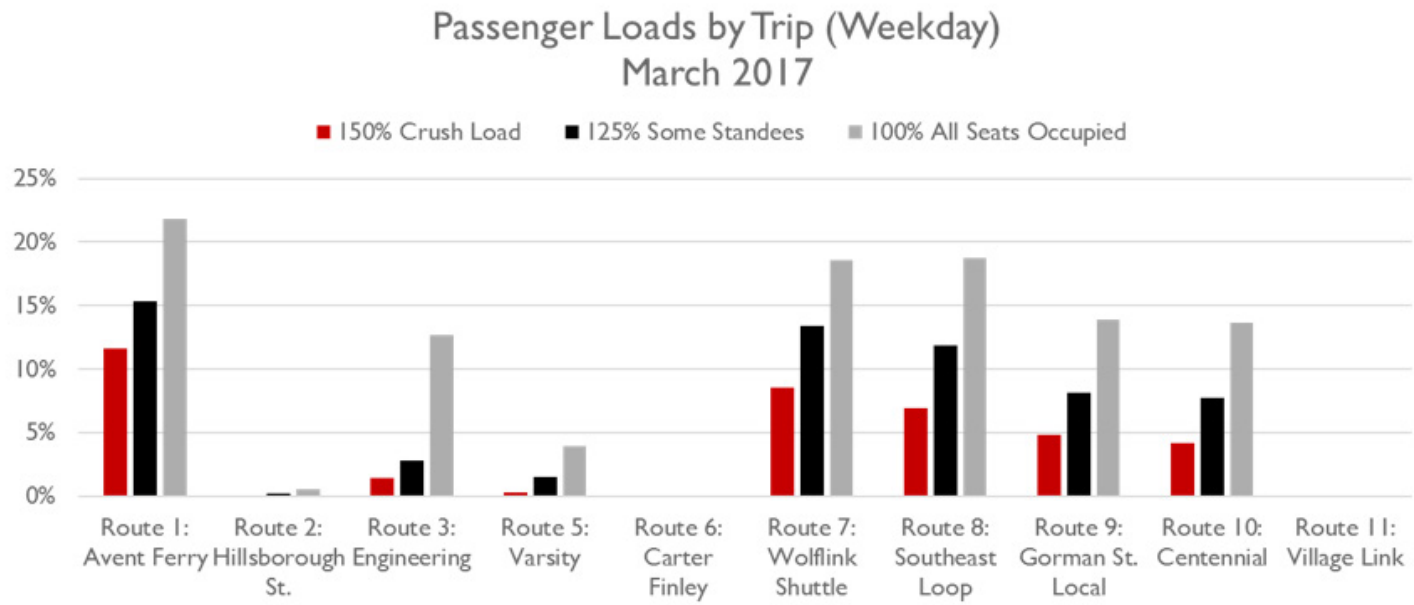


Figure 5.4: Weekday Passenger Loads by Trip Summary

Daily Passenger Miles Traveled

Daily passenger miles traveled measures the total miles that are traveled by all riders for the route. This measure can show a difference in route performance that ridership data alone does not highlight. For example, total miles traveled will help illustrate routes with high ridership that serve an above average number of short trips. In March 2017, Route 3 had 17% more trips than Route 9 but had 25% fewer passenger miles traveled. Route 1 had the highest passenger miles traveled (8,196 passenger miles) and Route 11 had the lowest (519 passenger miles). The results of the measure are used as another performance metric evaluating ridership per mile.

The passenger miles traveled by all night routes are lower than the daytime routes. Since the alignment of night routes are similar in length to daytime routes, the low passenger miles traveled directly correlates to the lower nighttime ridership. The Centennial Night route had the highest passenger miles traveled (334 passenger miles) and the Wolfprowl route had the lowest (122 passenger miles).

Table 5.3 and Figure 5.5 illustrate the daily passenger miles traveled based on the existing Wolfline routes.

Daily Passenger Miles Traveled					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
	8,196	949	4,164	1,741	1,310
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	3,093	6,524	5,569	1,441	519

Daily Passenger Miles Traveled				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
	267	122	334	123

Table 5.3: Daily Passenger Miles Traveled Summary

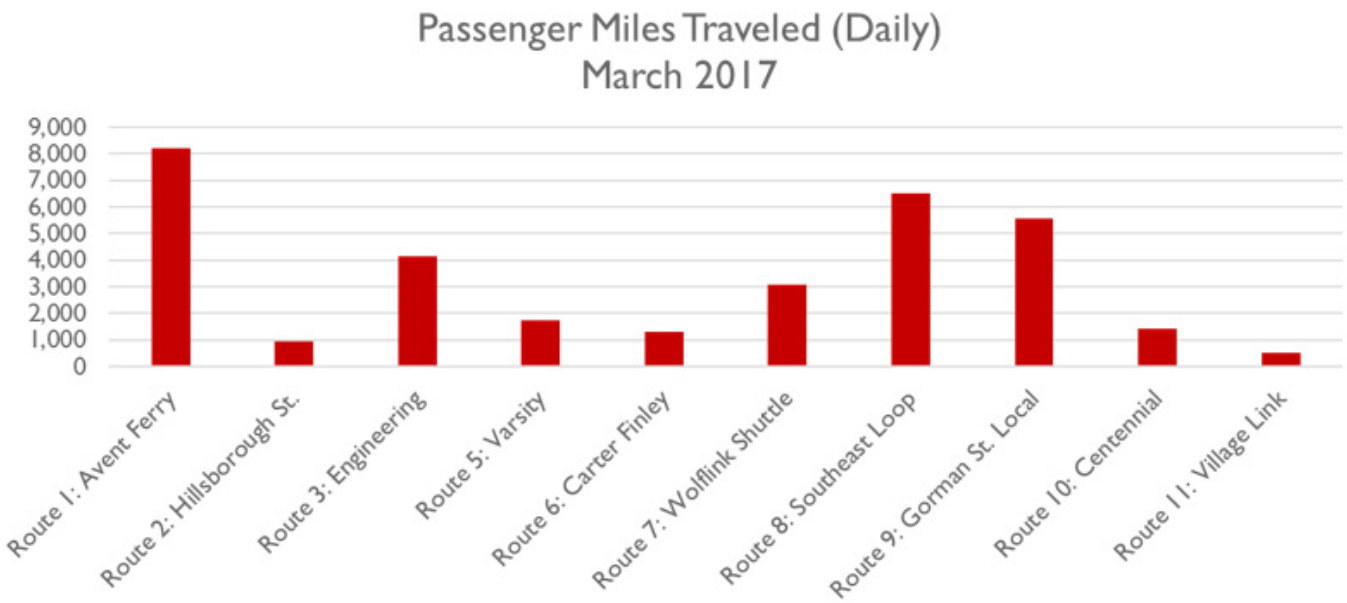


Figure 5.5: Daily Passenger Miles Traveled Summary

Passengers Per Service Hour

To account for the differing route frequency and schedules, the passengers per service hour measure is used to indicate the routes that are more consistently productive. Route 3 has the third highest ridership, and it also carries the highest average number of passengers per service hour (63.3 passengers per service hour) as a result of its express route characteristics. In contrast, Route 9 has the fourth highest ridership but carries the fourth lowest average number of passengers per service hour (40.7 passengers per service hour). Route 3 and Route 8 had the highest number of passengers per service hour (63.3 and 60.9 passengers per service hour, respectively) and Route 11 and Route 6 had the lowest (23.5 and 17.4 passengers, respectively). When compared to the daytime routes, the nighttime routes had an average to low number of passengers per service hour. The Night Wolf route had the highest number of passengers per service hour of the nighttime routes (32 passengers per service hour), and was higher than three of the daytime routes (Routes 2, 6, and 11). The Wolfprowl route had the lowest overall number of passengers per service hour (8.2 passengers per service hour).

Table 5.4 illustrates the passengers per service hour based on the existing Wolfline routes.

Passengers Per Service Hour					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
	53.9	28.7	63.3	43.6	17.4
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	57.6	60.9	40.7	47.4	23.5

Passengers Per Service Hour				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
	32.0	8.2	12.9	12.9

Table 5.4: Passenger Per Service Hour Summary

Passengers Per Service Mile

Passengers per service mile relates ridership relative to the length of the route. A higher ratio of passengers to service mile indicates a more productive route. In March 2017, Route 7 and Route 3 had the highest number of passengers per service mile (8.1 and 6.9 passengers per service mile, respectively), while Route 11 and Route 6 had the lowest (2.2 and 1.6 passengers per service mile, respectively). The main reason for the low number of passengers per service mile for Route 6 may be due to the longer distance trips to the Biomedical Campus, which are less common than the more popular, short trips to and from Main and Centennial Campuses. For the nighttime routes, the Night Wolf route had the highest number of passengers per service mile (3 passengers per service mile) and Wolfprowl had the lowest (0.5 passengers per service mile).

Table 5.5 and Figure 5.6 illustrate the passengers per service mile based on the existing Wolfline routes.

Passengers Per Service Mile					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
	5.5	2.2	6.9	4.9	1.6
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	8.1	6.4	4.9	4.6	2.2

Passengers Per Service Mile				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
	3.0	0.5	1.3	1.6

Table 5.5: Passengers Per Service Mile Summary

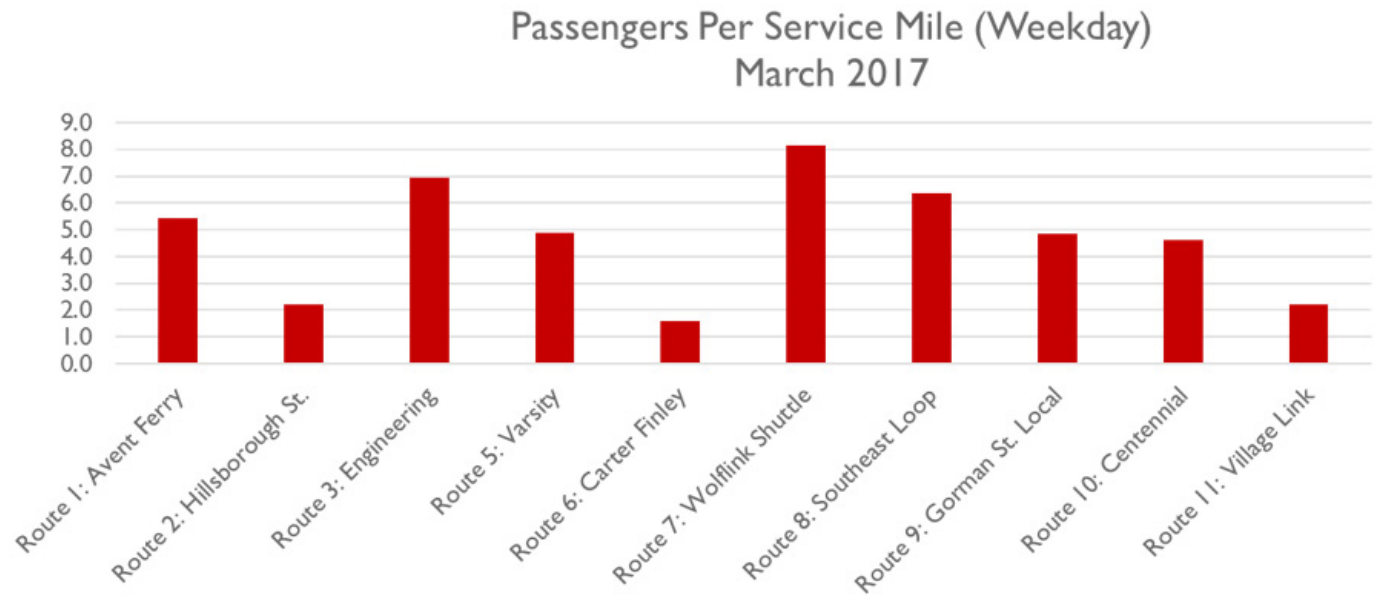


Figure 5.6: Passengers Per Service Mile Summary

On-Time Performance

On-time performance (OTP) is a measure of the route's service reliability. While no routes operate at 100% OTP, the Werewolf Shuttle operates at the highest reliability (94.9%) and Route 2 operates at the lowest reliability (65.6%). In addition to the operating procedures, congestion on roadways within the Wolfline network (i.e., Hillsborough Street) also impacts the OTP for Wolflink buses. Route 1 operates at the second highest reliability at 90.5% and also has the highest average daily ridership.

Due to routing changes for the Fall 2017 semester, Route 3 is currently achieving a 95% OTP and Route 8 is achieving a 75% OTP.

Table 5.6 and Figure 5.7 illustrate on-time performance based on the existing Wolfline Routes. Table 5.7 provides a summary of the route performance metrics for the Wolfline system.

On-Time Performance					
Daytime Routes	1	2	3	5	6
	Avent Ferry Road	Hillsborough Street	Engineering	Varsity	Carter Finley
	90.5%	65.6%	75.7%	85.0%*	83.7%
	7	8	9	10	11
	Wolflink Shuttle	Southeast Loop	Gorman Street Local	Centennial	Village Link
	83.9%	71.2%	77.5%	69.2%	81.8%

On-Time Performance				
Night Service Routes	12	13	14	15
	Night Wolf	Wolfprowl	Centennial Night	Werewolf
	88.2%	No Data Available	79.7%	94.9%

Table 5.6: On-Time Performance Summary **85% is the expected estimate of OTP for Route 5 provided by University staff*

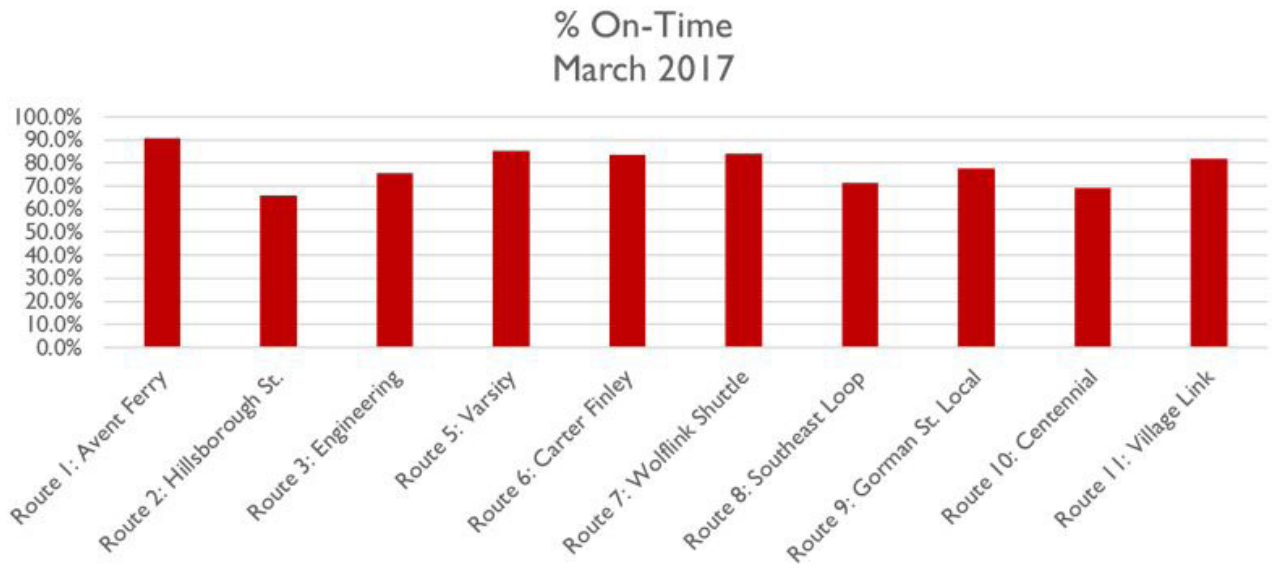


Figure 5.7: On-Time Performance Summary

March 2017 Wolfline Service Summary		Ridership		Capacity			Route Productivity								
		Average Weekday		Passenger Load by Trip (weekday)			Passenger Miles Traveled Daily		Passengers Per Service Hour		Passengers Per Service Mile		Service Reliability		
		Mar-17	Ridership Rank	150% Crush Load	125% Some standees	100% All seats occupied	Weekday	Weekday Rank	Weekday passengers per hour	Weekday Rank	Weekday passengers per mile	Weekday Rank	On-Time Departures	Detected Departures	% On-Time
Daytime Routes	Route 1: Avent Ferry	3,725	1	12%	15%	22%	8,196	1	53.9	4	5.5	4	5,365	5,926	90.5%
	Route 2: Hillsborough St.	750	8	0%	0%	0%	949	9	28.7	8	2.2	8	1,026	1,563	65.6%
	Route 3: Engineering	3,196	3	1%	3%	13%	4,164	4	63.3	1	6.9	2	3,242	4,283	75.7%
	Route 5: Varsity	1,263	6	0%	1%	4%	1,741	6	43.6	6	4.9	5	1,887	3,394	55.6%*
	Route 6: Carter Finley	449	9	0%	0%	0%	1,310	8	17.4	10	1.6	10	1,444	1,725	83.7%
	Route 7: Wolflink Shuttle	2,106	5	9%	13%	19%	3,093	5	57.6	3	8.1	1	3,908	4,659	83.9%
	Route 8: Southeast Loop	3,245	2	7%	12%	19%	6,524	2	60.9	2	6.4	3	3,768	5,290	71.2%
	Route 9: Gorman St. Local	2,645	4	5%	8%	14%	5,569	3	40.7	7	4.9	6	5,000	6,452	77.5%
	Route 10: Centennial	991	7	4%	8%	14%	1,441	7	47.4	5	4.6	7	674	974	69.2%
	Route 11: Village Link	254	10	0%	0%	0%	519	10	23.5	9	2.2	9	288	352	81.8%
Night Service Routes	Night Wolf	147	1	0%	0%	2%	267	2	32.0	1	3.0	1	613	695	88.2%
	Wolfprowl	43	4	0%	0%	0%	122	4	8.2	4	0.5	4	NO TIMETABLE		
	Centennial Night	133	2	1%	1%	1%	334	1	12.9	3	1.3	3	956	1,199	79.7%
	Werewolf	60	3	0%	0%	0%	123	3	12.9	2	1.6	2	75	79	94.9%

**NC State believes there is an error in TransLoc data for Route 5. The estimated OTP is 85%.*

Table 5.7. Route Performance Summary, provided by NC State

Infrastructure

There are several planned projects associated with the NC State campus that will improve the circulation of buses within and between the campuses. Roadway improvements are planned for the NC State campus, as well as improvements to parking, general circulation, transit connections, and technology.

Roadway and Parking Improvements

Initiative Way, located along the southeast side of Centennial Campus, currently provides access from Main Campus Drive to a parking lot behind the Engineering III building. An extension currently under construction will connect Initiative Way to Oval Drive and parking storage lots to the north, and connect to Blair Drive east of Centennial Campus. This project will provide more direct access to the planned Spring Hill Park and Ride facility on Barbour Road. Another roadway extension planned for the improvement of campus circulation is the extension of Pullen Road and Oval Drive. This extension will provide a direct connection between Main and Centennial Campuses that bypasses the intersection of Western Boulevard and Avent Ferry Road. Routes that incorporate this extension will likely see a reduction in travel time by decreasing route miles and avoiding some congestion points.

Founders Drive is currently used as an eastbound frontage road for Wolfline buses operating parallel to Hillsborough Street before providing continuing service around the NC State campuses. Due to the signal timing at Hillsborough Street and mixed traffic on the east end of Founders Drive, congestion occurs in this area. To improve service, this road should continue to operate as a frontage road with restricted access from off-campus transportation, and improved signal timing at Hillsborough Street intersections.

Circulation Improvements

To improve east-west circulation on campus, various improvements are planned. Cates Avenue and Dunn Avenue are currently parallel, one-way streets bounded by Jeter Drive on the west and Pullen Road on the east. Due to the one-way loop routes and roadways, congestion is caused by buses queuing traffic at stops and intersections. Reconstructing Cates Avenue to be two-way would alleviate congestion because the traffic would ideally split between the two roads, providing more flexibility for both transit routing and access to the busy Coliseum Parking Deck. Additionally, NC State is considering creating a transit hub in the Coliseum Deck carriageway on Cates Avenue. This two-way conversion will provide more options for transit routing through this potential hub.

Transit Connection Improvements

The existing transit center on Morrill Drive ineffectively provides bi-directional access to Wolfline routes due to the minimal property widths resulting in improper turning radii for buses. In addition, the northbound routes on Morrill Drive are not provided a stop with a shelter or additional amenities. The construction of a new transit hub between Cates Avenue and Dunn Avenue that could potentially be integrated into the Coliseum Parking Deck is proposed to provide a better connection for Wolfline routes and improve circulation because it will offer complete bi-directional access. The proposed transit hub has the potential to offer amenities as well as incorporate parking. Currently, the old portion of the deck is approaching the end of its useful life. Therefore, the deck is under consideration as the site for the new transit hub with additional parking planned for the facility to help preserve a portion of the existing parking capacity. Further analysis is required to confirm this rehabilitation. In May 2018 construction will begin on the Carmichael Gym. This construction will directly impact the transit hub on Morrill Drive. It is recommended to relocate the transit hub to the Coliseum Deck carriageway or farther south along Morrill Drive.

Figure 5.8: Existing Transit Center on Morrill Drive

Other transit connections are planned just outside the NC State campus that would provide connections from campus to the City of Raleigh and beyond. The North Carolina Department of Transportation has plans for a tunnel under Western Boulevard for bicycle and pedestrian only access. It is recommended to work

with NCDOT and the City of Raleigh to consider incorporating small autonomous transit vehicle access into the design of this tunnel. Wake County Transit has plans for frequent network routes to be deployed on Pullen Road and Hillsborough Street. This would also improve circulation of transit between the campuses on NC State. The Wake County Transit Plan highlights plans for a Bus Rapid Transit (BRT) service that would operate on Western Boulevard located between Main and Centennial Campuses, and may include dedicated lanes, modified signal timing, and station-like stops for quick boarding. Figure 5.9 shows the BRT corridor that is planned by Wake County Transit. In addition to signal timing along the proposed BRT route, signal timing with designated phases is recommended to improve transit circulation on Hillsborough Street (e.g., eastbound right-turn into Main Campus). Transit signal priority (TSP) is a future recommendation that would allow for the most efficient operation of the signals along Hillsborough Street and Western Boulevard. Upon further analysis of traffic operations, the recommended intersections for TSP include: Hillsborough Street at Horne Street, Western Boulevard at Avent Ferry Road, Western Boulevard at Dan Allen Drive, Avent Ferry Road at Centennial Parkway, and Western Boulevard at Varsity Drive.

The Wake County Transit Plan includes short-term service changes, scheduled for August 2017, to GoTriangle Routes, which will directly influence transit connections to the NC State campus. Route 100 connects downtown Raleigh, NC State, Raleigh-Durham International Airport, and the GoTriangle Regional Transit Center, and travels along Hillsborough Street with stops near Enterprise Street, Horne Street, and Dan Allen Drive. This route will operate at an improved frequency of 30 minutes from 6:10 AM to 7:25 PM Monday – Friday and from 7:30 AM to 7:15 PM on Saturday. Route 300 connects downtown Raleigh, NC State, and downtown Cary, and travels along Western Boulevard with a stop between Dan Allen Drive and Avent Ferry Road. This route will operate every 30 minutes from 6:00 AM to 7:00 PM Monday – Friday and from 7:00 AM to 7:00 PM on Saturday.

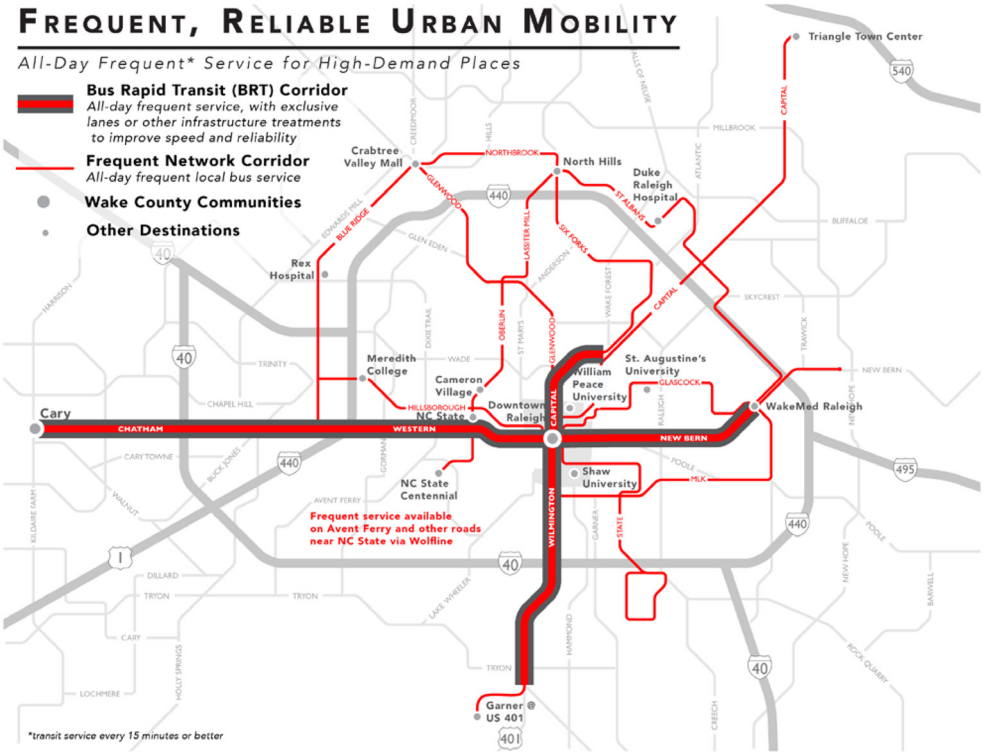


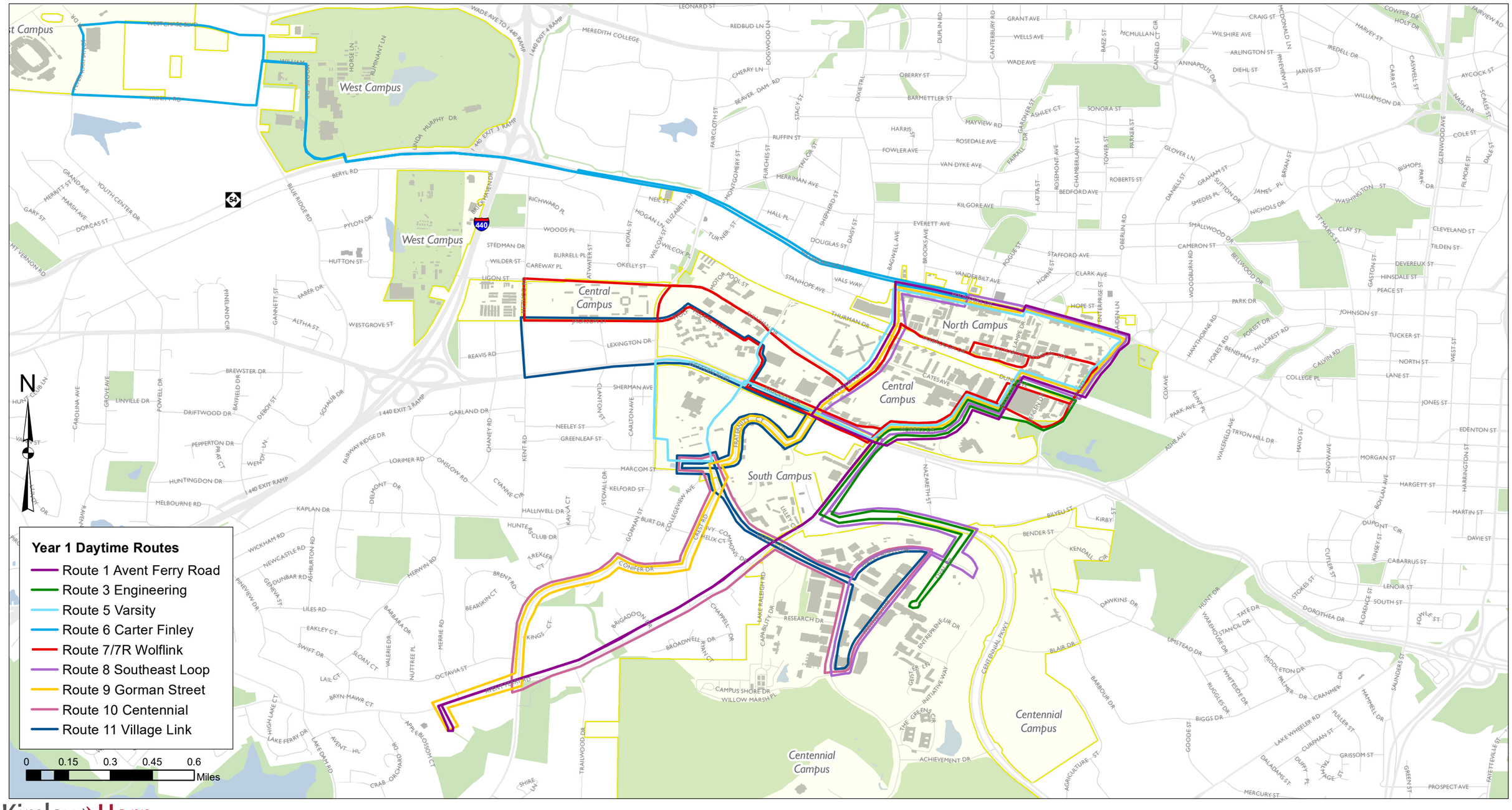
Figure 5.9. Frequent, Reliable Urban Mobility Network, Wake County Transit Plan

RECOMMENDATIONS

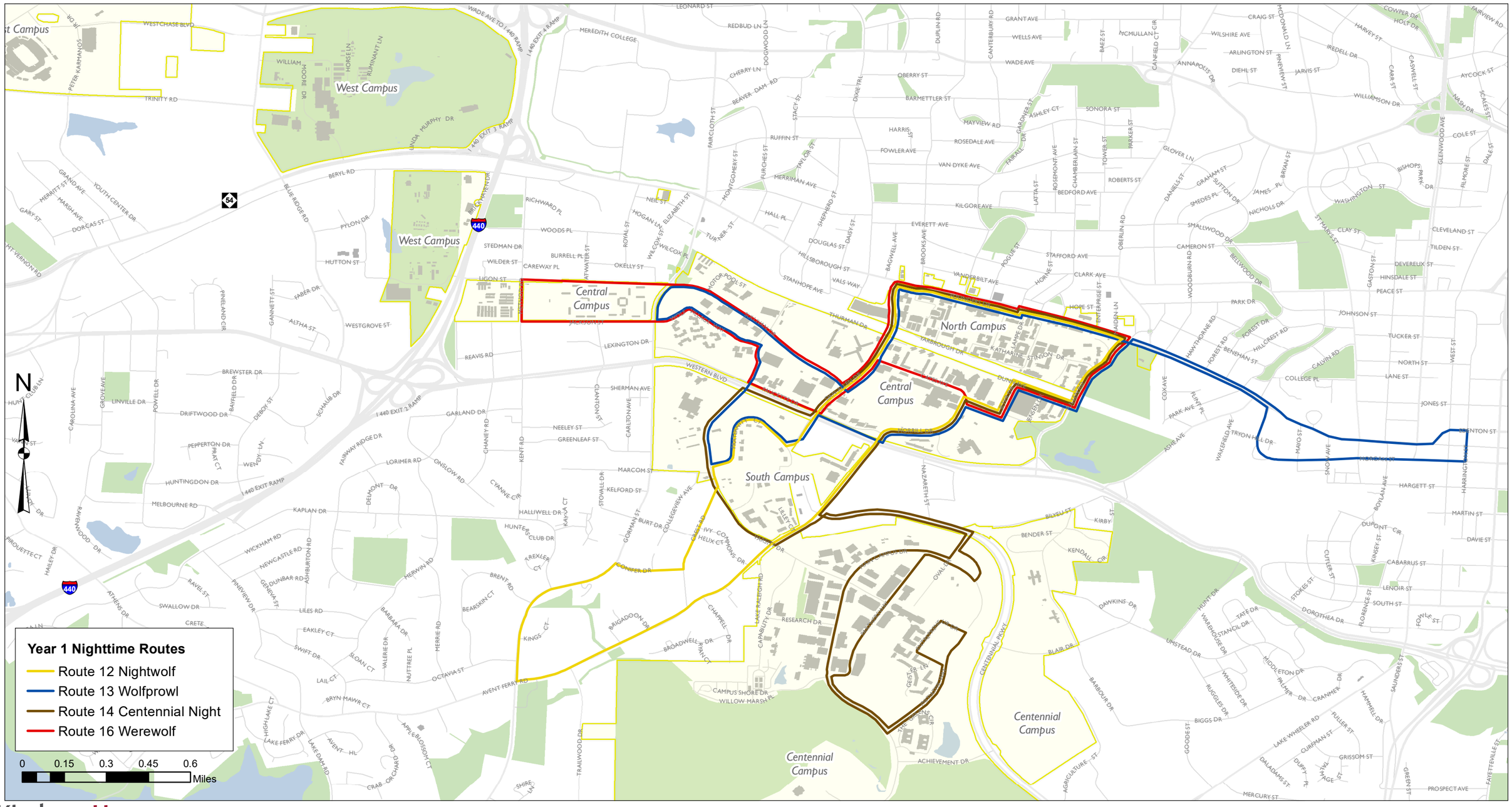
Combined Route Maps (Year 1 and Years 2-5)

The following maps show the proposed combined route maps for the daytime and night time routes for Year 1 and Years 2-5.

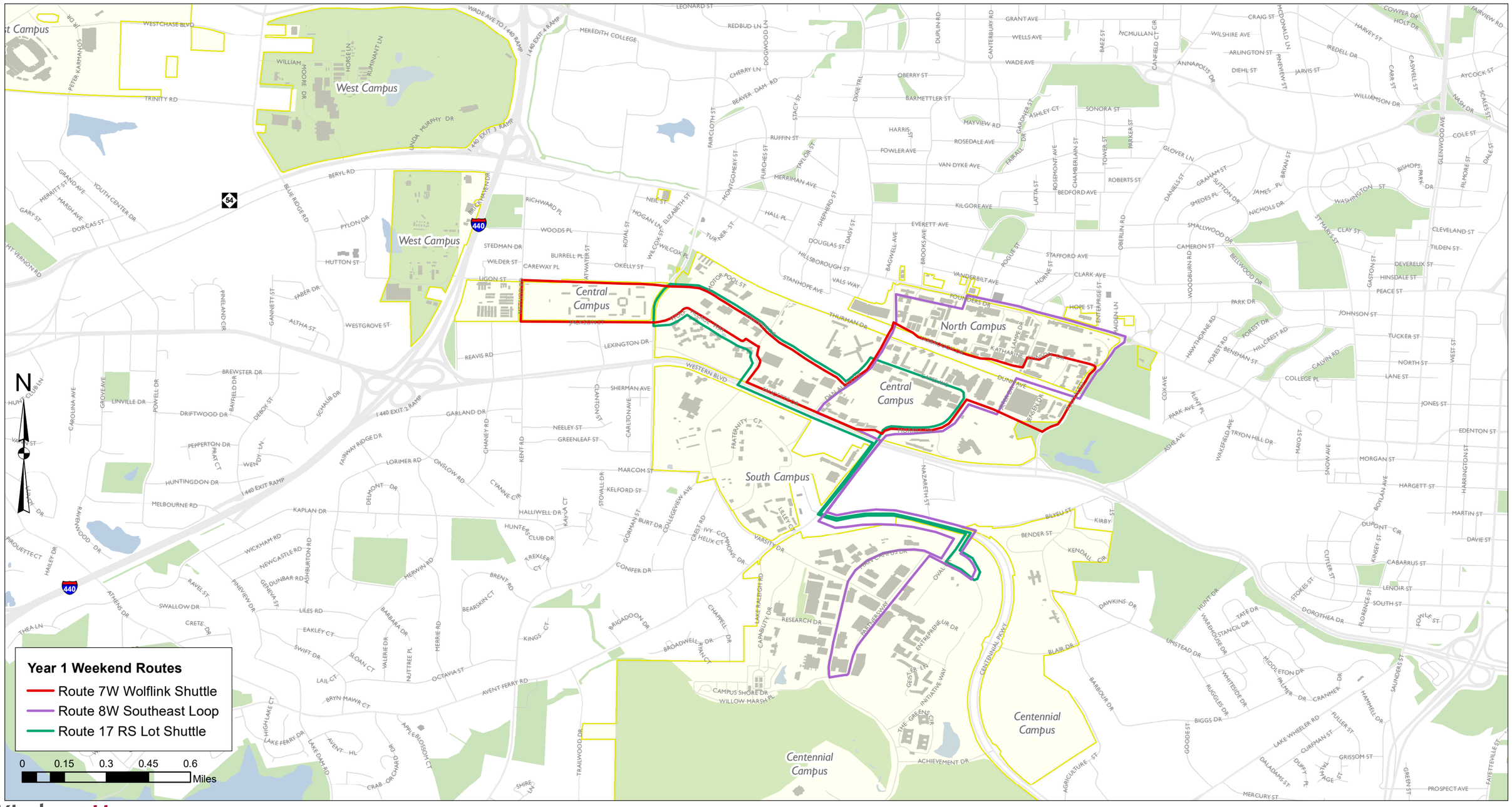
YEAR 1 DAYTIME ROUTE MAP



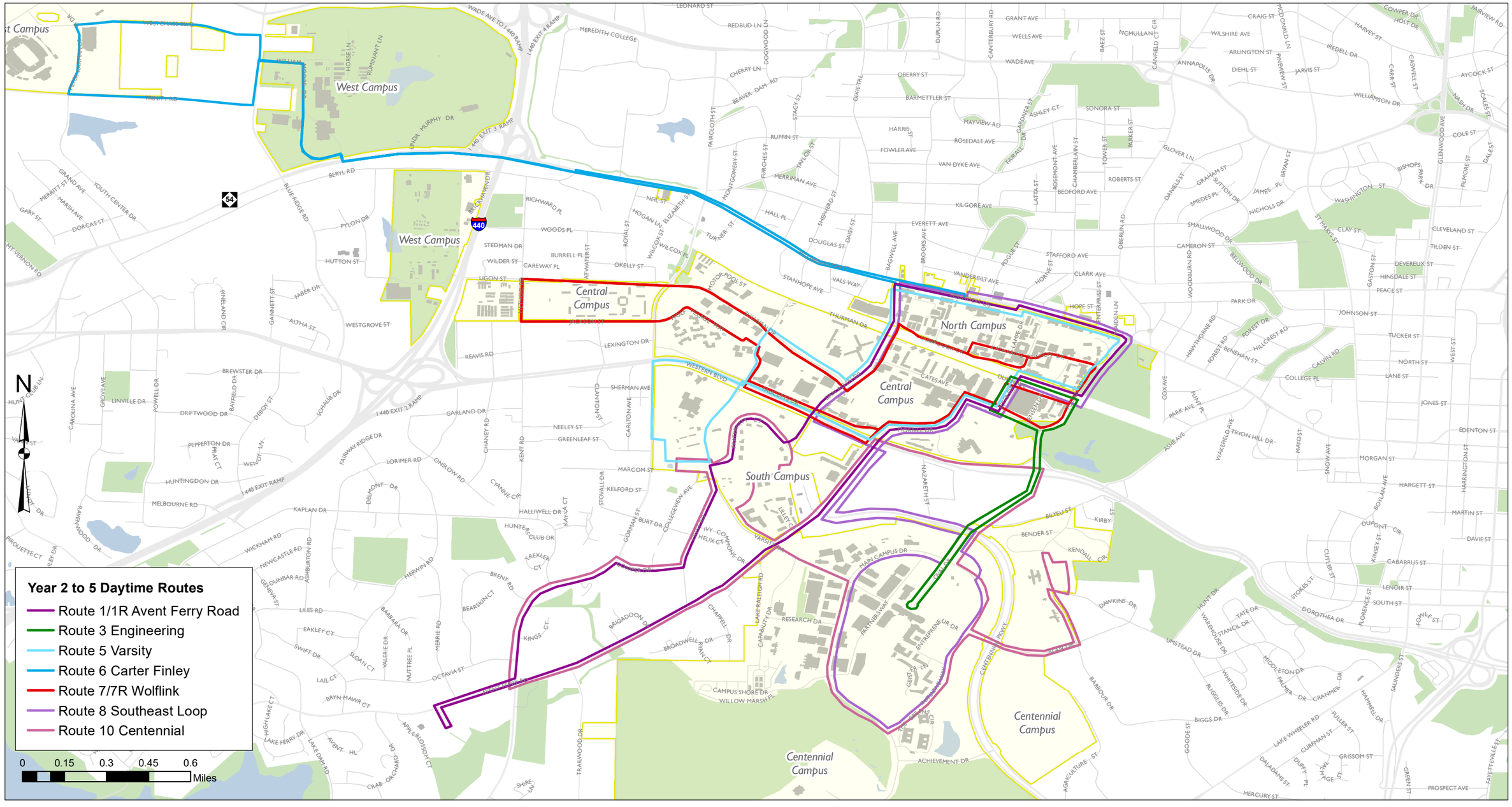
YEAR 1 NIGHTTIME ROUTE MAP



YEAR 1 WEEKEND ROUTE MAP



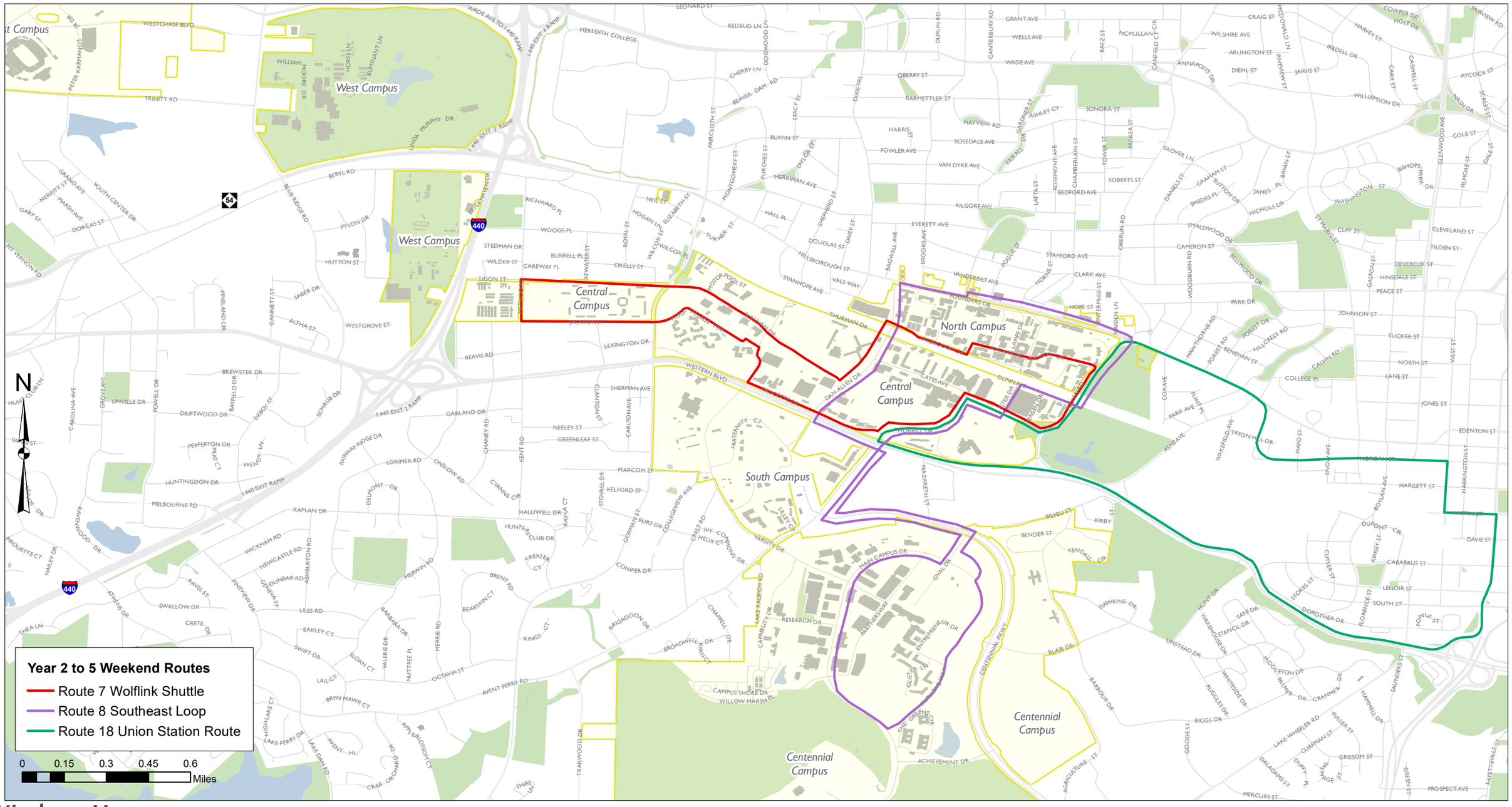
YEARS 2 TO 5 DAYTIME ROUTE MAP



YEARS 2 TO 5 NIGHTTIME ROUTE MAP

Kimley»Horn

YEARS 2 TO 5 WEEKEND ROUTE MAP



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Overall Recommendations

Specific recommendations have been made for each route that contribute to the overarching recommendation that the Wolfline service be made more efficient and consolidated without excluding any trip purposes. For example, where facilities are removed from one route (i.e., reduction in number of buses per route), additional service can be offered to meet the demand of another route. The modified route alignments will continue to accommodate existing trips but expand to serve more students and employees, providing more reliable access to all campuses and desirable destinations outside of NC State. The figure below is a recommendation for the overall service duration and the following route profiles highlight route-by-route changes for Year 1 and Years 2-5.

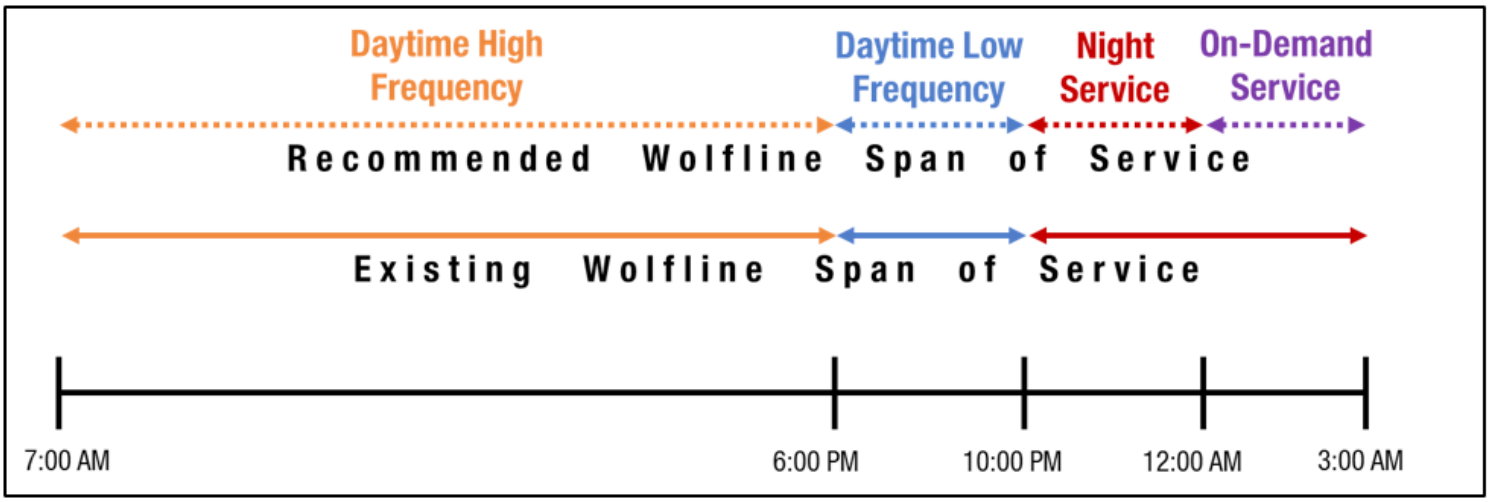


Figure 5.10: Span of Service — Existing and Recommended

NC State Route Profiles

October 2017

The following pages include route profiles for the current system at NC State. The profiles include a brief discussion of existing conditions (data from March 2017) and proposed route recommendations. The recommendations include operating changes, changes in travel time, and baseline weekly service hours versus proposed weekly service hours. The recommendations also indicate a implementation timeframe: Year 1, Year 2-5. A summary of improvements based on this timeframe is included in the table below.

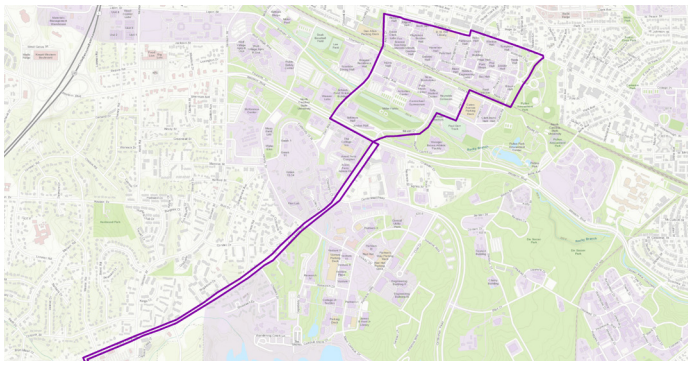
Timeframe	Weekly Service Hours
Year 1	-94.1
Year 2 through Year 5	30.3
Total	-63.8

ROUTE 1 AVENT FERRY ROAD

Current Conditions

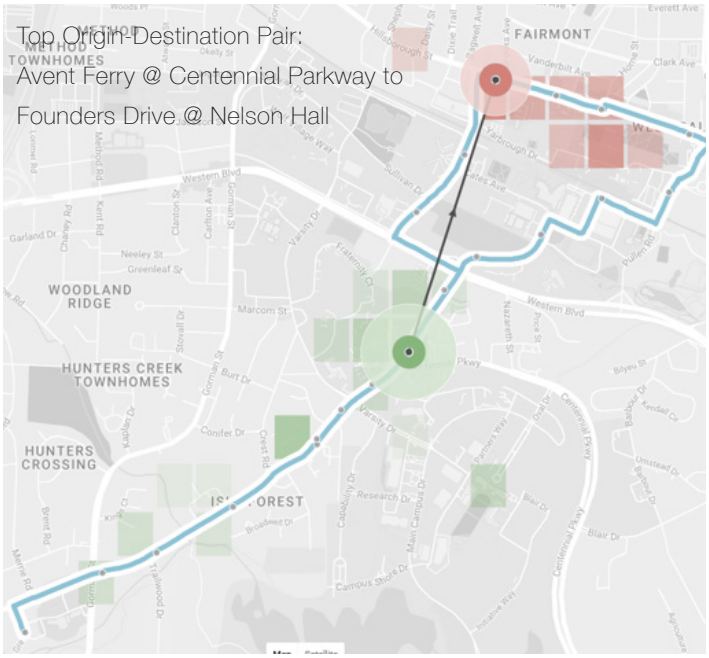
The Avent Ferry Road Route (Route 1) serves Main Campus and uses Avent Ferry as a north-south route to serve many of the residential areas south of Main Campus. Greek Way is the southernmost point of the route.

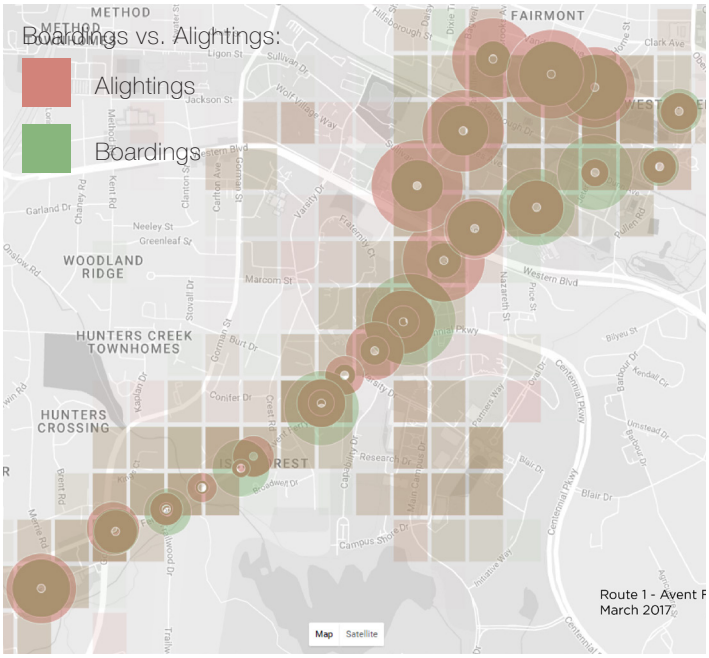
The Avent Ferry Road Route had a average weekday ridership of 3,725 passengers in March 2017, with an on-time performance just over 90%. The route served 5.5 passengers per service mile and 53.9 passengers per service hour on an average weekday. Route 1 has a peak headway of 7 minutes (8:00 AM to 4:30 PM) and an average daily headway of 9 minutes.



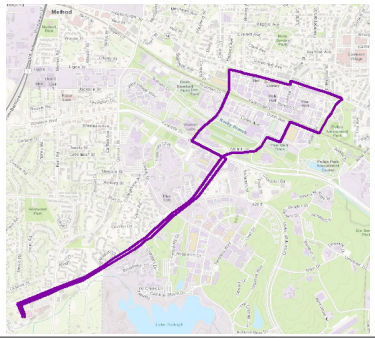
Performance Statistics	
Average Weekday Ridership	3,725
On-Time Performance	90.5%
Passengers/Service Mile (Weekday)	5.5
Passengers/Service Hour (Weekday)	53.9
Ridership Rank (Daytime Routes)	1
Peak Headway; Average Headway (min)	7; 9

Travel Patterns (March 2017)

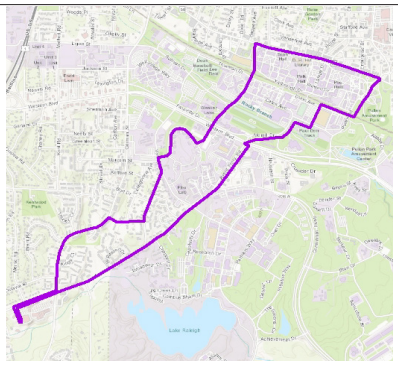




Proposed Route Recommendations

Route 1	1A
Project Description	
No modifications to existing route alignment. Modify frequency throughout the day.	
Route Alignment	 There are no route modifications recommended for Route 1 during the short-term implementation process. Route 1 will continue to serve Main Campus and use Avent Ferry Road as a north-south route to serve many of the residential areas south of Main Campus. Greek Way is the southernmost point of the route. Operating changes will include an average decrease in headway throughout the day.
Operating Changes	Increase headway from 7 to 8 minutes between 7:00 AM and 4:30 PM, 10 minute headway from 4:30 to 6:30 PM, and reduce headway from 40 to 20 minutes in the evenings. Reduce the cumulative number of buses from 6 to 5 buses.
Change in Travel Time	No significant change in travel time.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
365.5	323.5	-42.0	Savings	Year 1

Route 1	1B
Project Description	
Modify existing route with consolidated Routes 1 and 9 to provide bi-directional service.	
Route Alignment	 Route 1 is recommended to be consolidated with Route 9 and provide a high frequency, bi-directional loop service from Main Campus to the areas south of Main Campus along Gorman Street and Avent Ferry Road. The route will connect destinations along Hillsborough Street, Greek Village, and residential developments. Proposed operating changes include an increase in frequency (i.e., reduced headways) to serve strong ridership needs. See Route 9 recommendations. The connection to Greek Way was analyzed for potential removal to improve travel time along the alignment, however, it was not recommended due to the high boardings and alightings at this stop. The Greek Way stop represents the seventh highest ridership out of 25 stops along Route 1.
Operating Changes	Modify route to serve stops in reverse (i.e., run route counterclockwise). Serve eight additional stops currently being served by Route 9. Increase route frequency.
Change in Travel Time	Increase in overall travel time due to deviation to serve the route in reverse and additional dwell time associated with eight additional stops served.

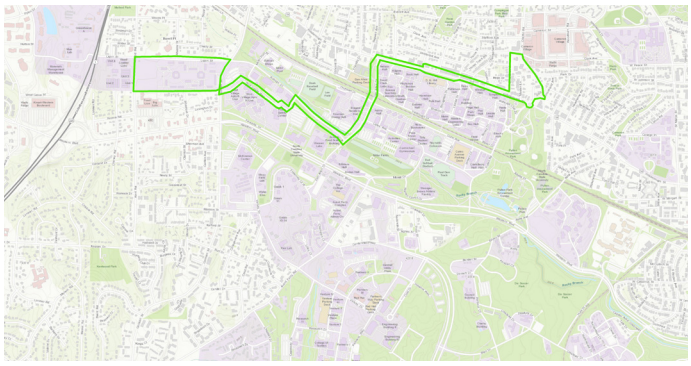
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
0.0	294.0	294.0	Cost	Year 2-5

ROUTE 2 HILLSBOROUGH STREET SHUTTLE

Current Conditions

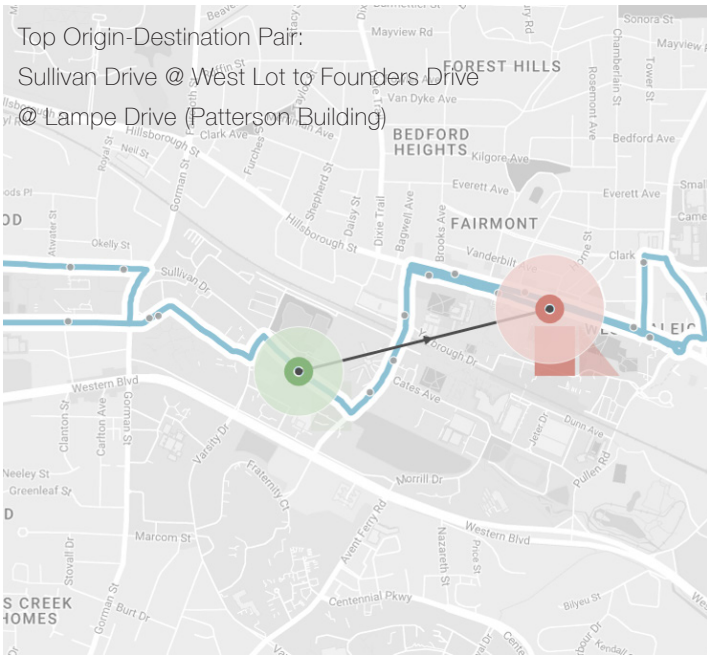
The Hillsborough Street Shuttle (Route 2) currently serves Cameron Village, Hillsborough Street, and west Main Campus (Wolf Village, King Village).

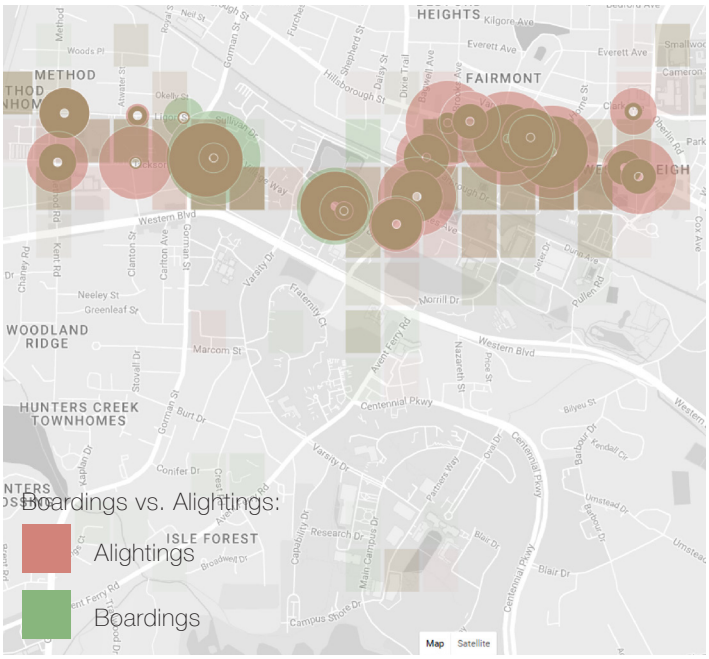
The Hillsborough Street Shuttle had a average weekday ridership of 750 passengers in March 2017 with an on-time performance just over 65%. The route served 2.2 passengers per service mile and 28.7 passengers per service hour on an average weekday. Route 2 has a peak headway of 18 minutes (7:20 AM to 10:25 AM) and an average daily headway of 22 minutes.



Performance Statistics	
Average Weekday Ridership	750
On-Time Performance	65.6%
Passengers/Service Mile (Weekday)	2.2
Passengers/Service Hour (Weekday)	28.7
Ridership Rank (Daytime Routes)	8
Peak Headway; Average Headway (min)	18; 22

Travel Patterns (March 2017)





Proposed Route Recommendations

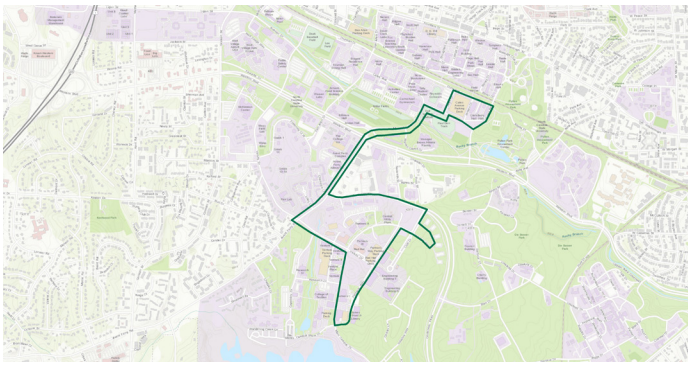
Route 2				2A
Project Description				
Eliminate route. Existing service replaced with proposed Route 7Reverse (Project 7B).				
Route Alignment	Route 2 will be eliminated during the short-term implementation process. Most destinations that Route 2 served will be included in the reverse route (7R), which will operate in the reverse direction of the existing Route 7 alignment. Operating changes will result in an increase in overall travel time when compared to the existing Route 2 alignment. See Route 7 recommendations.			
Operating Changes	Eliminate Route.			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
136.5	0.0	-136.5	Savings	Year 1

ROUTE 3 ENGINEERING

Current Conditions

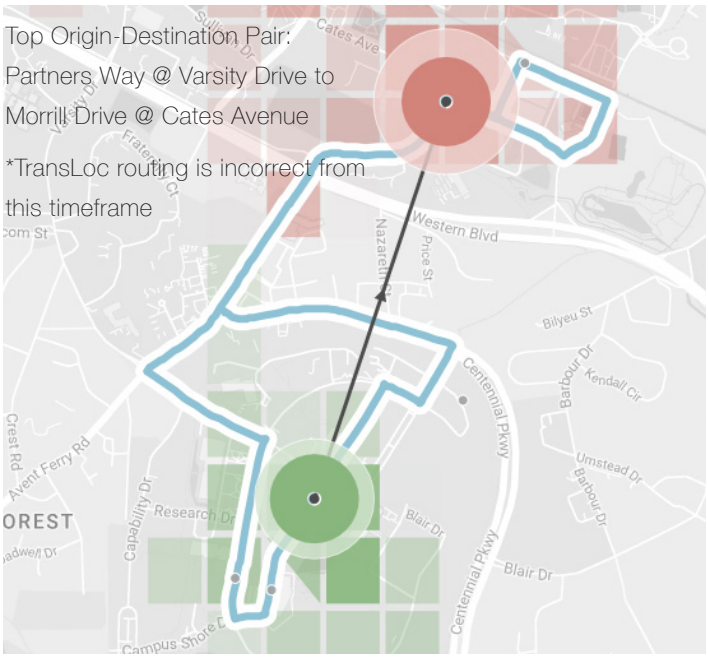
The Engineering Route (Route 3) serves the most direct route from Main Campus to Centennial Campus. The route serves major stops in Main Campus including Carmichael Gym and the Coliseum Parking Deck. Routing onto Avent Ferry Road, the route circulates Centennial Campus using Varsity Drive, Main Campus Drive, Partners Way, and Centennial Parkway.

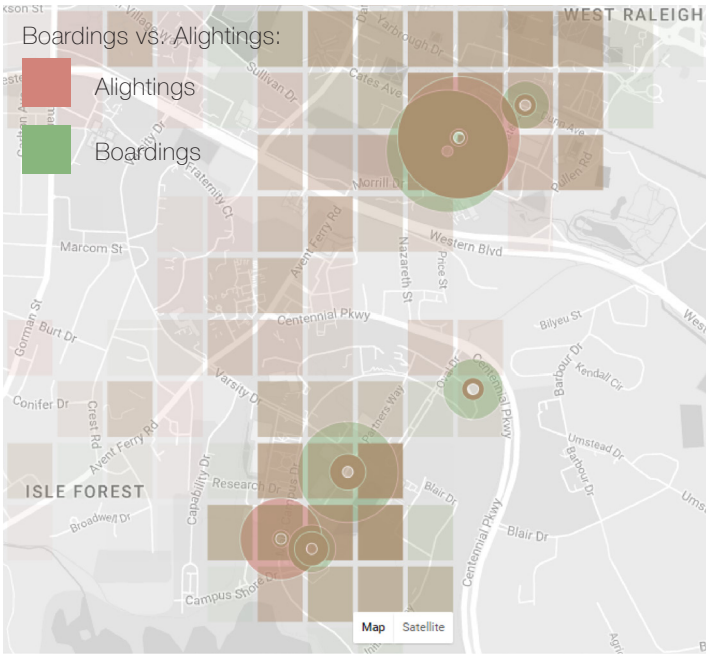
The Engineering Route had a average weekday ridership of 3,200 passengers in March 2017 with an on-time performance just over 75%. The route served 6.9 passengers per service mile and 63.3 passengers per service hour on an average weekday. Route 3 has a peak headway of 7 minutes (8:30 AM to 4:30 PM) and an average daily headway of 9 minutes.



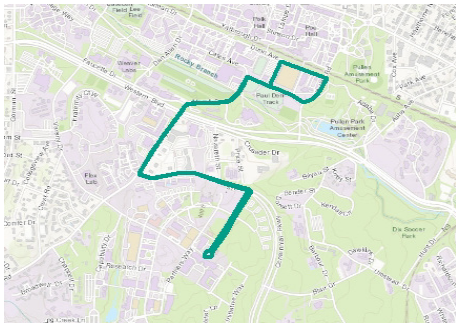
Performance Statistics	
Average Weekday Ridership	3,196
On-Time Performance	75.7%
Passengers/Service Mile (Weekday)	6.9
Passengers/Service Hour (Weekday)	63.3
Ridership Rank (Daytime Routes)	3
Peak Headway; Average Headway (min)	7; 9

Travel Patterns (March 2017)

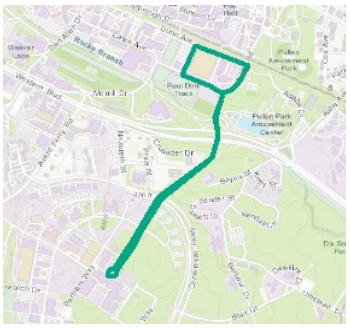




Proposed Route Recommendations

Route 3	3A
Project Description	
Convert existing route to an express route (i.e., shorten total distance and consolidate stops).	
Route Alignment	 Route 3 is recommended to be modified to become more of an express route during the short-term implementation process. The total route distance will be shortened and stops will be consolidated. Route 3 will continue to provide the most direct route between Main Campus and Centennial Campus with stops at Carmichael Gym, Coliseum Parking Deck, Avent Ferry Road, and Oval Drive. Operating changes will include a decrease in headway and decrease in overall travel time.
Operating Changes	Realign route; consolidate two stops; increase frequency. Change headways from 10 to 6 minute headway from 7:00 AM to 2:30 PM, 8 minutes from 2:30 PM to 6:00 PM, 12 minutes after 6:00 PM.
Change in Travel Time	Decrease in overall travel time due to route realignment and stop consolidation, 4 minute saving in cycle time.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
252.0	250.0	-2.0	Savings	Year 1

Route 3	3B
Project Description	
Modify route to use the Pullen Rd extension to Oval Dr.	
Route Alignment	 Route 3 is recommended to be modified using the Pullen Road extension. This modification will further facilitate Route 3 as an express route between Main Campus and Centennial Campus, and decrease the overall travel time by avoiding the congestion at the Western Boulevard at Avent Ferry Road intersection.
Operating Changes	Realign route to use future extension of Pullen Rd.
Change in Travel Time	Decrease in overall travel time, 7 minute saving in cycle time.

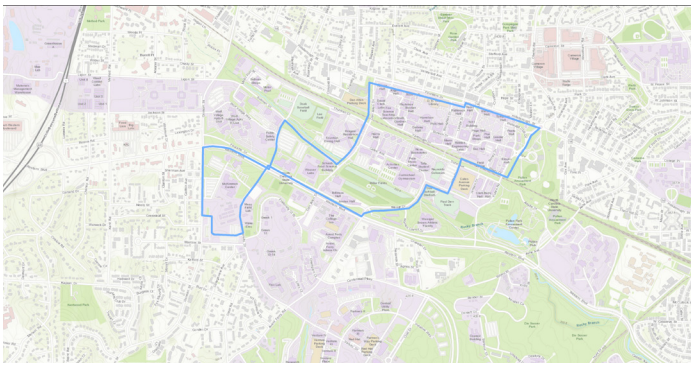
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
250.0	177.0	-73.0	Savings	Year 2-5

ROUTE 5 VARSITY ROUTE

Current Conditions

The Varsity Route (Route 5) currently serves Main Campus and the Wolf Village. Route 5 provides a connection from the McKimmon Conference and Training Center, the Special Events Parking lot, and the Gorman Street and Varsity Park & Ride lots to Main Campus as well as the restaurants and shops along Hillsborough Avenue.

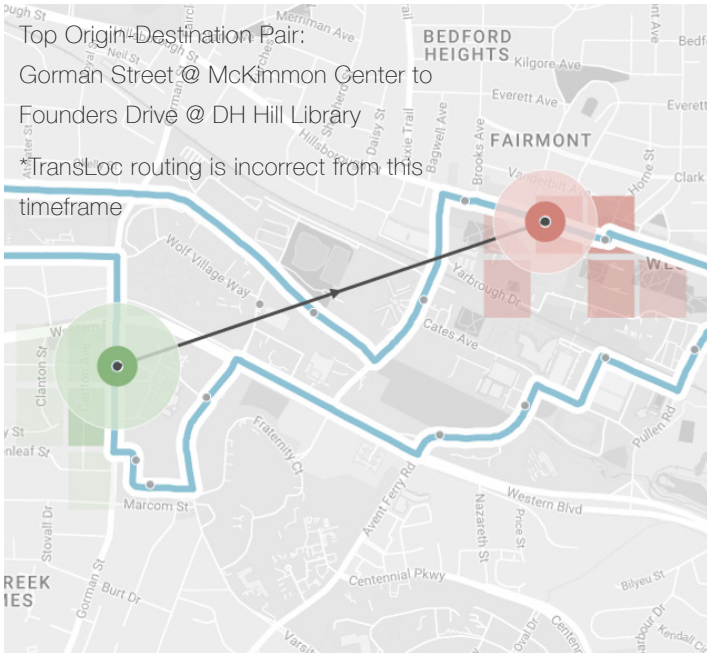
The Varsity Route had a average weekday ridership of 1,265 passengers in March 2017 with an on-time performance of 85%. The route served 4.9 passengers per service mile and 43.6 passengers per service hour on an average weekday. Route 5 has a peak headway of 10 minutes (7:15 AM to 10:05 AM) and an average daily headway of 15 minutes.

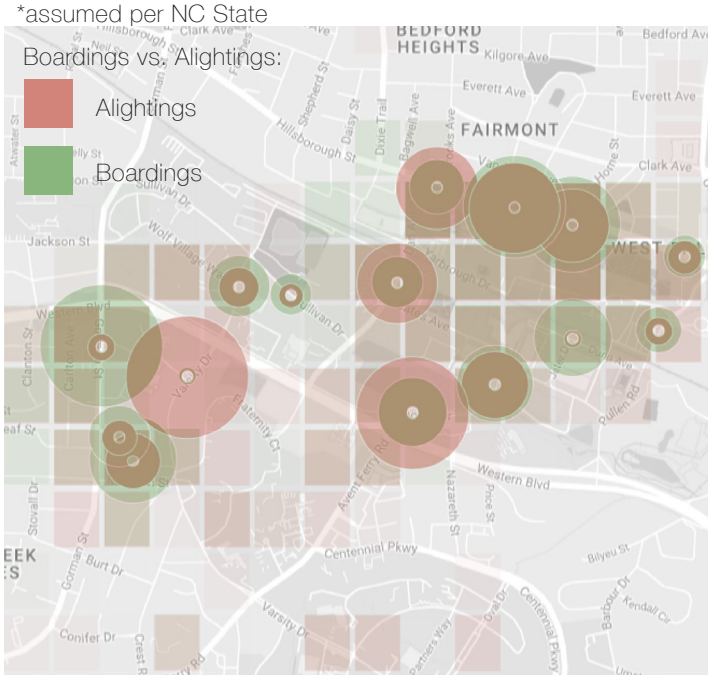


Performance Statistics	
Average Weekday Ridership	1,263
On-Time Performance	85%*
Passengers/Service Mile (Weekday)	4.9
Passengers/Service Hour (Weekday)	43.6
Ridership Rank (Daytime Routes)	6
Peak Headway; Average Headway (min)	10; 15

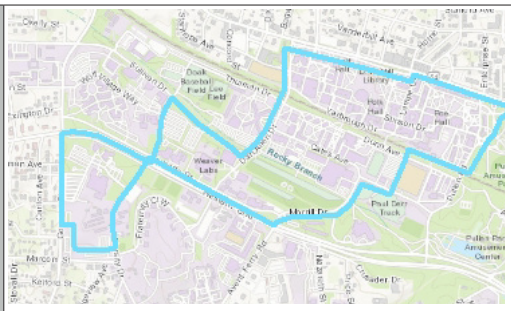
*assumed per NC State

Travel Patterns (March 2017)





Proposed Route Recommendations

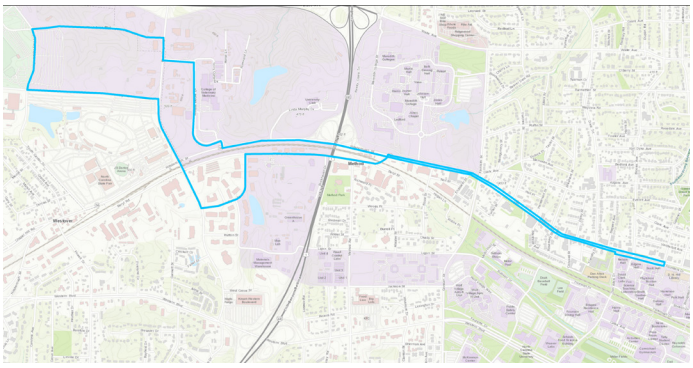
Route 5				5A
Project Description				
No route alignment modification, consolidate two stops (Varsity Dr Park and Ride).				
Route Alignment	 There are no alignment modifications recommended for Route 5 during the short-term implementation process. Route 5 stops will be consolidated to only serve the second stop at the Varsity Lots. Route 5 will continue to serve Main Campus and Wolf Village and provide connection from the McKimmon Conference and Training Center on Gorman Street to destinations along Hillsborough Street. Operating changes will include a marginal decrease in travel time due to the consolidated stops. No further changes are planned for years 2 to 5.			
Operating Changes	Consolidate two stops at Varsity Park and Ride. Serve only 2nd shelter.			
Change in Travel Time	Marginal decrease in overall travel time due to stop consolidation (~20 sec savings).			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
150.0	147.5	-2.5	Savings	Year 1

ROUTE 6 CARTER-FINLEY

Current Conditions

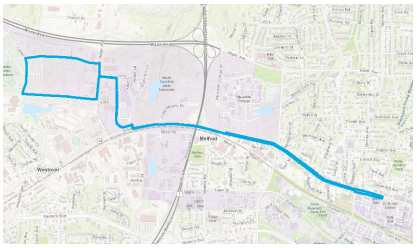
The Carter-Finley Route (Route 6) serves Main Campus and the Carter Finley Park & Ride. Route 6 provides a connection from the Carter Finley Stadium and NC State Biomedical Campus to Main Campus as well as the restaurants and shops along Hillsborough Avenue.

The Carter-Finley Route had a average weekday ridership of 450 passengers in March 2017 with an on-time performance of 83%. The route served 1.6 passengers per service mile and 17.4 passengers per service hour on an average weekday. Route 6 has a peak headway of 20 minutes (7:10 AM to 6:30 PM) and an average daily headway of 23 minutes.



Performance Statistics	
Average Weekday Ridership	449
On-Time Performance	83.7%
Passengers/Service Mile (Weekday)	1.6
Passengers/Service Hour (Weekday)	17.4
Ridership Rank (Daytime Routes)	9
Peak Headway; Average Headway (min)	20; 23

Proposed Route Recommendations

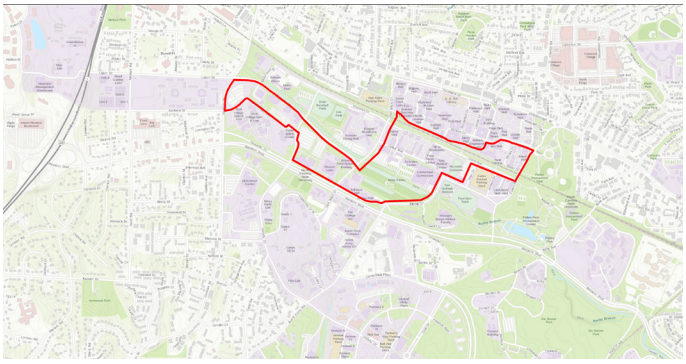
Route 6				6A
Project Description				
Modify existing route into an express route (i.e., shorten total distance and consolidate stops).				
Route Alignment	 Route 6 is recommended to be modified to become an express route during the short-term implementation process. It is recommended that the route utilize William Moore Drive for northbound and southbound trips instead of Blue Ridge Road to provide bi-directional service to the NC State Biomedical Campus. Route 6 will continue to provide connection from the Carter Finley Park and Ride to Main Campus via Hillsborough Street, but be consolidated to 6 stops along this corridor. Operating changes will include a decrease in headway and decrease in overall travel time. No further changes are planned for			
Operating Changes	Realign route and consolidate stops along Hillsborough (remove 2 of the existing 8 stops), change headway from 20 to 15 minutes from 7:00 AM to 6:00 PM, 40 to 30 min headway after 6:00 PM.			
Change in Travel Time	Change in overall travel time, 10 minute decrease in cycle time.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
133.5	132.5	-1.0	Savings	Year 1

ROUTE 7 WOLFLINK SHUTTLE

Current Conditions

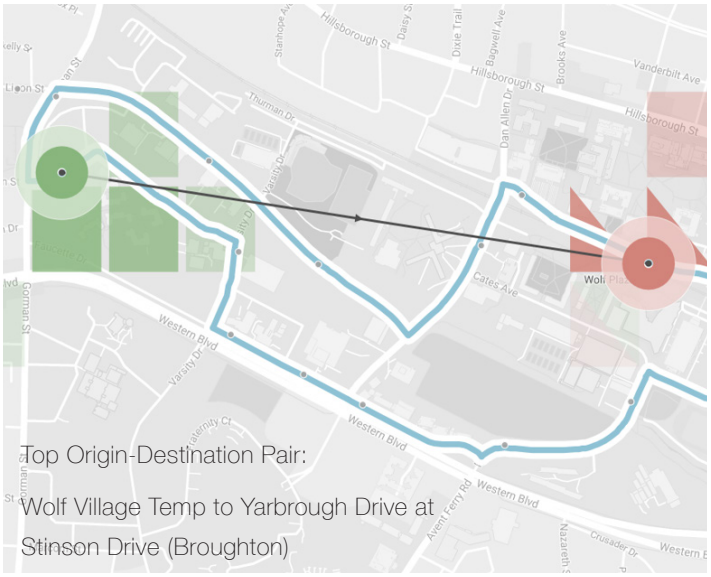
The Wolflink Shuttle (Route 7) serves Main Campus and west Main Campus. It routes using Yarbrough Drive instead of Hillsborough Street like many of the other NC State routes. The route also hits major destinations such as Carmichael Gym and Wolf Village.

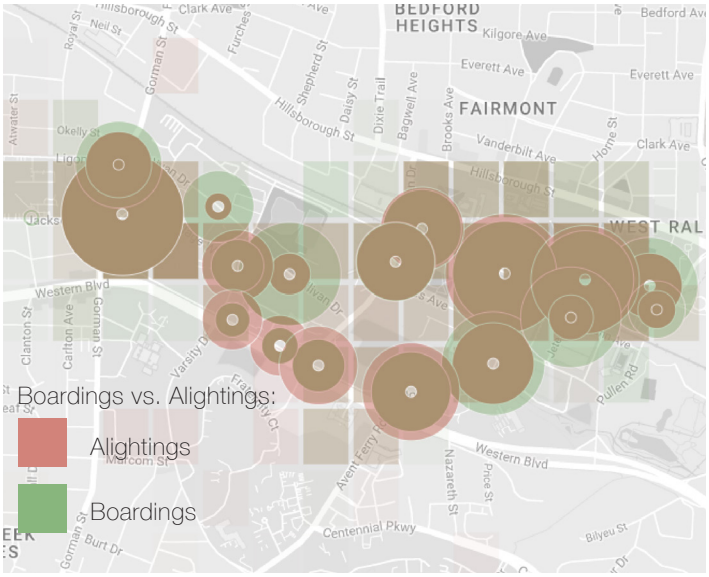
The Wolflink Shuttle had a average weekday ridership of 2,100 passengers in March 2017 with an on-time performance of 83%. The route served 8.1 passengers per service mile and 57.6 passengers per service hour on an average weekday. Route 7 has a peak headway of 10 minutes (7:00 AM to 6:30 PM) and an average daily headway of 12 minutes.



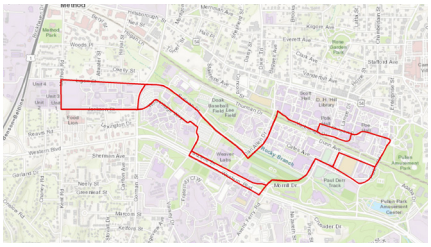
Performance Statistics	
Average Weekday Ridership	2,106
On-Time Performance	83.9%
Passengers/Service Mile (Weekday)	8.1
Passengers/Service Hour (Weekday)	57.6
Ridership Rank (Daytime Routes)	5
Peak Headway; Average Headway (min)	10; 12

Travel Patterns (March 2017)

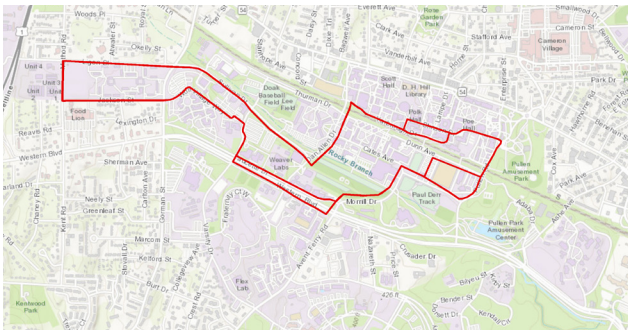




Proposed Route Recommendations

Route 7	7A
Project Description	
Extend Route 7 service to E.S. King Village and modify headway. Run the reverse route (Route 7R) between 7:00 AM and 6:00 PM at 18 minute headways.	
Route Alignment	 Route 7 is recommended to be modified to provide service to E.S. King Village, extending the west side of the alignment from Gorman Street to Method Road. Route 7 will continue to serve Main Campus and provide connection from the student housing on the east side of campus to Wolf Village Apartments on the west side, Yarbrough Drive, Morrill Drive, and Wolf Village Way. Operating changes will include a decrease in headway. Route 7 is recommended to be modified to include a reverse route (7R) that will follow a similar alignment, but will not service E.S. King Village and will travel on Western Boulevard. Operating changes will include an increase in overall travel time.
Operating Changes	Modify Route 7 headway from 10 to 12 minute from 7:15 AM to 6:30 PM and from 30 to 18 minutes after 6:30 PM. Add reverse Route 7R service between 7:00 AM and 6:00 PM at 18 minute headways.
Change in Travel Time	Increase in overall travel time.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
192.5	305.5	113	Cost	Year 1

Route 7	7B
Project Description	
Maintain bi-directional service, Route 7 and 7R. Maintain extension to E.S. King Village as proposed in year 1 for Route 7 and extend service for Route 7R to include E.S. King Village. Decrease headway for Route 7R from 18 min to 12 min.	
Route Alignment	 No proposed changes to Route 7. Route 7R is recommended to be modified to provide service to E.S. King Village and continue to provide the reverse (counterclockwise) service around Main Campus. Decrease Route 7R headway from 18 minutes to 12 minutes.
Operating Changes	N/A
Change in Travel Time	Decrease headway for Route 7R from 18 min to 12 min.

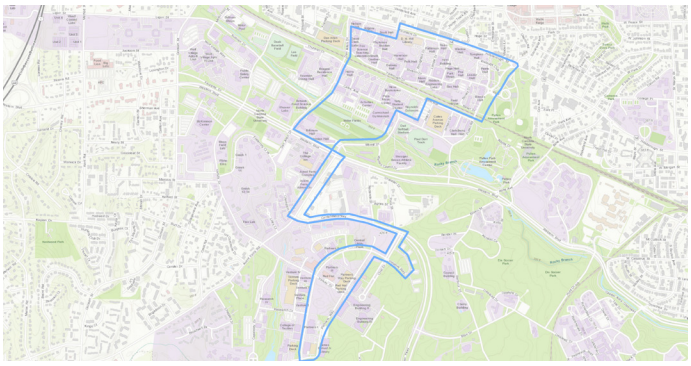
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
305.5	381.0	75.5	Cost	Year 2-5

ROUTE 8 SOUTHEAST LOOP

Current Conditions

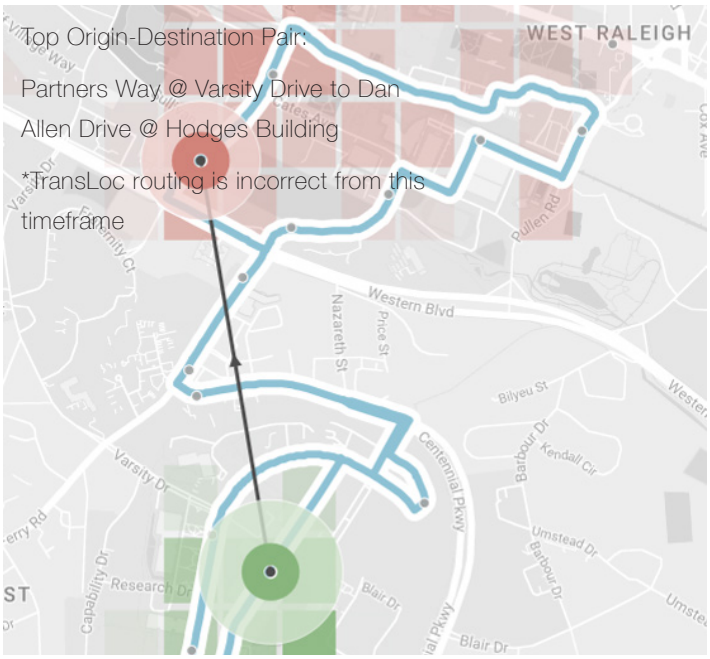
The Southeast Loop (Route 8) serves Main and Centennial Campuses. The route serves major destinations in both Main Campus and Centennial including but not limited to Carmichael Gym, D.H. Hill Library and Avent Ferry Road.

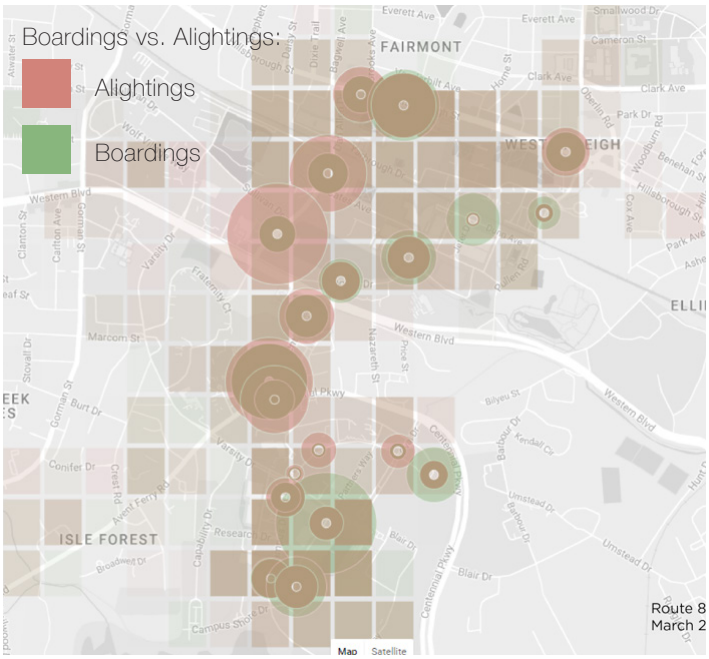
The Wolflink Shuttle had a average weekday ridership of 3,245 passengers in March 2017 with an on-time performance of 71%. The route served 6.4 passengers per service mile and 60.9 passengers per service hour on an average weekday. Route 8 has a peak headway of 9 minutes (8:45AM to 4:00PM) and an average daily headway of 12 minutes.



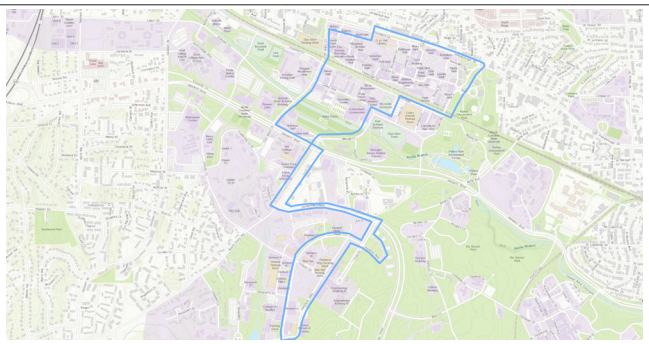
Performance Statistics	
Average Weekday Ridership	3,245
On-Time Performance	71.2%
Passengers/Service Mile (Weekday)	6.4
Passengers/Service Hour (Weekday)	60.9
Ridership Rank (Daytime Routes)	2
Peak Headway; Average Headway (min)	9; 12

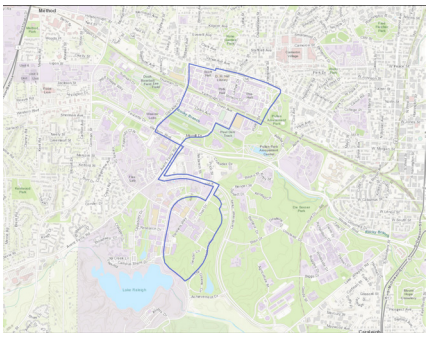
Travel Patterns (March 2017)





Proposed Route Recommendations

Route 8				8A
Project Description				
No change.				
Route Alignment	 There are no alignment modifications recommended for Route 8 during the short-term implementation process. Route 8 will continue to provide connections between Main and Centennial Campus.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
258	258	0.0	Net Zero	Year 1

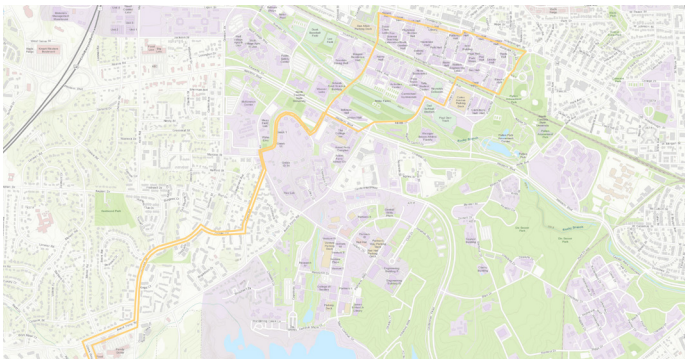
Route 8				8B
Project Description				
Increase frequency; modify existing route to travel counter-clockwise around Centennial Campus, serving the relocated Wolf Ridge stop				
Route Alignment	 Route 8 is recommended to be modified to better serve Centennial Campus and travel counter-clockwise around the campus. This route modification will travel on the Initiative Way extension and include a stop at Wolf Ridge apartments. Operating changes will include an average increase in frequency and increase in overall travel time.			
Operating Changes	Modify headway from 12 to 10 minutes from 7:00AM to 6:30PM, 18 to 20 minutes after 6:30PM (increased frequency before 6:30PM).			
Change in Travel Time	Increase in overall travel time, 4 minute increase in cycle time.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
258.0	270.0	12.0	Cost	Year 2-5

ROUTE 9 GORMAN STREET

Current Conditions

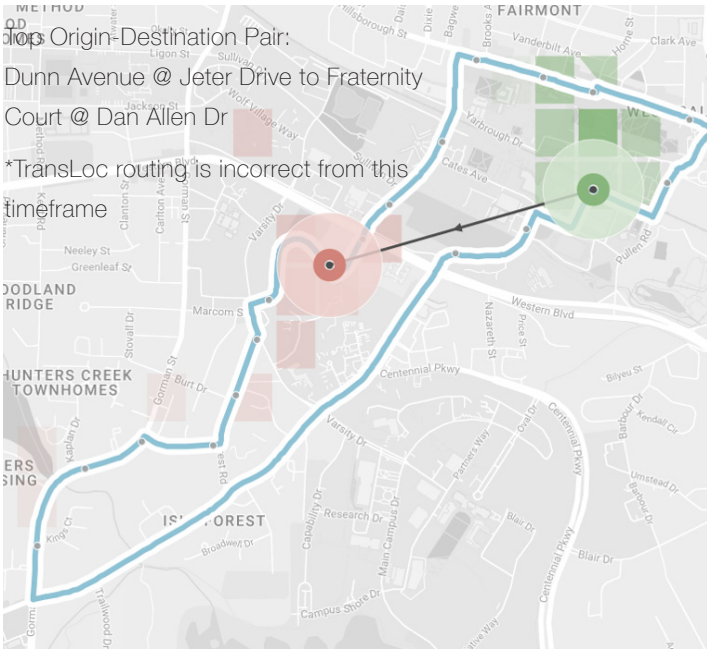
The Gorman Street Route (Route 9) serves Main Campus, Greek Village, and south of NC State. Route 9 provides a connection along Gorman Street between the Food Lion (along Greek Way), residential developments, Greek Village, and Main Campus as well as the restaurants and shops along Hillsborough Avenue.

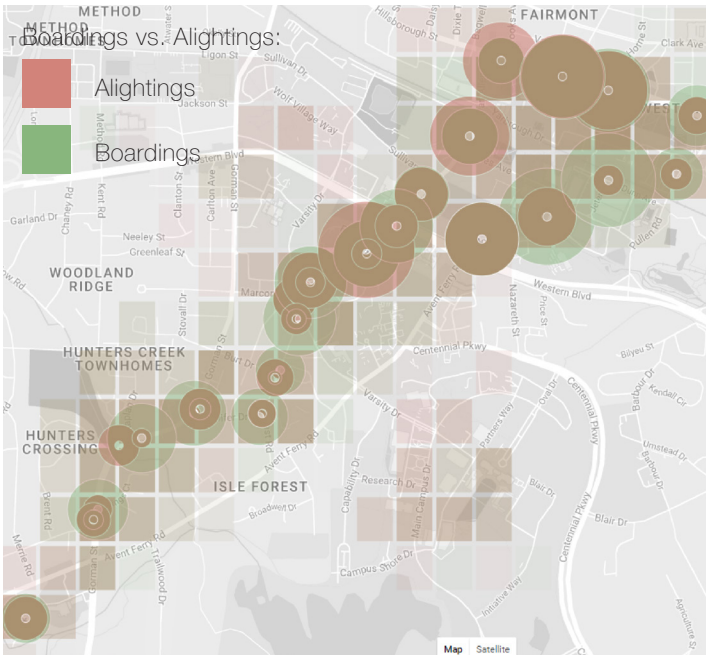
The Gorman Street Route had a average weekday ridership of 2,645 passengers in March 2017 with an on-time performance of 78%. The route served 4.9 passengers per service mile and 40.7 passengers per service hour on an average weekday. Route 9 has a peak headway of 8 minutes (8:40 AM to 4:20 PM) and an average daily headway of 12 minutes.



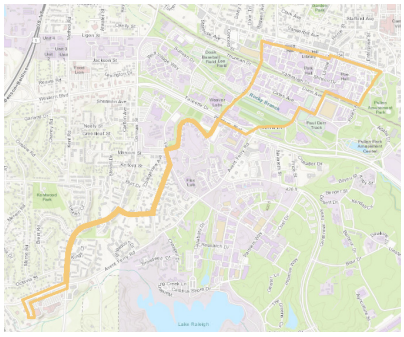
Performance Statistics	
Average Weekday Ridership	2,645
On-Time Performance	78%
Passengers/Service Mile (Weekday)	4.9
Passengers/Service Hour (Weekday)	40.7
Ridership Rank (Daytime Routes)	4
Peak Headway; Average Headway (min)	8; 12

Travel Patterns (March 2017)

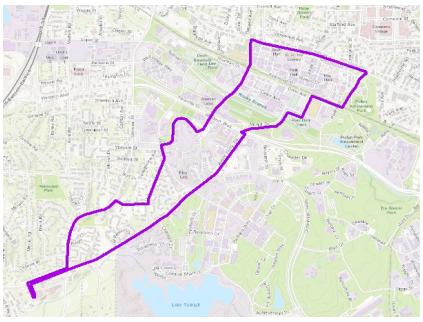




Proposed Route Recommendations

Route 9	9A
Project Description	
No route modifications, change to headways throughout the day.	
Route Alignment	 There are no alignment modifications recommended for Route 9 during the short-term implementation process. Route 9 will continue to provide connections between the Food Lion on Gorman Street, Greek Village, and Main Campus, including destinations along Hillsborough Street. Operating changes will include marginal increase in headway.
Operating Changes	No changes to existing route or stops. Modify headway to 9 minutes from 7:00 AM to 4:15 PM, 12 minutes from 4:15 PM to 6:15 PM, and 45 minutes after 6:15 PM.
Change in Travel Time	No significant change in travel time.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
344.0	306.5	-37.5	Savings	Year 1

Route 9	9B
Project Description	
Eliminate route, replace with proposed Route 1Reverse (Project 1B).	
Route Alignment	 Route 9 is recommended to become consolidated with Route 1 and provide bi-directional service between Main Campus to the areas located south of campus along Gorman Street and Avent Ferry Road. The route connects destinations along Hillsborough Street, Greek Village, and residential developments. The modified route operating in a reverse direction to Route 1 will provide a similar level of operations to the year 1 recommendations. Note: this bi-directional route will be called Route 1/1R; Route 9 will no longer exist.
Operating Changes	Eliminate route.
Change in Travel Time	N/A

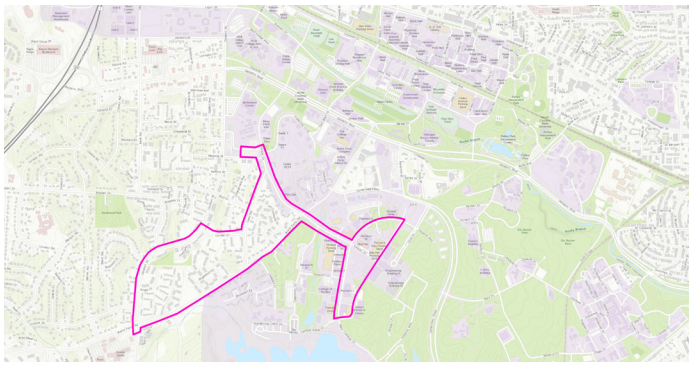
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
306.5	0	-306.5	Savings	Year 2-5

ROUTE 10 CENTENNIAL

Current Conditions

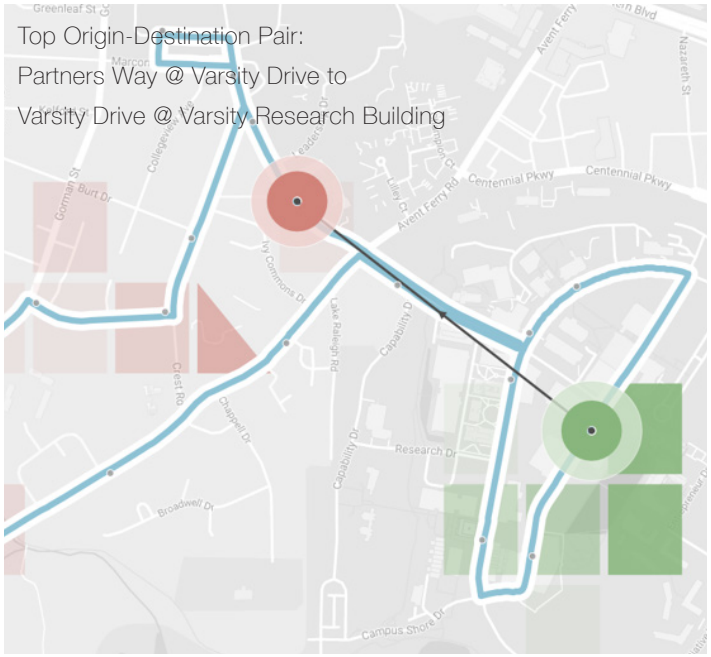
The Centennial Route (Route 10) serves the residential areas to the south along Gorman Street and Avent Ferry Road, Varsity Parking Lot, and connects to Centennial Campus via Varsity Drive.

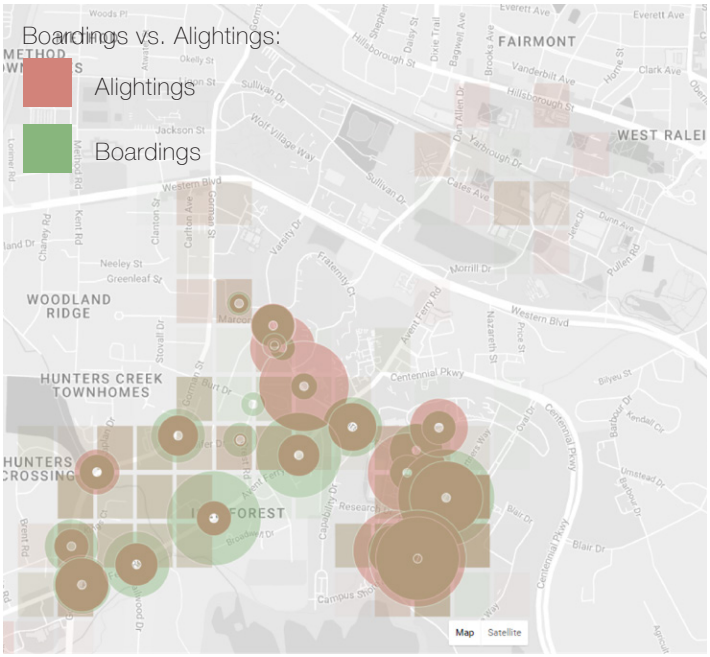
The Centennial Route had a average weekday ridership of 990 passengers in March 2017 with an on-time performance of 69%. The route served 4.6 passengers per service mile and 47.4 passengers per service hour on an average weekday. Route 10 has a peak headway of 15 minutes (7:45 AM to 12:15 PM) and an average daily headway of 21 minutes.



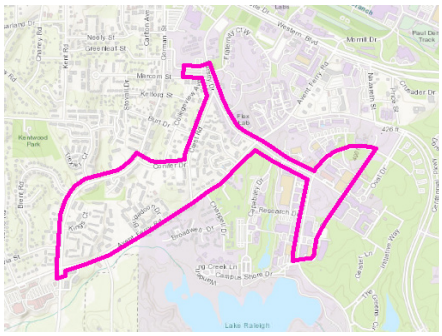
Performance Statistics	
Average Weekday Ridership	991
On-Time Performance	69.2%
Passengers/Service Mile (Weekday)	4.6
Passengers/Service Hour (Weekday)	47.4
Ridership Rank (Daytime Routes)	7
Peak Headway; Average Headway (min)	15; 21

Travel Patterns (March 2017)

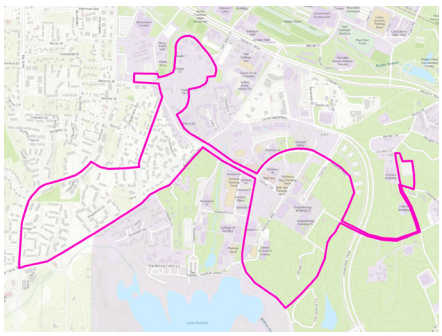




Proposed Route Recommendations

Route 10	10A
Project Description	
No route modifications, increase frequency.	
Route Alignment	 There are no alignment modifications recommended for Route 10 during the short-term implementation process. It will continue to serve the residential areas to the south of Main Campus located along Gorman Street and Avent Ferry Road, the Varsity Parking Lot, and Centennial Campus via Varsity Drive. Operating changes will include a marginal decrease in headway.
Operating Changes	Decrease headway from 30 to 15 minutes 7:00 AM to 6:00 PM and 30 minutes after 6:00 PM.
Change in Travel Time	No significant change in travel time.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
110.0	132.5	22.5	Cost	Year 1

Route 10	10B
Project Description	
Modify route to serve the Spring Hill Park and Ride and travel via Initiative Way extension.	
Route Alignment	 Route 10 is recommended to be modified to include the planned Spring Hill Park and Ride that will be located on Barbour Drive. The route will connect to the Park and Ride via Initiative Way and Blair Drive. Route 10 will also be modified to include Greek Village, rerouting to Leadership Drive, Greek Village Drive, and Fraternity Court. Operating changes will include an increase in overall travel time due to the extended alignment and proposed layover at the Park and Ride.
Operating Changes	Extend route to serve the proposed Spring Hill Park and Ride.
Change in Travel Time	Increase in overall travel time, 18 minutes increase in cycle time due to extended alignment and layover at the proposed Spring Hill Park and Ride stop.

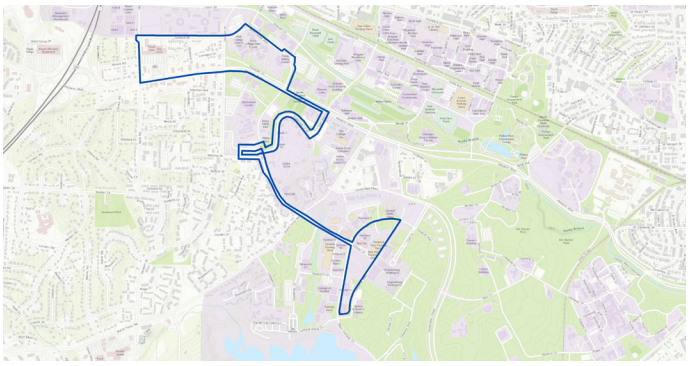
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
132.5	176.0	43.5	Cost	Year 2-5

ROUTE 11 VILLAGE LINK

Current Conditions

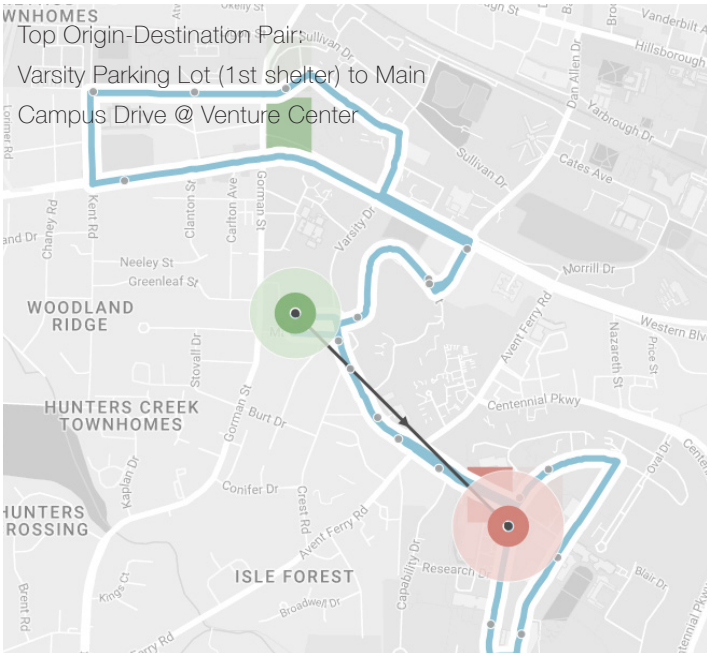
The Village Link (Route 11) serves the Wolf Village, including the athletic fields, Centennial Campus, Varsity Parking Lot, and Greek Village. Route 11 travels along Western Boulevard, Wolf Village Way, and Varsity Drive and primarily provides a connection from Wolf Village to Centennial Campus.

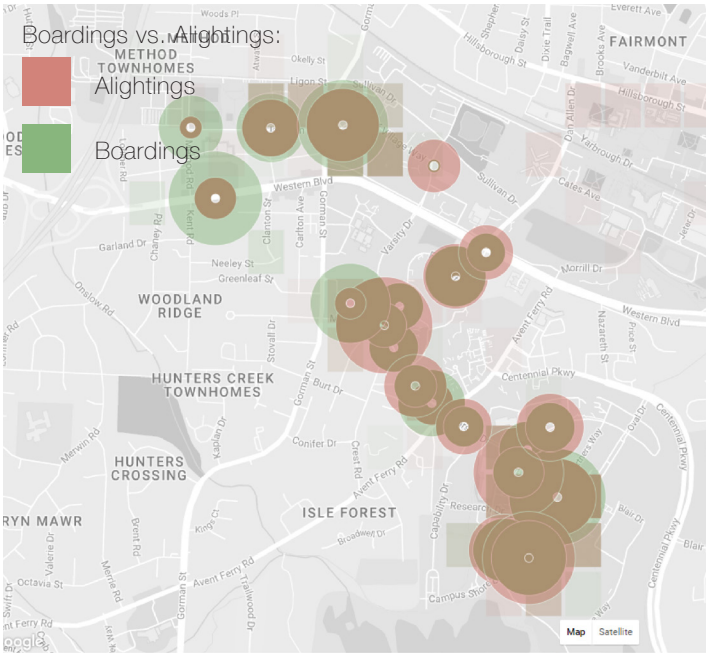
The Village Link had a average weekday ridership of 250 passengers in March 2017 with an on-time performance of 82%. The route served 2.2 passengers per service mile and 23.5 passengers per service hour on an average weekday. Route 11 has a headway of 36 minutes.



Performance Statistics	
Average Weekday Ridership	254
On-Time Performance	81.8%
Passengers/Service Mile (Weekday)	2.2
Passengers/Service Hour (Weekday)	23.5
Ridership Rank (Daytime Routes)	10
Peak Headway; Average Headway (min)	36; 36

Travel Patterns (March 2017)

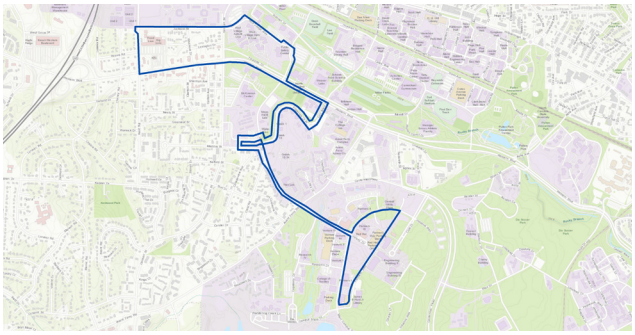




Kimley»Horn

Proposed Route Recommendations

Route 11	11A
Project Description	
No change.	

Route Alignment	 There are no alignment modifications recommended for Route 11 during the short-term implementation process. Route 11 will continue to serve Wolf Village, E.S. King Village, Athletic Fields, Centennial Campus, the Varsity Drive Parking Lots, and Greek Village, via Western Boulevard and Varsity Drive.
Operating Changes	N/A
Change in Travel Time	N/A

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
57.0	57.0	0.0	Net Zero	Year 1

Route 11	11B
Project Description	
Consolidate with Route 10 or elimination with service enhancement provided by Routes 7 and 7Reverse (Project 7B) and Route 3.	

Route Alignment	Eliminate Route 11 and serve existing passengers with proposed Route 10 or a combination of proposed Route 7/7R and Route 3. A travel time estimate was developed to ensure equivalent service would be provided to existing Route 11 passengers if those passengers shift to Route 7/7R and Route 3. The travel time estimate analyzes the trip between E.S. King Village and Wolf Village and assumes an average layover time at the start of the trip and at the transfer location. Assuming existing Route 11 characteristics, a passenger would incur a 36-minute travel time. With the elimination of Route 11, a passenger would incur a travel time between 38 minutes and 41 minutes (peak and off-peak period, respectively) using Route 7/7R and Route 3.
Operating Changes	Eliminate route.
Change in Travel Time	N/A

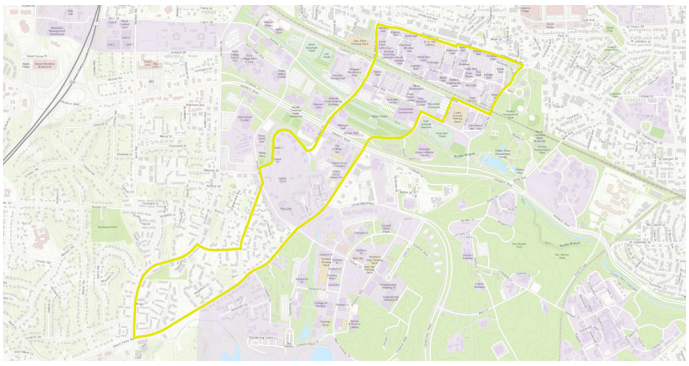
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
57.0	0.0	-57.0	Savings	Year 2-5

ROUTE 12 NIGHT WOLF

Current Conditions

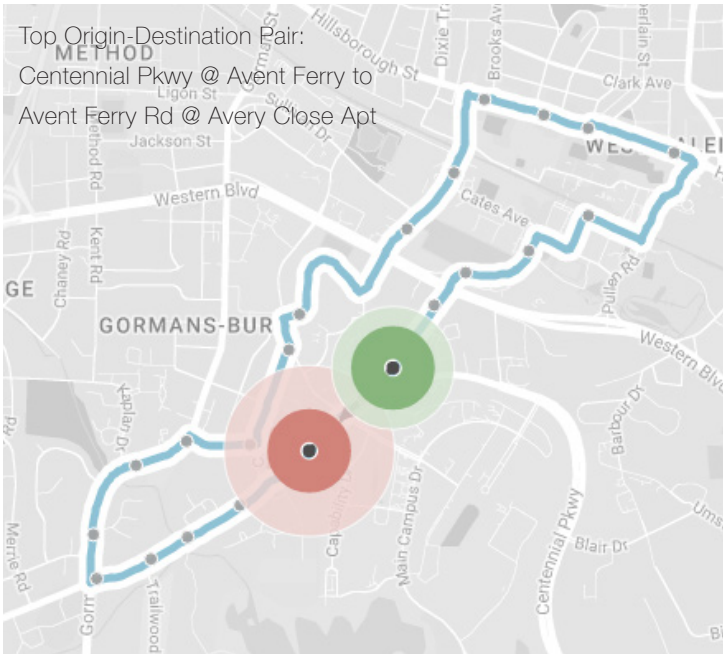
The Night Wolf Route (Route 12) is a combination of Route 1 and Route 9 and begins service at 10:00PM. As such, Night Wolf serves Main Campus, Greek Village, and south of NC State. Night Wolf provides connection along Avent Ferry Road and serves the DH Hill Library and Carmichael Gym at the north end of the route. This route also operates on weekends from 6:15PM to 3:00AM.

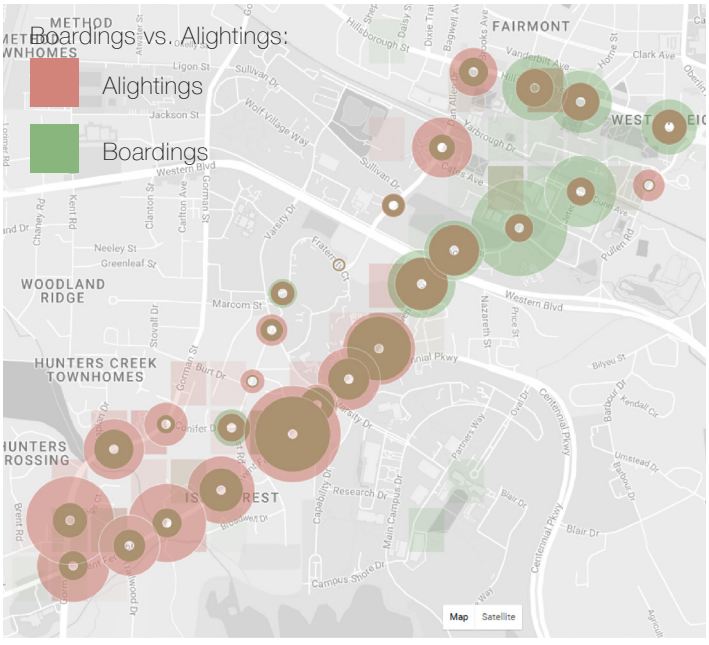
The Night Wolf Route had a average weekday ridership of 150 passengers in March 2017 with an on-time performance of 88%. The route served 3.0 passengers per service mile and 32.0 passengers per service hour on an average weekday. Route 12 has a headway of 35 minutes.



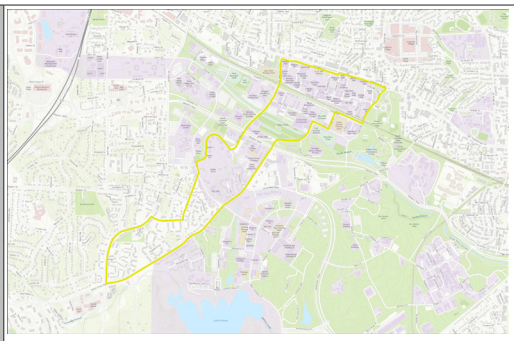
Performance Statistics	
Average Weekday Ridership	147
On-Time Performance	88.2%
Passengers/Service Mile (Weekday)	3.0
Passengers/Service Hour (Weekday)	32.0
Ridership Rank (Nighttime Routes)	1
Peak Headway; Average Headway (min)	35; 35

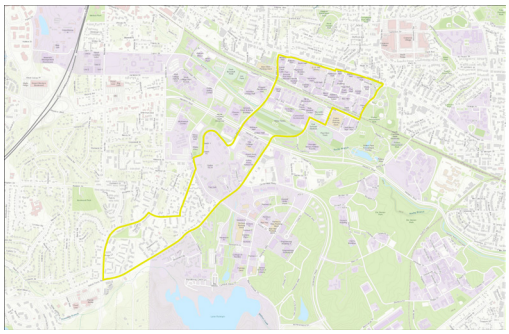
Travel Patterns (March 2017)





Proposed Route Recommendations

NIGHT WOLF				12A
Project Description				
No change.				
Route Alignment	 There are no alignment modifications recommended for Night Wolf during the short-term implementation process. Night Wolf will continue to serve Main Campus, Greek Village, and areas south of Main Campus. There are no operating changes recommended.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
42.0	42.0	0.0	Net Zero	Year 1

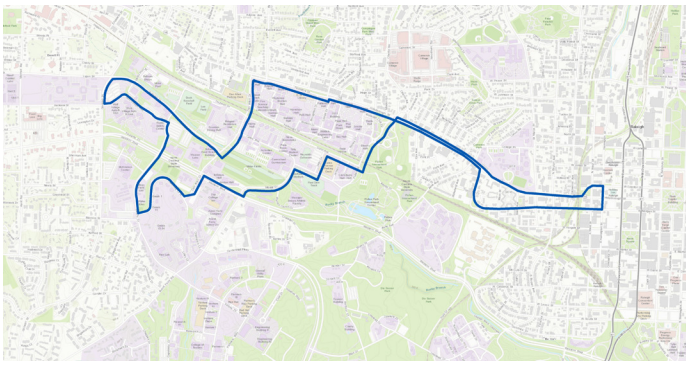
ROUTE 1N				12B
Project Description				
Incorporate Route 12 to Route 1/1R and rename to Route 1N to simplify service schedule. Route 12 will be bi-directional to align with Route 1/1R and operate at 35 minute headways.				
Route Alignment	 It is recommended that Route 12 be incorporated in the Route 1/1R schedule and renamed to 1N to simply the service schedule. This route will be bi-directional to align with Route 1/1R and operate at 35 minute headways.			
Operating Changes	Bi-directional route with 35 minute headways.			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
42.0	81.7	39.7	Cost	Year 2-5

ROUTE 13 WOLFPROWL

Current Conditions

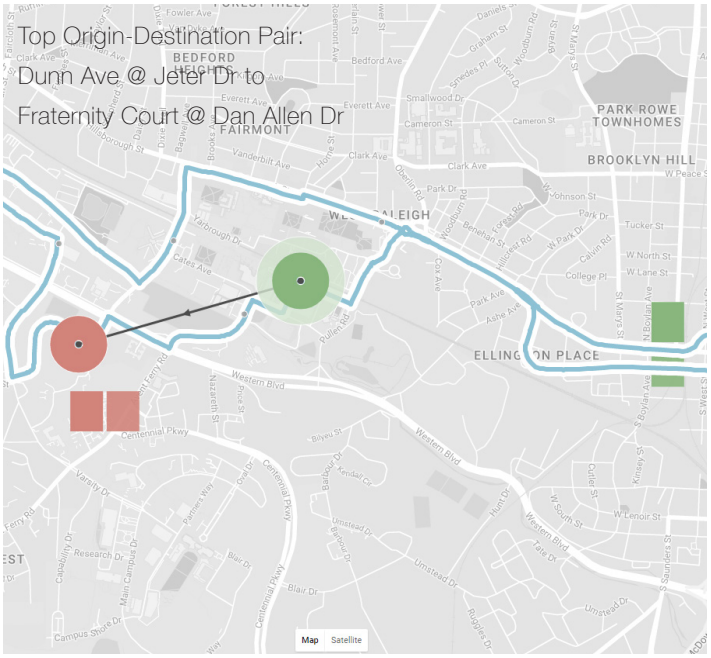
WolfProwl (Route 13) connects Main Campus to the City of Raleigh. The route connects Wolf Village to Downtown Raleigh via Hillsborough Street, McDowell Street, and Edenton Street. WolfProwl provides service from Thursday through Saturday from 10:00 PM to 3:00 AM at 35 minute headways.

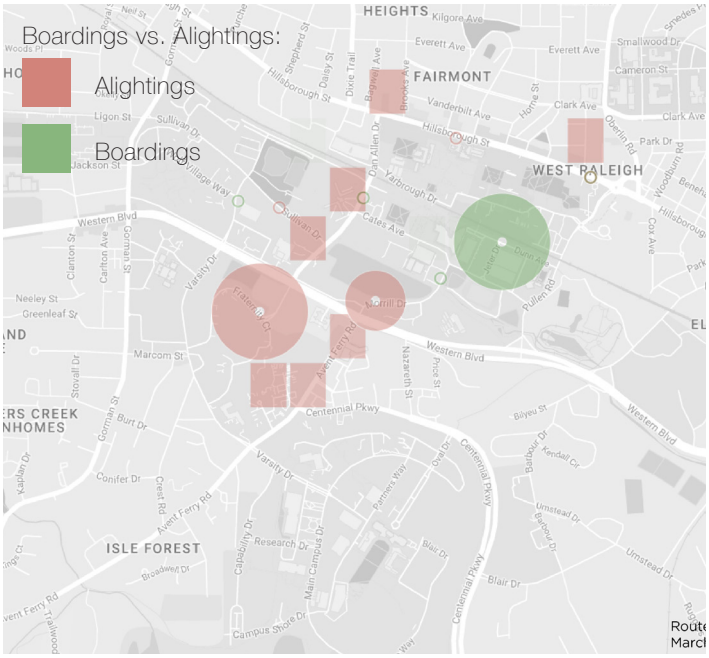
The Wolfprowl had a average weekday ridership of 40 passengers in March 2017. The route served 0.5 passengers per service mile and 8.2 passengers per service hour on an average weekday. Route 13 has a headway of 35 minutes.



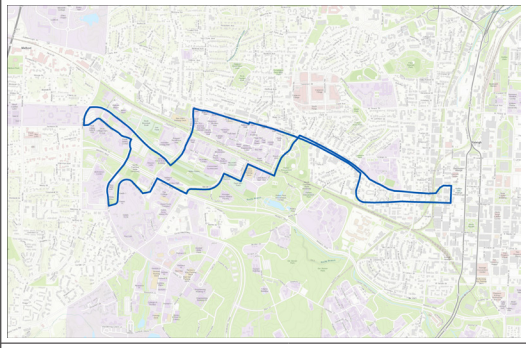
Performance Statistics	
Average Weekday Ridership	43
On-Time Performance	N/A
Passengers/Service Mile (Weekday)	0.5
Passengers/Service Hour (Weekday)	8.2
Ridership Rank (Nighttime Routes)	4
Peak Headway; Average Headway (min)	35; 35

Travel Patterns (March 2017)





Proposed Route Recommendations

WOLFPROWL				13A
Project Description				
Drop Thursday				
Route Alignment	 There are no alignment modifications recommended for Wolfprowl during the short-term implementation process. This route will continue to serve Wolf Village, Greek Village and Main Campus, and provide connection to Downtown Raleigh via Hillsborough Street. Operating changes include the elimination of service on Thursday evenings.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
15.8	10.5	-5.3	Savings	Year 1

WOLFPROWL				13B
Project Description				
Eliminate Route.				
Route Alignment	Eliminate Route 13 due to low ridership.			
Operating Changes	Eliminate route.			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
10.5	0.0	-10.5	Savings	Year 2-5

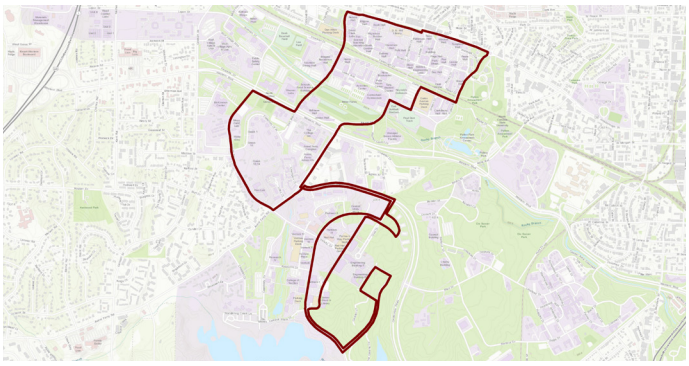
ROUTE 14 CENTENNIAL NIGHT

Current Conditions

The Centennial Night (Route 14) serves Main Campus and its southern loop serves Centennial Campus. The route travels along Hillsborough Street providing connection to the DH Hall Library at the north end of the route and travels along Partners Way to connect the College of Engineering at the south end.

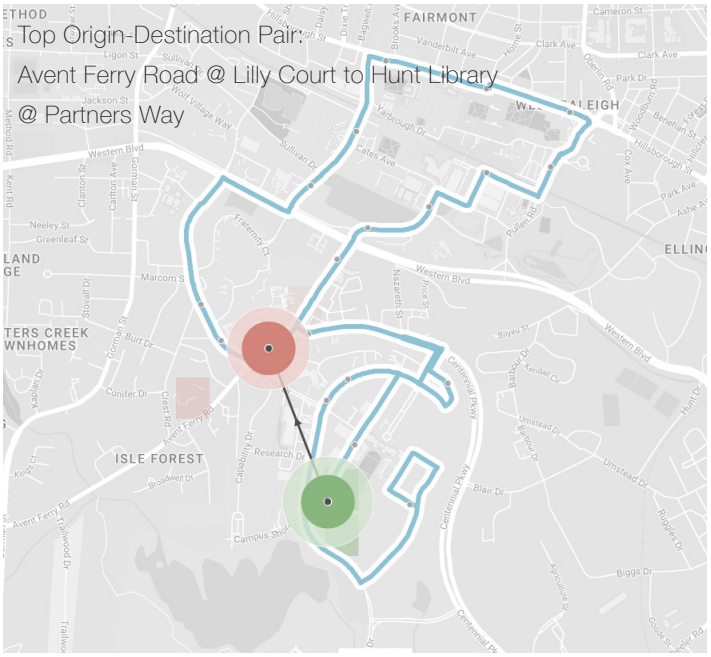
The Centennial Night had a average weekday ridership of 130 passengers in March 2017 with an on-time performance of 80%. The route served 1.3 passengers per service mile and 12.9 passengers per service hour on an average weekday. The route has current headway of 21 minutes Monday to Friday and 42 minutes on Saturday and Sunday.

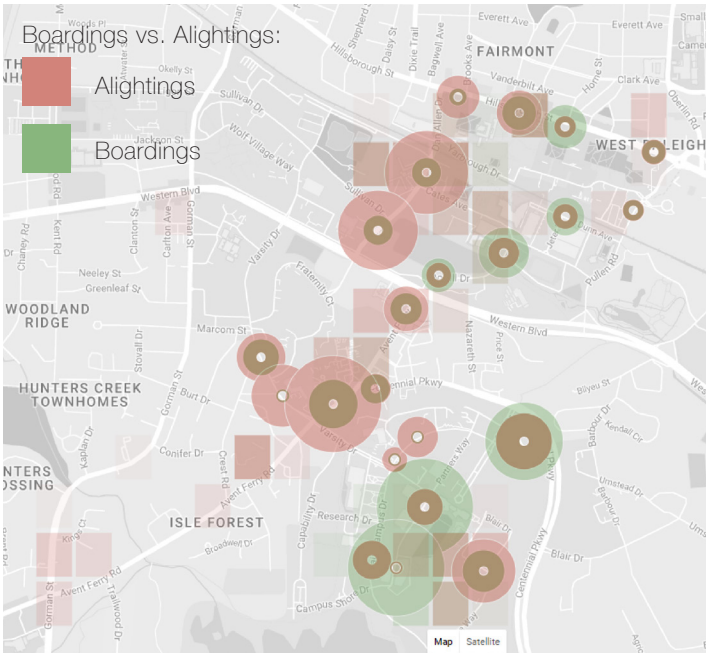
Centennial night had the second highest ridership and highest passenger miles for nighttime routes in March 2017. Also during March 2017, for all categories of passenger loading (150%, 125%, and 100%) 1% of trips reached the capacity. Centennial Night ranked third highest for the nighttime routes for the passengers per service hour and passengers per service mile.



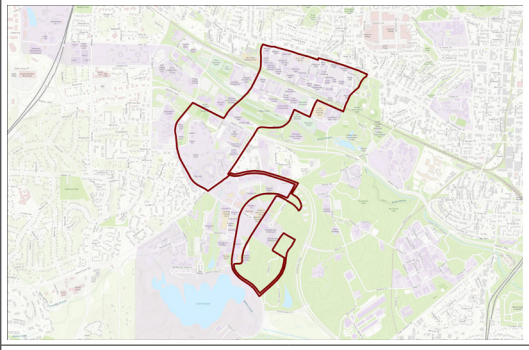
Performance Statistics	
Average Weekday Ridership	133
On-Time Performance	79.7%
Passengers/Service Mile (Weekday)	1.3
Passengers/Service Hour (Weekday)	12.9
Ridership Rank (Nighttime Routes)	2
Peak Headway; Average Headway (min)	21; 21

Travel Patterns (March 2017)

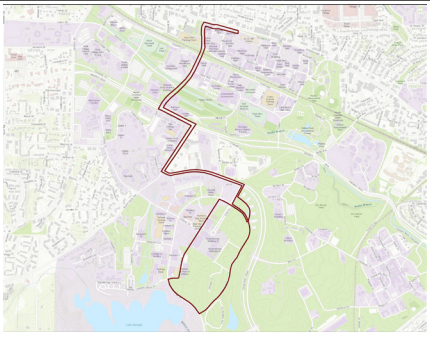




Proposed Route Recommendations

CENTENNIAL NIGHT	14A
Project Description	
Minor time adjustments between stops and a reduction in layover time at the storage lots.	
Route Alignment	 There are no route modifications recommended for Centennial Night during the short-term implementation process. This route will continue to serve Main Campus and Centennial Campus, traveling on Hillsborough Street, Morrill Drive, Avent Ferry Drive, Main Campus Drive, and Varsity Drive. Operating changes include a reduction in layover time at storage lots on Centennial Campus, providing a marginal decrease in headway and overall travel time.
Operating Changes	Reduction in layover time at the storage lots thereby allowing higher frequency (20 minute headway).
Change in Travel Time	No change to travel time. Cycle time decreases by 2 minutes as a result of lower layover times at the storage lots.

Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
74.1	70.7	-3.3	Savings	Year 1

CENTENNIAL NIGHT	14B
Project Description	
Realign route to travel via Initiative Way extension and travel clockwise around Centennial Campus, no change to frequency.	
Route Alignment	 Centennial Night is recommended to be modified to travel on the Initiative Way extension. The route will travel clockwise around Centennial Campus, serving Wolf Village. Operating changes include a decrease in headway and decrease in overall travel time.
Operating Changes	Reduce headway from 20 to 17 minutes.
Change in Travel Time	Decrease in travel time associated with less circuitous route to Centennial Campus. Cycle time decreases by 7 minutes.

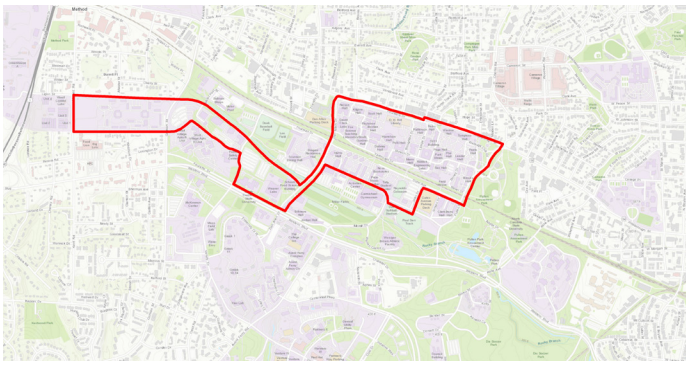
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
70.7	67.4	-3.3	Savings	Year 2-5

ROUTE 16 WEREWOLF SHUTTLE

Current Conditions

The Werewolf Shuttle (Route 16) connects Main Campus to The route uses Cates Avenue and Dan Allen Drive, similar to Daytime Route 7.

The Werewolf Shuttle had a average weekday ridership of 60 passengers in March 2017 with an on-time performance of 95%. The route served 1.6 passengers per service mile and 12.9 passengers per service hour on an average weekday. The Werewolf Shuttle operates weekends from 6:15 PM to 3:00 AM at 30 minute headways.



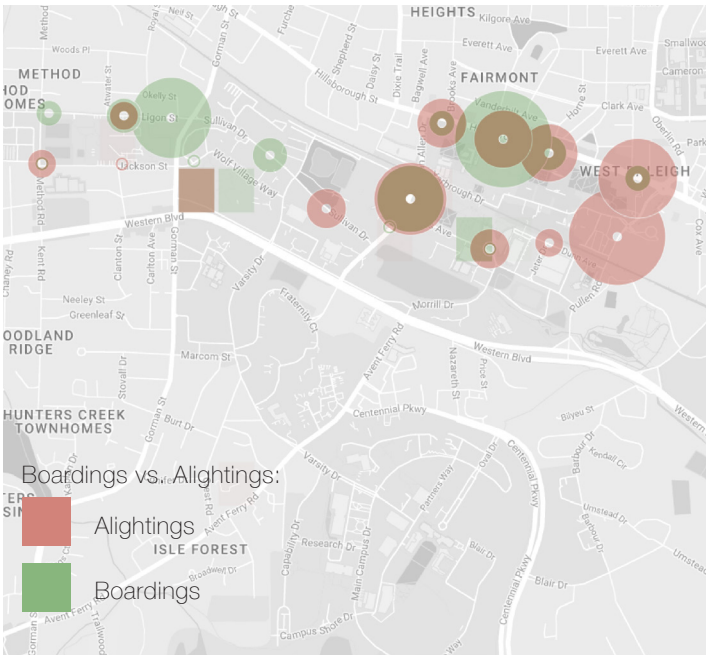
Performance Statistics	
Average Weekday Ridership	60
On-Time Performance	94.9%
Passengers/Service Mile (Weekday)	1.6
Passengers/Service Hour (Weekday)	12.9
Ridership Rank (Nighttime Routes)	3
Peak Headway; Average Headway (min)	30; 30

Travel Patterns (March 2017)

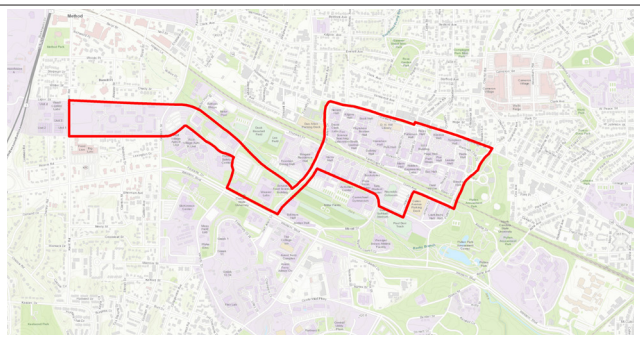
Top Origin-Destination Pair:

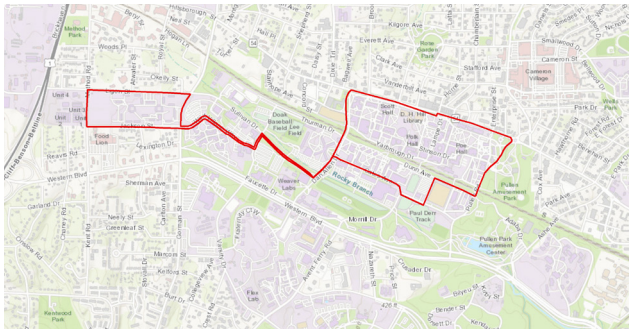
Founders Drive @ D.H. Hill Library to Pullen Road @ Gold Residence Hall

*TransLoc routing is incorrect from this timeframe



Proposed Route Recommendations

WEREWOLF SHUTTLE				16A
Project Description				
No change.				
Route Alignment	 There are no route modifications recommended for Werewolf Shuttle during the short-term implementation process. Werewolf Shuttle will continue to serve Main Campus and provide connection from the student housing on the east side of campus to King Village on the west side, Yarbrough Drive, Morrill Drive, and Wolf Village Way. No further changes are planned for years 2 to 5.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
40.7	40.7	0.0	Net Zero	Year 1

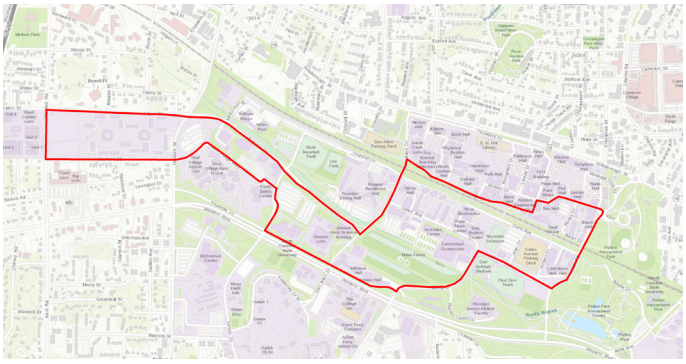
WEREWOLF SHUTTLE				16B
Project Description				
Route 16 will be bi-directional and operate at 60 minute headways.				
Route Alignment	 Route 16 will be bi-directional and operate at 60 minute headways. Route 16 is recommended to travel on Sullivan Drive until Varsity Drive and then Wolf Village Way and will no longer travel on Faucette Drive.			
Operating Changes	Bi-directional route with 60 minute headways.			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
40.7	43.0	1.3	Cost	Year 2-5

ROUTE 7W WOLFLINK SHUTTLE - SATURDAY

Current Conditions

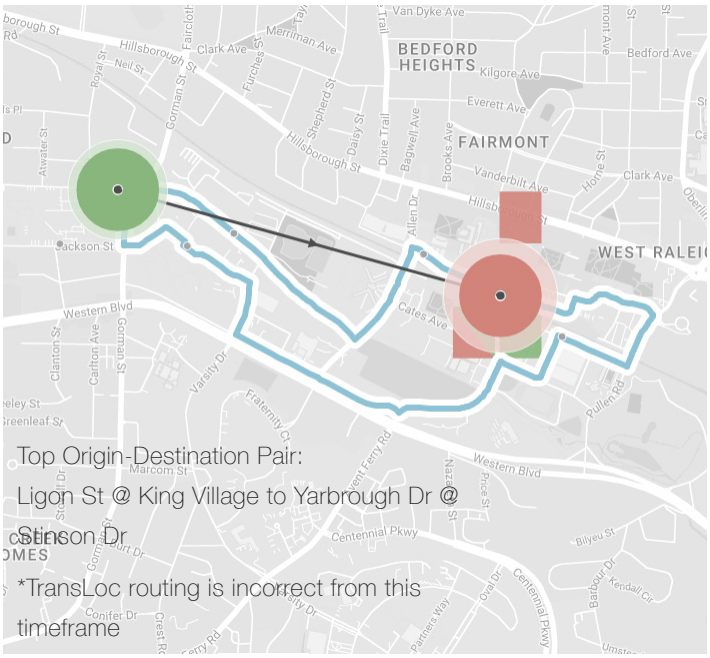
The Wolflink Shuttle (Route 7) offers service on Saturdays from 8:45 AM to 6:00 PM at 30 minute headways. Route 7 (Saturday) offers a similar service to Route 7 (weekday) but includes an extension of service on the west side of Main Campus serving King Village and the Soccer Lacrosse Athletic Fields via Ligon Street, Method Road, and Jackson Street.

The Wolflink Shuttle had a average weekday ridership of 215 passengers in March 2017. The Wolflink Shuttle operates weekends from 8:45 AM to 6:15 PM at 30 minute headways.

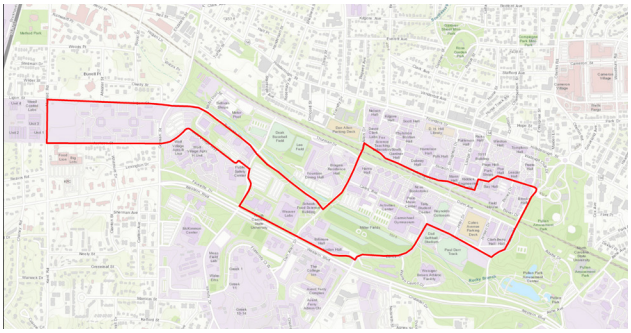


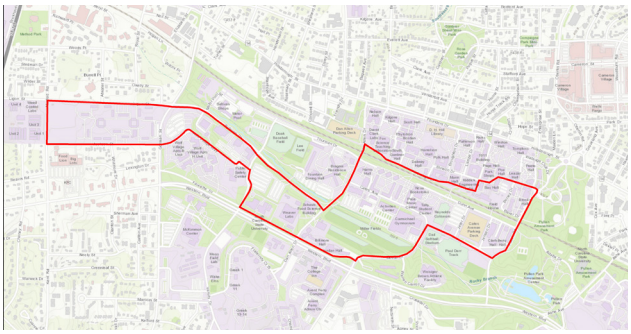
Performance Statistics	
Average Weekday Ridership	214
On-Time Performance	N/A
Passengers/Service Mile (Weekday)	N/A
Passengers/Service Hour (Weekday)	N/A
Peak Headway; Average Headway (min)	30; 30

Travel Patterns (March 2017)



Proposed Route Recommendations

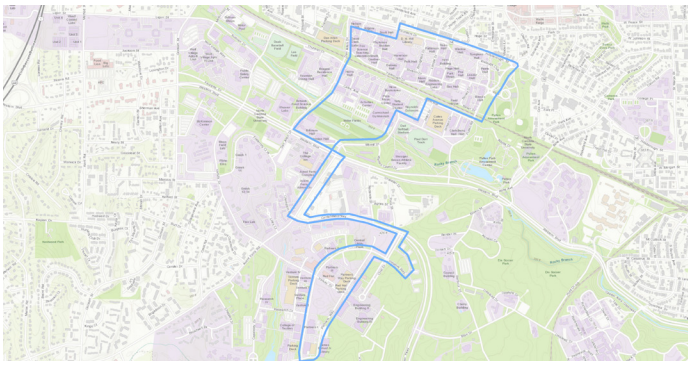
WOLFLINK SHUTTLE - SATURDAY				7WA
Project Description				
No change.				
Route Alignment	 There are no route modifications recommended for Route 7W during the short-term implementation process. This route will continue to serve Main Campus and provide connection from the student housing on the east side of campus to King Village on the west side, Yarbrough Drive, Morrill Drive, and Wolf Village Way.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
9.5	9.5	0.0	Net Zero	Year 1

WOLFLINK SHUTTLE - SATURDAY				7WB
Project Description				
Route 7W should be renamed Route 7. The Route 7 schedule should consistently reflect the weekday and weekend service hours.				
Route Alignment	 Route 7W should be renamed Route 7. The Route 7 schedule should consistently reflect the weekday and weekend service hours. This will not be a bi-directional route and will travel counter-clockwise around the Central and North campuses.			
Operating Changes	Incorporate operating hours into Route 7 service to simplify schedule.			
Change in Travel Time	No change to travel time.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
9.5	9.5	0.0	Net Zero	Year 2-5

ROUTE 8W SOUTHEAST LOOP (SATURDAY/SUNDAY)

Current Conditions

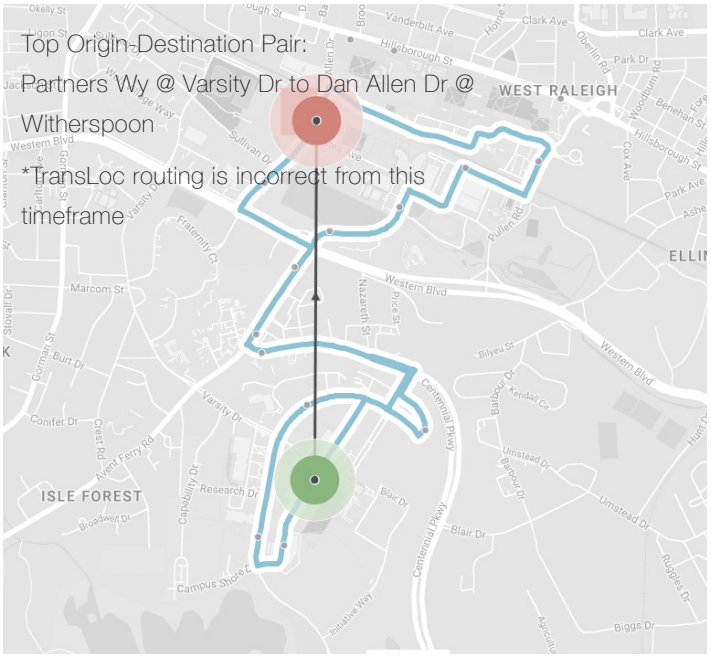
The Southeast Loop (Route 8W) provides weekend service on Saturdays and Sundays from 8:45 AM to 6:00 PM with 35 minute headways. The weekend service provides the same service at the weekday route. It serves Main and Centennial Campuses. The route serves major destinations in Main Campus and Centennial including Carmichael Gym, D.H. Hill Library and Avent Ferry Road.



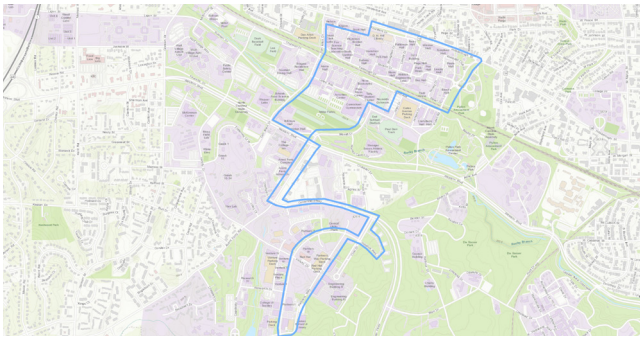
The Southeast Loop had a average ridership of 446 passengers on Saturdays and 365 passengers on Sundays in March 2017. The route served 4.6 passengers per service mile and 47.6 passengers per service hour on an average weekend day. The Southeast Loop operates weekends from 8:58 AM to 6:20 PM at 35 minute headways.

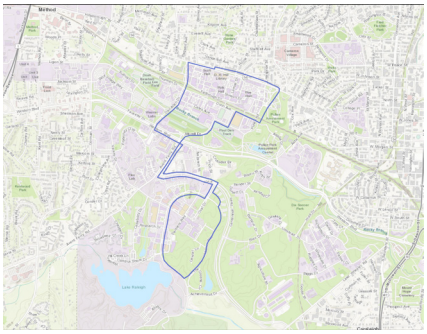
Performance Statistics	
Average Ridership (Sat; Sun)	446; 365
On-Time Performance	N/A
Passengers/Service Mile (Weekday)	4.6
Passengers/Service Hour (Weekday)	47.6
Peak Headway; Average Headway (min)	35; 35

Travel Patterns (March 2017)



Proposed Route Recommendations

SOUTHEAST LOOP (SATURDAY/SUNDAY)				8WA
Project Description				
No change.				
Route Alignment	 There are no route modifications recommended for Route 8W during the short-term improvement process.			
Operating Changes	N/A			
Change in Travel Time	N/A			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
19.2	19.2	0.0	Net Zero	Year 1

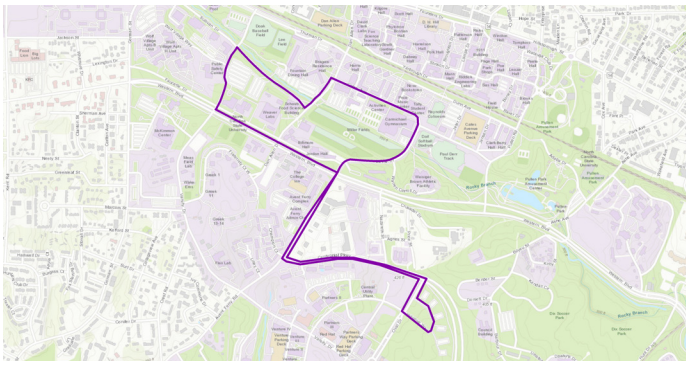
SOUTHEAST LOOP (SATURDAY/SUNDAY)				8WB
Project Description				
Modify existing route to travel counter-clockwise around Centennial Campus serving the relocated Wolf Ridge stop and rename Route 8W to Route 8. The Route 8 schedule should consistently reflect the weekday and weekend service hours.				
Route Alignment	 Route 8W is recommended to be modified to better serve Centennial Campus and travel counter-clockwise around the campus. This route modification will travel on the Initiative Way extension and include a stop at Wolf Ridge apartments. Operating changes will include an average increase in headway and increase in overall travel time. Rename Route 8W to Route 8. The Route 8 schedule should consistently reflect the weekday and weekend service hours.			
Operating Changes	Modify existing route to serve Wolf Ridge, modify headway from 36- to 40-minutes.			
Change in Travel Time	Increase in overall travel time, 4 minute increase in cycle time.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
19.2	20.0	0.8	Cost	Year 2-5

ROUTE 17 SUNDAY/HOLIDAY

Current Conditions

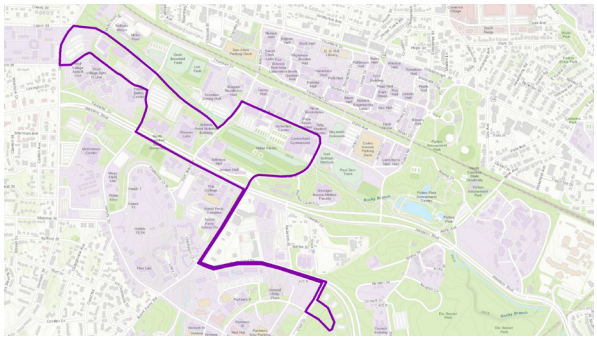
The Holiday/Sunday Shuttle connects the southern portion of Main Campus, Varsity Drive, and Centennial Campus. The largest origin-destination pair is from Morrill Drive at Carmichael Gym to the Main Campus Drive Lots.

The Holiday/Sunday Shuttle had a average weekday ridership of 80 passengers in March 2017. The route served 1.7 passengers per service mile and 19.8 passengers per service hour on an average weekday. The Holiday/Sunday Shuttle operates weekends from 8:00 PM to 12:00 AM at 30 minute headways.

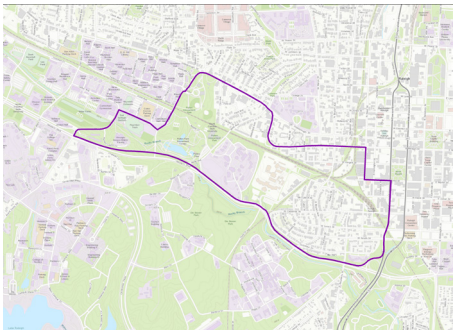


Performance Statistics	
Average Ridership	78
On-Time Performance	N/A
Passengers/Service Mile (Weekday)	1.7
Passengers/Service Hour (Weekday)	19.8
Peak Headway; Average Headway (min)	30; 30

Proposed Route Recommendations

SUNDAY/HOLIDAY				17A
Project Description				
Route modification, extend service to Gorman Street. Rename to RS Lot Shuttle.				
Route Alignment	 Route 17 is recommended to be modified to extend to Gorman Street on the west end of the route to provide service to E.S. King Village. It will continue to travel counterclockwise on Main Campus and use Avent Ferry Road to connect to the storage lots at the north of Centennial Campus. There are no recommended operating changes. No further changes are planned for years 2-5.			
Operating Changes	Route modification, extend service to Gorman Street. Operate route counter-clockwise on Main Campus, and services stops along Cates Avenue, Sullivan Drive, and Wolf Village.			
Change in Travel Time	No change to travel time.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
4.0	4.5	0.5	Cost	Year 1

ROUTE 18 UNION STATION ROUTE

WEEKEND				17B
Project Description				
New route to provide service to Union Station on Friday evenings and Sunday Evenings.				
Route Alignment	 A new route is proposed to operate on Friday and Sunday evenings that will provide service from Tally Student Union to Union Station. This route will have a cycle time of 35 minutes.			
Operating Changes	Serve Union Station and Talley Student Union for 6 hours on Friday evenings and Sunday evenings.			
Change in Travel Time	Cycle time of 35 minutes.			
Baseline Weekly Service Hours	Proposed Weekly Service Hours	Change in Service Hours	Costs/Savings	Implementation Timeframe
0	12.8	12.8	Cost	Year 2-5

Additional Service Recommendations

Transit Hub

In addition to the transit hub that is being considered at the Coliseum Parking Deck location, the existing transit hub at DH Hill Library may be modified. As mentioned in the Campus Capacity and Assessment Study, with the reopening of the Hillsborough Street doors to the Erdhal-Cloyd wing of the library, the DH Hill Library transit hub should be moved to a new location that will not be directly in front of the library entrance. The two existing transit stops on Founders Drive could be consolidated to one stop, relocating the transit hub near DH Hill Library. This recommended transit hub has the potential to relieve congestion on the transit way in front of the library, while not losing access to Founders Drive.

On-Demand Shuttle

On-demand service is a common transit option offered at various universities and cities where flexibility of service is necessary. Typically, the on-demand service supplements an existing high-capacity, fixed-route transit system and provides enhanced travel options for specific point-to-point needs within a limited geography or serving a specific ridership need (i.e., short trip in-town shuttle, mobility limited passengers, etc.) where the service demand is inefficient for a regular fixed-route service, and/or as part of a late-night services program.

For NC State, an on-demand service could offer service within the campus and the surrounding area particularly during late-night hours to provide a safe ride home. The service could consist of low capacity shuttles (i.e., vans, cutaways, or electric cars) that have limited hours of operation within the existing Wolfline transit system area, and primarily operate after the fixed-route service ends for the night. The on-demand shuttle would offer flexible service and use the Wolfline fixed-route stops as the point of pick-up and drop-off to control the operations, or potentially provide door-to-door service based on a shuttle demand response protocol (i.e., limited mobility passenger, safety reasons, etc.). On-demand shuttle hailing would be arranged using an application or reservation and dispatch system.

To the right are examples of on-demand services that operate in conjunction with fixed-route services provided by the peer review institutions.

Service Example: University of Maryland Nite Ride

NITE Ride (point-to-point service within main campus and to other campus properties)

Shuttle capacity

20 passengers

Hours of operation per day

14 hours

Ridership

70 passengers during the Fall and Spring (when fixed route service ends at 3:00 AM) and 150 passengers during the Summer (when fixed-route service ends at 9:00 PM)

Passengers per service hour

5 passengers per hour for the Fall and Spring,
10 passengers per hour for the Summer

Service Example: Tampa Downtown Partnership Point to Point Service

Downtowner (point-to-point service within an approximately ¾ mile radius, including the University of Tampa)

Shuttle capacity

12 vehicles with 6-passenger capacity, and
2 electric vehicles (Chevy Bolt)

Hours of operation per day

17 hours (Monday-Friday),
12 hours (Saturday and Sunday)

Service Example: ECU Night Service

SafeRide (point-to-point, demand-response route that serves the main campus (1.5 square miles and other campus properties)

Hours of operation per day

6:30 PM – 2:15 AM Monday to Friday,
12:30 PM – 2:15 AM Saturday and Sunday

AV Transit

The development of autonomous vehicles (AV) will ultimately transform the provision of transit services globally in the near future. While real-life deployment of AV transit vehicles is currently limited to select locations around the world and several pilot projects in the U.S., the AV transit landscape is changing constantly and includes changes in the regulatory setting to address a wide range of potential issues related to operations, management, oversight and deployment. The AV transit locations have 12-passenger electric shuttle vehicles with room for about six people seated and typically operate in a closed network location (e.g., campuses and airports). Different manufacturers, such as Local Motors and EasyMile, have similar configurations being piloted and proposed throughout the U.S., and are working toward future mixed-traffic operations along roadways.

Campus settings, such as NC State, with support by early-adopter (e.g., technologically savvy, sharing economy users such as students) are good candidates for the innovative transit options. By deploying AV transit in an environment that is intuitive and prepared for the user and infrastructure connections, the technology can enhance the overall mobility for NC State. Current constraints to AV transit include low operational speeds (below 25 miles per hour) especially related to crash worthiness on public roadways, passenger capacity of vehicles, infrastructure, and vehicle costs.

To further the consideration of the emerging AV transit technology application at the NC State campus, additional evaluation of the potential corridor(s), capital improvements, operating conditions, and financial investment will be required.

One consideration could be to plan for a future AV transit lane in the bicycle and pedestrian tunnel planned under Western Boulevard. This could be as little as 12 feet wide and could allow for bi-directional service through transit signaling.

Figure 5.11: Easy Mile Autonomous Transit Vehicle

Partnerships/Continued Coordination

Off-Campus Housing

Similar to other universities, NC State has the opportunity to implement a program for University transit to offer direct access to off-campus housing developments. With the proper space and location, a housing development would provide funding to maintain the stop amenities and service for the transit to provide greater service to that area. In addition to incentivizing off-campus housing to provide premium service at their locations, NC State can also regulate private shuttle service that is offered by off-campus housing developments. Access can be limited for private shuttles to certain areas on campus (i.e., the transit access way on Founders Drive) through an access fee or gate system, giving priority to the Wolfline buses. Additionally, certain private off-campus housing complexes are located on potential high-frequency transit routes as identified in the Wake Transit Plan, and may be better served by that service in the future.

Areawide Transit

Coordinating with areawide transit partners offers the opportunity to alleviate any misconceptions of GoRaleigh Transit, Wake County Transit, or Wolfline, from any riders of another service. All transit services in the area can be successful through the promotion from the other services. The following are additional partnership opportunities with areawide transit.

City of Raleigh – GoRaleigh

In their Capital Improvement Program for FY 2018, the City of Raleigh has established a TSP project for Capital Boulevard that will reduce the travel time for buses along that corridor. There is potential for NC State to partner with the City to improve the travel time of the Wolfline buses as they travel on Hillsborough Street, Avent Ferry Road, and Western Boulevard. Support from GoRaleigh could also lead to enhanced service on Avent Ferry Road during non-school periods with high frequency transit on Avent Ferry 19 hours a day—seven days a week—365 days a year, providing first-last mile local connections to future BRT.

Wake County Transit

Wake County Transit has plans to invest in a BRT route that will improve bus speed and reliability. The Wake County Transit Plan references Western Boulevard between Raleigh and Cary as a corridor to deploy BRT, while the station locations are still being determined. There is also opportunity to partner with Wake County Transit for other frequent service corridors on Pullen Road and Hillsborough Street. Coordination between NC State and Wake County could potentially lead to the shared use of the future BRT stations.

6—BICYCLE/PEDESTRIAN/TRANSPORTATION DEMAND MANAGEMENT (TDM)

INTRODUCTION

NC State currently operates a Transportation Demand Management (TDM) program (WolfTrails) and has an extensive network of bicycle and pedestrian facilities. The goal of this project is to identify ways to create a more robust TDM program and improve the bicycle and pedestrian network.

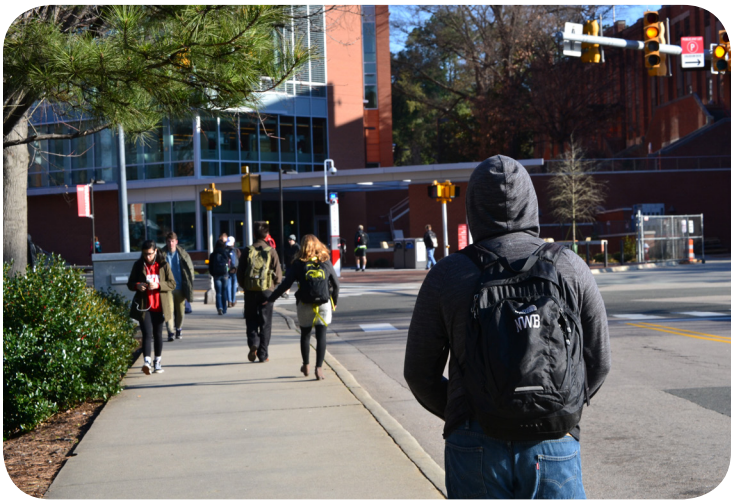


Figure 6.1: Pedestrians on Morrill Drive, NC State

Figure 6.2: Bike Lanes, Varsity Drive, NC State

The planning process included the following tasks:

Existing Conditions: Existing conditions of the TDM program were analyzed to identify system-improvement priorities.

Peer Review: A peer review of comparable universities that have innovative bicycle, pedestrian, and TDM services was conducted. Several peer systems were identified with a similar campus structure and could therefore be used to identify opportunities for improvement to the bicycle, pedestrian, and TDM network. In addition, a bike share peer review was conducted to develop recommendations for the University to proceed with developing a bike share system.

Analysis: A review of the Campus Bicycle and Pedestrian Plan (Martin-Alexiou-Bryson, October 2011) was performed to determine high priority projects that have not been completed. Additional projects were identified to provide a complete bicycle and pedestrian network and to meet the service goals. An analysis was conducted using performance metrics from the NC State TDM Department. Additionally, City of Raleigh and NCDOT projects that will have a direct impact on NC State's bicycle/pedestrian network were identified.

Recommendations: In this section recommendations were made for high priority projects that the University should consider to enhance the bicycle and pedestrian network on and around campus. Additionally, TDM program recommendations were developed based on service goals, peer review recommendations, and TDM best practices. Policy recommendations also were developed to help employees continue to stay ahead of development and shape the future of the University.

Key Bicycle/Pedestrian Recommendations

1. Build multi-use path to connect the campuses along Nazareth Street
2. Construct cycle track on Morrill Drive and Avent Ferry Road
3. Install bike lanes or multi-use path on Pullen Road and the Pullen Road/Oval Drive Extension
4. Provide additional bike storage capacity on campus
5. Evaluate pilot bike share program

EXISTING CONDITIONS

Summary Of Existing Transportation Demand Management (TDM) Program

The NC State Transportation department offers a robust menu of traditional options for transportation to and around campus. Additionally, NC State Transportation provides resources to facilitate the organization and promotion of carpooling and vanpooling, as well as car sharing and reduced transit costs for local and regional bus services, further supported in the offering of an emergency ride home program for University employees.

NC STATE UNIVERSITY
WOLFTRAILS
Alternative transportation options for getting to, from & around campus!

NC State has received designation as both a Bike Friendly Workplace and a Bicycle Friendly University by The League of American Bicyclists. Bicycle paths throughout the campus connect to the overall city and regional network of trails, with several paths designated by community users as “preferred paths.” There are currently two bicycle locker facilities on campus, both located within the North Campus and within approximately one block of each other. In addition the bicycle lockers, two Fix It Stations are available, one in the Centennial Campus area and one in the Main Campus area.

NC State has a TDM Program (WolfTrails) that is open to the employees and students of NC State. The WolfTrails website provides alternative transportation options and advertises the programs NC State offers. NC State offers a variety of services and incentives to students and employees that choose alternative transportation.

These services and incentives include the following:

- Free bicycle registration
- Bicycle racks on buses
- Bike Share (NC State is currently doing a pilot project with LimeBike)
- GoPass at a cheaper rate to students and employees (provides access to city and regional transit)
- 8 daily parking passes to students and 24 daily parking passes for employees who register as transit, bike, or walking commuter
- Discounted parking permit for student and employee carpoolers and 8 daily parking passes to each student and 24 passes to each employee carpooler
- Guaranteed Ride Home for employees who participate in carpool, transit, biking, walking, or vanpool commutes
- Zipcar program – There are eight vehicles available for use on the NC State campus
  - Two Zipcars on Dan Allen Drive
  - Three Zipcars at the Avent Ferry Complex
  - One Zipcar at ES King Village
  - Two Zipcars on Centennial Campus
- Wolfpack Pick Up on Main Campus provides a transit service with a golf cart to students with temporary or permanent mobility impairment on Main Campus

These wide variety of services and incentives encourage students and employees to consider alternate forms of transportation.

PEER REVIEW

Bicycle/Pedestrian/TDM Systems Peer Review

A peer review of similar university bicycle, pedestrian, and TDM systems was conducted to gain an understanding of operations and strategies that have been successful and that may be applicable to NC State. The peer review included phone interviews with Georgia Institute of Technology (GT), University of Wisconsin-Madison (UW-M), and Colorado State University (CSU) to gain further insights of transit operations relevant to NC State.

The goal of the peer review was to identify best practices and potential strategies for select issues (i.e., type of night time service, use of shuttles or on-demand service, private residential shuttle on campus, etc.).

The phone interviews and comparisons specifically focused on several key themes:

- Priorities and goals
- Challenges and successes
- Technology and innovation
- TDM Program Successes/Challenges
- Performance indicators

Key Takeaways

There are several major takeaways from the peer review that can be utilized by NC State in the development of a better bicycle, pedestrian, and TDM network.

Leverage Passionate Student Volunteers

CSU and GT both utilize student volunteers in an effective manner to promote and support cycling within the campus community. At GT, a joint venture between a student sustainability group and the local Atlanta bicycle advocacy group created Starter Bikes, an on-campus bike co-op that provides free or low cost-maintenance for students. The program is run out of a cage the size of approximately 2.5 parking spaces in one of the on-campus parking decks and is run by student volunteers during limited hours. The students help teach bike maintenance for only the cost of parts. The student-volunteers, limited hours, operating space, and partnership allow for the shop to operate at a low cost to the University. NC State could consider a similar collaboration with the local advocacy organization and support passionate student-volunteers to create a similar bike shop.

CSU uses student-volunteers in a slightly different capacity than GT. CSU has six student ambassadors that assist with a variety of programming to promote cycling. The programming includes presenting at new student orientations, a bike education course during move-in weekend, and a residential hall education program. Ambassadors present to new students at their orientation regarding the benefits of cycling and proper bike usage on campus. The move-in education course brings together various campus departments, including parking and transportation, housing, and police to talk about various aspects of cycling from bike safety to proper bike storage. The residential hall education program focuses on educating students on the effects of transportation on the cost of living. During the program students explore different living options on and off campus and are shown how to compare costs of living for the different options. Programs like these can be an effective way to help encourage more bicycle usage within the student body and are particularly affective because they are student run. NC State could consider new student orientation that leans on the expertise of student-volunteers.

Remove Barriers of Entry for Active Transportation Modes

All peer universities provided good examples of ways to reduce barriers to entry for active transportation modes. For example, UW-M provides over 14,000 bike parking spots, making travel by bike the easiest and most obvious transportation option for students and employees. CSU and GT both encourage active transportation modes by providing bicycle and pedestrian supportive amenities when designing new buildings. These amenities include commuter showers, lockers for personal belongings, and safe and secure bike parking. This includes either indoor bike parking, covered bike racks or bike lockers. CSU advocates for mixed-use buildings and districts to reduce single occupancy vehicle trips while Georgia Tech incorporates sustainability into their campus development and planning.

Figure 6.3: UW-M Cycle Track

NC State should continue to collaborate with the Office of the University Architect to design buildings that support active transportation.

UW-M, CSU, and GT agreed that bike share is not viable as a stand-alone campus system and collaborate with their respective city's bike share systems. CSU tries to encourage new developments to design bike share stations into their public spaces. Six (6) GT bike share stations were installed without a fee in coordination with the city of Atlanta roll out of its first 500 bikes for their Relay Bikes system. At UW-M, the Student Senate approved $300,000 for the purchase and installation of 5 bike share stations – 3 "on campus" and 2 others at offsite dorms about 1 mile away. Stations are largely in public right-of-way for all three campuses. See the Bike Share Peer Review for more details.

Figure 6.4: Clemson BikeShare, SC

The orientation program at CSU removes the barrier to entry from the start by providing information about how to get around campus without a vehicle before the student moves to campus. NC State could consider providing information at new student orientation about their active transportation options.

Empower the TDM Program Manager

A common practice between the peer Universities was an active TDM manager with access to collaborate internally between University departments and externally with municipal transportation and development agencies. By thinking outside of the box and reaching out to other University departments, the TDM manager at CSU discovered that other departments had separately started similar TDM programs. The CSU manager was able to cultivate this organic movement instead of having to start from nothing.

A highly engaged and empowered TDM program manager increases awareness of the goals of the University to manage their transportation challenges. The TDM manager at GT and CSU are heavily involved in all transportation and development decisions at the city by sitting at the table for transportation and development decisions. This allows the University to encourage best practices to shift mode share towards more active transportation. Partnerships with transit agencies also help in this endeavor. GT provides discounted MARTA passes to students and employees, which has resulted in ridership increases. Collaboration between an active University TDM manager and city agencies has provided GT, CSU, and UW-M with an active role in the shaping area surrounding their respective campuses. NC State could consider empowering the TDM program manager to collaborate internally and externally to find support and avoid making TDM decisions alone.

See Appendix B for more information on the questions discussed during the phone interviews as well as a comprehensive table of the Peer Review Comparisons.

Bike Share Peer Review

A peer review of similar university bike share programs was conducted to gain an understanding of operations and strategies that have been successful and that may be applicable to NC State. This peer review was conducted to help NC State develop a bike share program. The peer review included the following universities to gain further insights of bike share systems:

- Georgia Institute of Technology
- North Dakota State University
- University of Maryland
- University of North Carolina, Greensboro
- University of Oregon
- University of South Florida
- University of Wisconsin
- University of North Carolina, Chapel Hill

There are several major takeaways from the peer review that can be utilized by NC State in the development of a bike share network.

- There is a high correlation of success (ridership and financial sustainability) in programs that serve the University and local government as a single program and have been tailored from a "partnership approach."

- Best chance of success with programs that include bikes available to a large number of users at strategically located origin AND destination locations.
- "Dockless" systems have the most flexibility and have led to early high ridership numbers because of their extended coverage area with a smaller number of bikes.
- Funding for bike share programs is done in many different ways. Options include, user payment, sponsorships, or direct University funding. Many universities have been successful in having bike share funded by the vendor or through other non-University related funding sources.
- Often, management and maintenance costs can be more than expected. Consideration for long term O & M costs should be considered, especially if funded by the University.

See Appendix B for more information on the bike share programs at all the universities listed above.

Figure 6.5: A LimeBike parked on Hillsborough Street, Raleigh, NC

Figure 6.6: Clemson University Bike Share Dock, SC

ANALYSIS

The following service goals were identified to guide the analysis and recommendations.

Service Goals

1. Improve safety of bicyclists and pedestrians on and around campus
2. Create a more robust Transportation Demand Management (TDM) Program
3. Start a culture shift towards alternative modes of transportation
4. Establish policies that will guide bicycle and pedestrian facilities for NC State in the future

Figure 6.7: Bicycle Parking, NC State

Bicycle and Pedestrian Project Analysis

A high-level analysis of NC State's bike and pedestrian network was performed to determine projects that would enhance the network and make progress towards reaching the service goals. The University provided a list of projects that have not been completed from the Campus Bicycle and Pedestrian Plan (Martin-Alexiou-Bryson, October 2011). This list was analyzed and supplemented with bicycle and pedestrian projects that will enhance the network and make progress towards reaching the service goals.

TDM Program Performance Metrics

The University reports TDM performance metrics to the Triangle J Council of Governments (TJCOG) every quarter of the fiscal year. A comparison of 2016 and 2017 performance metrics was performed and the following are major takeaways.

Participation Metrics

- In 2017, there are 4,413 students with GoPasses and 564 employees with GoPasses
- Share the Ride NC saw a large increase in users in quarter 3 of FY 2017 and it could be the result of a new commute campaign
- Vanpool does not reach many employees
  - There are 2 active vanpools and 5 vanpoolers in FY 2016 and 2017
- Student carpoolers have slightly increased from 359 participants in the third quarter of FY 2016 to 368 participants in FY 2017
- Employee carpoolers have slightly increased from 143 participants in the third quarter of FY 2016 to 144 participants in FY 2017

The following graphic illustrates how many students and employees participate in the WolfTrails program as a walking, biking, or transit commuter.

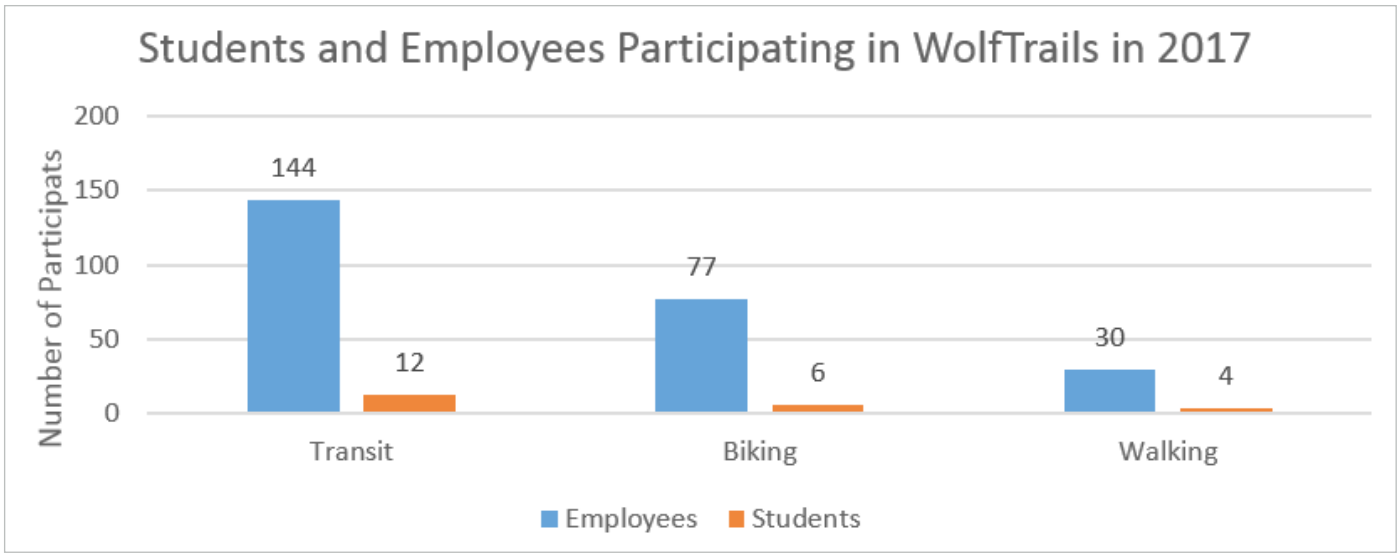


Figure 6.8: Students and Employees Participating in WolfTrails in 2017

Mode Split

2015 Employee Commute Survey

- Drive Alone - 83.2%
- Carpool - 5.6%
- Transit - 4.5%
- Bike - 1.9%
- Walk - 2%

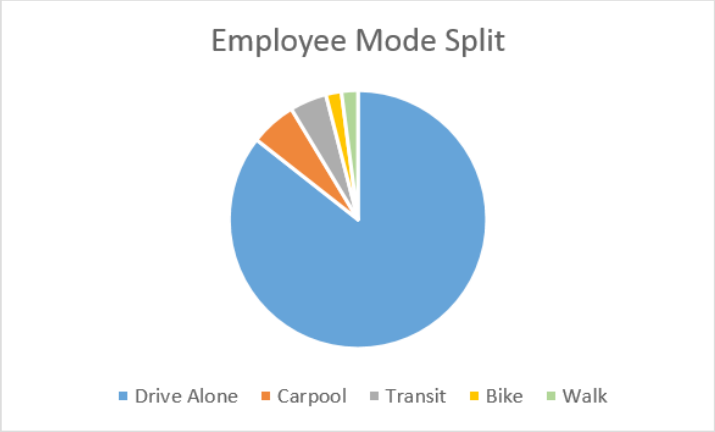


Figure 6.9: Employee Mode Split

2015 Student Commute Survey

- Drive Alone - 51%
- Carpool - 3.6%
- Transit - 26%
- Bike - 5.5%
- Walk - 10.4%

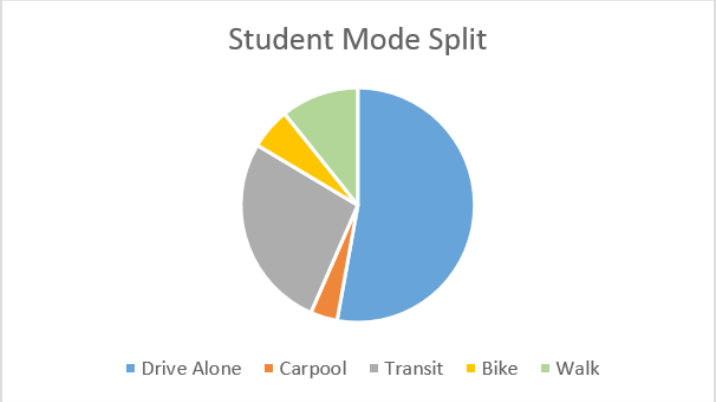


Figure 6.10: Student Mode Split

The 2015 mode split data is consistent for a university setting with a high number of student transit commuters and about half of commuting students driving alone. This mode split data does highlight system improvement priorities. For employees, it should be a priority to increase the percentage of transit commuters, and for students, it should be a priority to increase the percentage of carpool commuters.

In-person outreach

- The number of events where TDM Program information has been presented is has decreased from 52 events by the third quarter of FY 2016 to 41 events by the third quarter of 2017
- The total duration of events where TDM program information has been presented has increased from 72.5 hours by the third quarter of FY 2016 to 82 hours by the third quarter of FY 2017

According to the performance metrics reported to TJCOG, the TDM program is not seeing substantial growth from FY 2016 to FY 2017. In addition, there are very few students using the WolfTrails incentive programs. Using these performance statistics, recommendations were made to help improve the impact of the TDM program.

Figure 6.11: Bicyclists on Morrill Drive, NC State

Infrastructure

The City of Raleigh has ongoing projects that will impact the bike and pedestrian network on NC State's campus. These projects were taken into account when recommending high priority bike and pedestrian projects for the University.

The **Avent Ferry Road Corridor Study** is currently underway and preliminary recommendations include bikeways along Avent Ferry Road from Tryon Road to Western Boulevard. This recommendation would provide a bicycle connection from a primarily residential area to Main and Centennial Campuses.

The **Blue Ridge Road Bicycle and Pedestrian Improvements** project is looking to complete bicycle and pedestrian improvements on Blue Ridge Road from Trinity Road to Reedy Creek Road. This project is in the vicinity of the Centennial Biomedical Campus and could provide safe bicycle and pedestrian accommodations to students and employees at this campus.

The **Gorman Street Connector (Cycle Track)** is proposed to improve bicycle and pedestrian connectivity between the existing Rocky Branch Trail at Ligon Street/Sullivan Drive and the Reedy Creek Trail at Hillsborough Street/Clark Avenue. The project design includes a two-way cycle track bicycle facility on Gorman Street and bicycle and pedestrian improvements at major intersections. This project will provide a fully protected cycling commuting route from areas around NC State.

The **Pullen Road/Oval Drive Extension** will consist of an extension of Pullen Road from the Western Boulevard interchange to Oval Drive at Centennial Parkway. The cross-section of the proposed street will include bike lanes, a 6-foot sidewalk on the east side, and a 10-foot multi-use path on the west side. This project will provide an important connection for bicyclists and pedestrians. With these bike and pedestrian improvements on the extension and the proposed improvements put forth in this master plan, it is anticipated that this corridor will be highly used by bicyclists and pedestrians traveling between Main Campus and Centennial Campus.

Phase II of the Hillsborough Street Revitalization project is reconstructing 0.5 miles of Hillsborough Street from Rosemary/ Shepherd Street to Gardner Street. The project includes removing traffic signals and adding three roundabouts, and is intended to transform this section of Hillsborough Street from a congested three-lane street to a safer two-lane avenue—creating a more pedestrian-friendly environment, enhancing motorist safety, and supporting

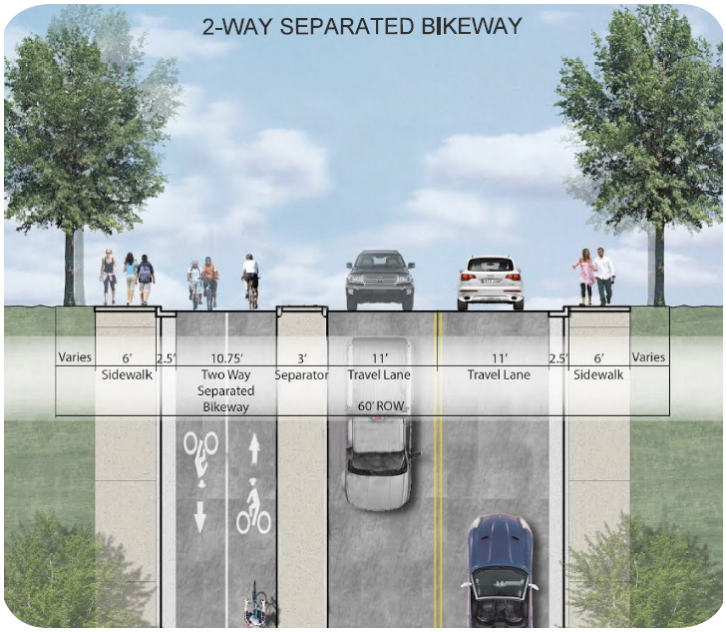


Figure 6.12: Gorman Street Connector, ALTA Planning + Design

revitalization efforts. Hillsborough Street acts as a barrier to the north side of Main Campus. The bike and pedestrian improvements will allow students and employees to safely access businesses and residential developments along and north of Hillsborough Street.

In addition to the City of Raleigh, NCDOT has ongoing or planned projects that will impact the bike and pedestrian network on NC State's campus.

The **Western Boulevard Tunnel (EB-5718)** proposes a bicycle and pedestrian tunnel immediately west of the Western Boulevard at Avent Ferry Road/Morrill Drive intersection. This project will provide a safe crossing for bicycles and pedestrians moving across Western Boulevard. In addition to the bicycle and pedestrian improvements outlined in this master plan, this tunnel will provide a crucial connection for bicycle and pedestrian movement between Main Campus and Centennial Campus.

The **Pullen Road Bridge Replacement (B-5675)** was identified due to the aging of the Pullen Road bridge over Western Boulevard. The project is not included in the current STIP, but is expected to be included in future versions. Additionally, due to the strong bicycle and pedestrian connection from Main to Centennial Campus identified with the Pullen Road Extension, it is recommended to work with the City of Raleigh and NCDOT as this project progresses to ensure a strong bicycle and pedestrian network can be extended along Pullen Road.

RECOMMENDATIONS

High Priority Project Recommendations

Specific recommendations have been made for high priority projects that the University should consider to enhance the bicycle and pedestrian network on and around campus.

A major issue facing NC State is safety and ease of access for bicyclists and pedestrians between the campuses. The University is surrounded by high volume and high speed roads and it is generally not safe or convenient to walk or bike between the campuses. The proposed list of high priority projects will connect Main Campus and Centennial Campus through different locations.

Specifically, a connection along Nazareth Street from Main Campus to Centennial Campus with protected crossing locations will provide a direct and safe connection for bicycles and pedestrians. Additionally, a connection with a separated cycle track on Morrill Drive and Avent Ferry Road, a tunnel under Western Boulevard, and various multi-use paths connecting into Centennial Campus will provide students and employees with another option for a safe and convenient connection between the campuses.

In addition to safety, it is important to start a culture shift towards alternative modes of transportation. In addition to a strong bike and pedestrian network, a connection to regional transit will help reinforce this culture shift. As part of the wake transit plan, Bus Rapid Transit (BRT) will service Western Boulevard and high frequency bus service will also service Hillsborough Street and Pullen Road. The recommendations noted in this plan will provide service to these high frequency regional transit routes.

The following are a few projects that will have a direct impact on the bike and pedestrian networks of Main and Centennial Campus

- Providing bicycle lanes on Centennial Campus

Figure 6.14: Existing Partners Way—no cross walks or sidewalks on the west site of Partner's Way. NC State

- Pedestrian hybrid beacon crossings

Figure 6.15: Pedestrian Hybrid Beacon on NC 49, UNC Charlotte, Google Maps

Figure 6.13: BRT on Western Boulevard, Photo Simulation

Figure 6.16: Street Converted to Pedestrian Plaza, University of Texas, Austin

- Closing Cates Avenue to traffic and creating a bike and pedestrian walkway
  - This project may not happen within the time frame of this master plan so an interim recommendation is making all parking parallel and widening the sidewalks
- Constructing a bike and pedestrian bridge from Broughton Hall to Talley Student Center
  - This project was identified in the Yarbrough Master Plan

In addition to these projects, other high priority projects were identified that help promote the service goals. The map on the following page highlights the high priority projects that the University should complete to provide a complete bicycle and pedestrian network. The tables following the graphics provide details on the high priority projects included in the graphic. For a list of all projects considered in this plan, see Appendix C.

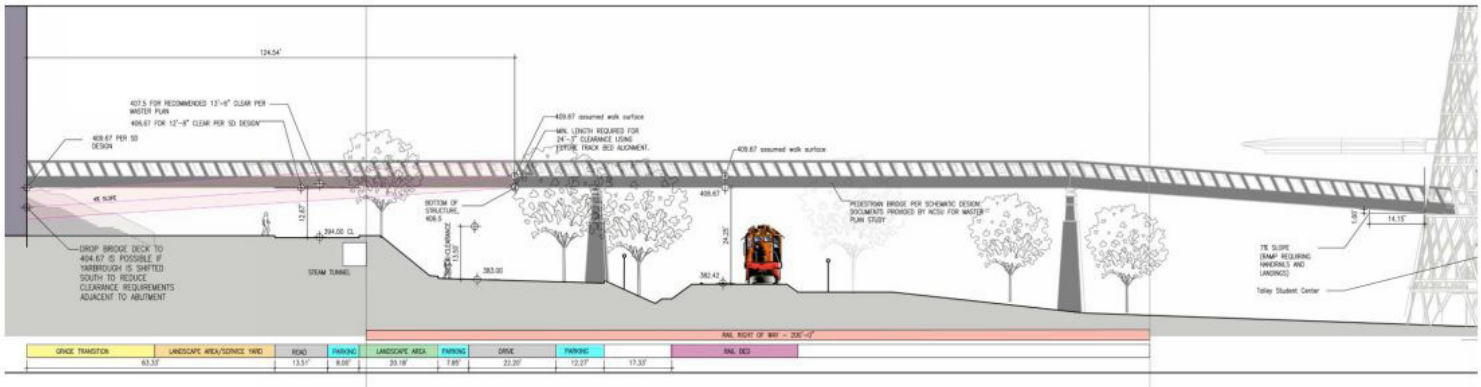
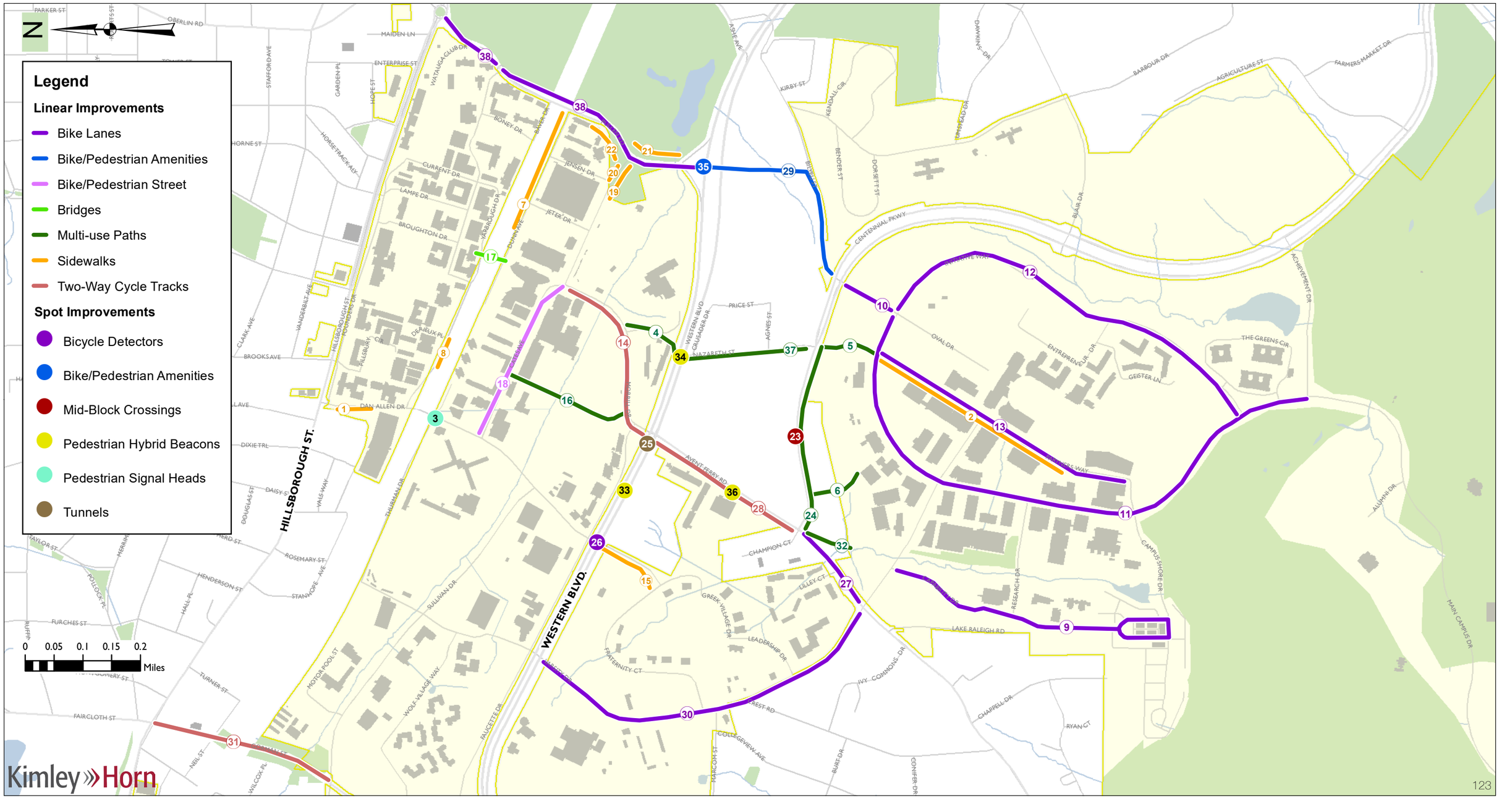


Figure 6.17: Proposed Yarbrough Talley Pedestrian Bridge, Yarbrough Master Plan

HIGH PRIORITY BIKE AND PEDESTRIAN PROJECTS



HIGH PRIORITY BIKE AND PEDESTRIAN PROJECTS

On Campus Bike and Pedestrian Projects							
Map ID	**Priority**	**Facility / Intersection**	**From**	**To**	**Comment**	**Length (mi)**	**Comments**
1	High	Dan Allen Dr	"Live On Hillsborough" Sidewalk on Dan Allen	Dan Allen Dr - Pedestrian table	Extend existing sidewalk along west side of Dan Allen Dr from Live on Hillsborough apartments to the Dan Allen parking deck	0.06	Currently Dangerous - trench in this location people clearly use this
2	High	Partners Way	Partners I	Main Campus Dr	Construct new sidewalk or path along west side of Partners Way	0.39	
3	High	Dan Allen Dr	Thurman Dr	N/A	Install countdown pedestrian signals for north-south direction	N/A	
4	High	New connection	Warren Carroll Dr	Western Blvd	Construct mulit-use path connection from Wood Hall to Western Blvd greenway	0.04	Consider changing to multi-use path. Creating a cycling connection is important
5	High	New connection	Partners Way	Nazareth St	Establish a multi-use path and connect with Nazareth Street	0.12	
6	High	New connection	Centennial Pkwy	Main Campus Dr	Establish a multi-use path from Main Campus Dr through apartments	0.13	Relocate to existing sidewalk location through the back of the residential storage lot to the west - create better sidewalk (will requrie easement)
7	High	Dunn Ave	Free Expression Tunnel	Pullen Rd	Construct new sidewalk or path along north side of Dunn Ave; connect all three tunnels and Pullen Rd; project within NCRR right-of-way	0.37	
8	High	Yarbrough Dr	End of sidewalk	Existing parking	Extend existing sidewalk from Wolfline bus stop eastward to parking area along Yarbrough Dr	0.04	Path might be used because of shade
9	High	Capability Drive	Varsity Dr	Campus Shore Drive	Stripe bicycle lanes along roadway	0.63	
10	High	Oval Dr	Centennial Pkwy	Main Campus Dr	Stripe bicycle lanes along roadway; connect with centennial campus multi-use path	0.12	
11	High	Main Campus Dr	Oval Dr	Achievement Dr	Stripe bicycle lanes along roadway	1.07	
12	High	Initative Way	Oval Dr	Main Campus Dr	Stripe bicycle lanes along roadway	0.71	
13	High	Partners Way	Hunt Library	Main Campus Drive	Stripe bicycle lanes along roadway (Approximately 80' climb from Hunt library to Main Campus Drive)	0.45	
14	High	Morrill Dr	Cates Ave	Western Blvd	Establish 2-way cycle track	0.32	
15	High	Dan Allen Drive	Western Blvd	Fraternity Court	Add sidewalk on west side	0.22	
16	High	IM Field Bisector	Cates Ave	Morrill Drive	Establish an ADA-compliant connection for bicycle/pedestrian access northbound from Cates Ave through Miller field and Wolfpack Training Center to Morrill Dr.	0.24	
17	High	Bike/Ped Bridge	Broughton Hall	Talley Student Center	Construct Bike/Ped Bridge over RR tracks from Broughton Hall to Talley Student Center. In addition construct ramp down from Talley Entrance to ground level.	0.07	
18	High	Cates Ave	Dan Allen Dr	Morrill Drive	Close Cates Avenue to Traffic and create a bike/pedestrian street - This project needs to be combined with the creation of a new east-west street connection. Interim solution - convert all parking to parallel and widen sidewalks	0.31	

HIGH PRIORITY BIKE AND PEDESTRIAN PROJECTS

Off Campus Bike and Pedestrian Projects							
Map ID	**Priority**	**Facility / Intersection**	**From**	**To**	**Comment**	**Length (mi)**	**KH Comments**
19	High	Cates Ave	Derr Track	Pullen Rd	Extend existing sidewalk (south side)	0.06	These are shown on Pullen Park Master Plan and thus should be constructable within Pullen Property
20	High	Cates Ave	Jensen Dr	Pullen Rd	Extend existing sidewalk (north side)	0.06	
21	High	Pullen Rd	Cates Ave	Western Blvd	Work with City of Raleigh to construct sidewalk along east side of road; connect to existing sidewalk at Cates / Pullen intersection	0.08	
22	High	Pullen Rd	Cates Ave	Bagwell Hall	Work with City of Raliegh to construct sidewalk along west side of road; connect to existing sidewalk	0.08	
23	High	Centennial Pkwy	Mission Valley	N/A	Work with City of Raleigh &/or NCDOT to provide mid-block crossing between Nazareth Street and Centennial Parkway and monitor for future PHB warrants	N/A	We are not recommending the crossing be at the back of mission valley. We propose to move it farther west (just east of the driveway at the Waffle House) to better align with pedestrian desired paths.
24	High	Centennial Pkwy	Avent Ferry Rd	Multi-Use Trail	Work with City of Raleigh to provide multi-use path from the intersection of Avent Ferry Road to the multi-use path entrance at Nazareth Street	0.33	
25	High	Western Blvd	Morrill Dr	Avent Ferry Rd	Work with City of Raleigh &/or NCDOT to provide tunnel for long-term separation of transit, bicycle, and pedestrians	0.06	Programmed on NCDOT STIP (EB-5718) for construction in 2021
26	High	Dan Allen Dr	Western Blvd	N/A	Work with City of Raleigh &/or NCDOT to install bicycle loop detectors at signalized intersection, both directions	N/A	
27	High	Avent Ferry Rd	Centennial Pkwy	Varsity Dr	Work with City of Raleigh &/or NCDOT to stripe bicycle lanes along roadway. Buffer bikes from traffic due to high traffic speeds and volumes	0.18	Needs to be done with ID 58
28	High	Avent Ferry Rd	Western Blvd	Centennial Pkwy	Work with City of Raleigh &/or NCDOT to provide a separated cycle track or multi-use path for bicyclists on west side of Avent Ferry Road.	0.24	Large grade and existing paths are not usable; needs to be done with ID 44
29	High	Pullen Rd	Western Blvd	Centennial Pkwy	Work with City of Raleigh &/or NCDOT to extend existing Pullen Rd to south and provide new connection; Construct sidewalks/bicycle facilities and improve intersection geometry	0.38	
30	High	Varsity Dr	Western Blvd	Avent Ferry Rd	Work with City of Raleigh &/or NCDOT to stripe bicycle lanes along roadway	0.67	Field observations show only sharrows have been striped, not bike lanes.
31	High	Gorman St	Sullivan Street	Hillsborough St / Faircloth St	Work with City of Raleigh to extend existing bicycle lanes. Provide 2-way cycle track from Sullivan to Hillsborough	1.64	City is building cycle track from Sullivan to Hillsborough Street. Bike lanes are only in a few locations along Gorman Street.
32	High	Extend Multi-Use Trail	End of trail	Avent Ferry Rd	Work with City of Raleigh to extend existing multi-use trail north and connect with Avent Ferry Rd sidewalk and/or Centennial Pkwy	0.07	
33	High	Western Blvd	Western Blvd	N/A	Install a PHB crossing between Avent Ferry and Dan Allen and time with adjacent signals (short-term solution before tunnel)		
34	High	Western Blvd	Nazareth Blvd	N/A	Install a PHB Crossing at Western Blvd. and Nazareth St. Time with Western/Avent Ferry Signal		
35	High	Western Blvd at Pullen Road Interchange			Work with City of Raleigh & NCDOT to include bike/ped amenities with future Pullen Road/Western Boulevard interchange rebuild (B-5675)		
36	High	Avent Ferry Road	South of Western Blvd		Install a PHB crossing between Centennial Parkway and Western Boulevard. Time with adjacent signals.		
37	High	Nazareth Street	Centennial Pkwy	Western Blvd	Upgrade sidewalk to multi-use path	0.21	Improve existing sidewalk to create multi-use path on Nazareth Street
38	High	Pullen Road	Western Blvd	Hillsborough Street	Work with City of Raleigh to &/or NCDOT to stripe bicycle lanes along roadway	0.51	

Establishing Policies

The following policy recommendations were determined to provide the University with control over bike, pedestrian, and TDM amenities on campus.

Bike Lane Requirement Policy

The following policy is recommended for the installation of bike lanes. On streets over 3 lanes, bike lanes are required unless the posted speed is 25 mph or less and average daily traffic (ADT) is less than 12,000 vehicles per day (VPD). For 3 or less lanes, the requirement of bike lanes is a function of speed and ADT. Industry suggestions may vary, but if either of the following are true bike lanes should be recommended:

1) Posted speed is over 25 MPH and/or

2) ADT is over approximately 8,000 VPD

Due to the low speeds and low traffic volumes on Main Campus, bike lanes would not be recommended and sharrows can be installed.

Shower Facility Policy

The following policy is recommended for the installation of shower facilities. A shower facility should be included in all new buildings on campus. If a major renovation is being done to an existing building, it should include a location for a shower facility.

Appendix D includes a current list of all existing shower facilities and proposed shower facilities.

Short-Term and Long-Term Bicycle Parking Policy

The City of Raleigh UDO states specific recommendations for bicycle parking requirements for short-term and long-term parking. Short-term bicycle parking must be located no more than 100 feet from the building entrance the bicycle rack is intended to serve. Long-term bicycle parking is intended to serve employees, students, residents, or other commuters who generally stay at a site for several hours. Long-term bicycle parking must be covered and water-resistant and must be located no more than 300 feet from the building entrance or 660 feet from a parking structure.

In addition, specific bicycle parking requirements by land use are defined below.

Dormitory:

- Short-term – 1 space per 20 bedrooms, minimum 6 spaces
- Long-term – 1 space per 5 bedrooms

Academic*:

- Short-term – 1 space per 5,000 SF of academic space
- Long-term – 1 space per 10,000 SF of academic space

*These values were modified to provide more short and long-term bicycle parking at the dense academic areas at NC State.

Office:

- Short-term – 1 space per 10,000 SF of gross floor area, minimum 4 spaces
- Long-term – 1 space per 5,000 SF of gross floor area, minimum 4 spaces

It is recommended that NC State adopt this policy for all future development and try to implement these requirements for existing buildings.

TDM PROGRAM RECOMMENDATIONS

The following specific recommendations of actions and policy changes were determined to embrace the guiding principles of park once, improve connections, and reprioritize mobility options. In addition, the recommendations include short-term and long-term actions:

Short-term Recommendations (Year 1):

- Consider requiring bicycle registration and inform students and employees about the WolfTrails program when they register their bike
- Provide additional covered bike parking (see bicycle parking policy)
- Inform students and employees about the WolfTrails program when they receive their discounted GoPass
- Consider providing additional bike lockers that are available for renting on a short-term basis
- Provide additional zipcars around campus and discuss the potential of free rides for students without parking permits

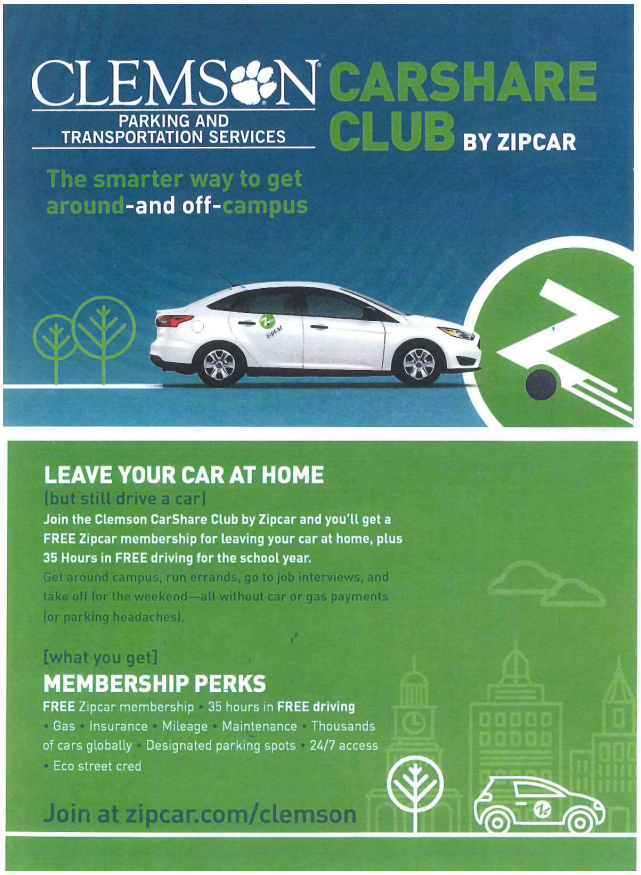


Figure 6.18: Clemson Zipcar Brochure

- Focus on TDM program branding and marketing and focus outreach efforts on locations where there is access to a large number of commuters who may be taking single-occupancy vehicle (SOV) trips
- Focus outreach to groups such as student government, sustainability, and first-year and transfer orientations
- Consider promoting a bike to school day
- Increase and enhance outreach efforts and evaluate outcomes
- Continue to focus Wolfline service on connecting the campuses and connecting to established parking areas while ensuring safe and comfortable spaces for buses to pick up passengers
- Monitor the new LimeBike bike share pilot program for successes and failures and continue to work as a partner with the City of Raleigh as they implement a bike share program
- Consider Providing more bicycle fix-it stations on campus to encourage bicycle use
- Provide specific details for commuter incentives on WolfTrails webpage
  - For carpoolers provide specific details on what decks the permits can be use at on the WolfTrails webpage
  - For carpoolers, transit, bicycle, and pedestrian commuters provide specific details on where "scratch-off" permits can be used on the WolfTrails webpage
- Consider extending WolfPack pick-up service to Centennial Campus

Long-term Recommendations (Years 2-5):

- Consider having the TDM program manager provide personalized trip planning and commuter assistance to students and employees
- Provide a bicycle shop on campus with the support of passionate student-volunteers
- Consider including the high cost of providing parking in TDM presentations to students and employees
- Include facts about how environmentally friendly alternative modes of transportation can be in WolfTrails presentations
- Consider incrementally transitioning from the year-long permits to monthly or pay-as-you-go passes to discourage SOV trips
- Advertise and encourage the use of vanpools to employees
- Advertise and encourage the use of Share the Ride NC to students and employees
- Provide a subsidy for students and employees who do not park on campus
- Create a complete bicycle and pedestrian network that connects the campuses and encourages students and employees to use alternate modes of transportation to travel around campus
- Monitor and analyze LimeBike data to determine bicycle trip desire lines on campus
- Conduct annual mode split surveys to track progress of all TDM efforts

The recommendations above could help strengthen the TDM program and inform more students and employees about the program. By conducting annual mode split surveys, the TDM program manager can track the progress of the TDM program and locate strengths and weaknesses.

7—CONCLUSION AND RECOMMENDATIONS

This Transportation Master Plan was developed for North Carolina State University (NC State) to serve as a guide for planning, management, and policy over the next 5 years. This plan outlines specific action measures and phasing recommendations for an enhanced multimodal campus transportation system.

Using these guiding principles, recommendations were made to the parking, transit, bicycle, and pedestrian network, and transportation demand management (TDM) program.

The plan focuses on three guiding principles:

Park Once

Improve Connections

Reprioritize Mobility Options

The combination of all the recommendations across the various transportation modes will lead to an enhanced multimodal campus transportation system for NC State.

Figure 7.1: Wolfline Bus Stop, NC State

RECOMMENDATIONS:

Park Once

To institute a park once mentality, there must be coordination between all modes of transportation on and around campus. If the park once philosophy is embraced, there will be decreased internal campus traffic congestion, as well as decreased congestion between the campuses. Specifically, this plan recommends NC State focus efforts on permitting strategies to discourage multiple trips and focus on varied circulation options, such as enhanced transit service and bicycle/pedestrian connections.

The strategic permitting that NC State has recently begun to implement will help promote the park once philosophy. Phase I of this strategy was implemented in the Fall 2017 semester and was targeted at students. Phase II is anticipated to be implemented in Fall 2018 and will target employees. In addition, a communications campaign aimed at employees should be developed and executed to promote the park once approach. This campaign could include the reasons, motives, and importance of the park once approach, and to provide resources that will assist employees with connecting to destinations after their car is parked.

The transit recommendations in this document make it safer and more convenient to get around campus and between the campuses, without moving personal vehicles. The recommendations provide a variety of services, including frequent service to new and existing parking areas, increased headways on a variety of routes, east to west connection on Main Campus with Route 7R, and a quicker and more direct connection from Centennial Campus to Main Campus with Route 3. As the park once permit strategies are implemented, further stress will be placed on the transit system and increased demand should be monitored as Phase II of the parking permit strategy is implemented in Fall 2018.

To further encourage a park once approach, a strong bicycle and pedestrian network is critical. Providing connections internally to each campus and between the campuses will encourage students and employees to park once and get to their destinations using other modes of transportation. The addition of a bike share pilot program with LimeBike adds another option for students and employees to get to their destination after parking. In addition, the high priority

bicycle and pedestrian projects identified in this plan include a variety of ways to increase alternative travel modes by providing increased bike and pedestrian accommodations on and between the campuses. Projects such as: providing bicycle lanes on Centennial Campus, narrowing Cates Avenue and creating a better bike and pedestrian environment, and providing a north-south multi-use path directly from Cates Avenue to Morrill Drive will increase the number of bicyclists and pedestrians and reduce personal vehicle trips on campus.

The TDM recommendations outlined in the report will also help provide support to students and employees exploring other modes of transportation. A strong TDM program can help provide support to all forms of transportation. Strengthening TDM branding and marketing and focusing outreach efforts on single-occupancy vehicle (SOV) commuters will help to spread the TDM program. Additionally, to encourage students and employees to use bicycles on campus, more covered bike parking is recommended at dormitories and academic buildings.

Improve Connections

Due to NC State's location in an urban area and the locations of its various campuses, it is important to provide accommodations for students and employees to connect between the campuses. In particular, high volumes of travel between Main and Centennial Campuses occur daily, with surges of demand at class change times. NC State is surrounded by high volume and high speed roads, and students and employees therefore need safer and more convenient ways for getting between campuses. To connect the campuses, the transportation plan focuses on making transit faster and more reliable, making strategic bicycle and pedestrian connections throughout the network, and expanding the reach of the TDM program.

The recommended Wolfline routes connect NC State's campuses by providing express service as well as bi-directional service for some routes. The routes are also simplified to make them more accessible to the occasional transit rider. The routes vary in frequency and stop location, providing fast, frequent, and reliable service between Main and Centennial Campuses.

The bicycle and pedestrian recommendations provide strong connections between Main and Centennial Campus. These connections are proposed along Nazareth Street, Pullen Road, Avent Ferry Road, and Varsity Drive to provide direct and safe connections for students and employees to use between the campuses. In addition, the pedestrian hybrid beacons (PHB) recommended along Western Boulevard and Avent Ferry Road will provide safer crossing locations for bicyclists and pedestrians.

With the impending dramatic expansion of transit service in Wake County, NC State has a prime location to connect to city and regional transit. Currently, city and regional routes touch the NC State campus and some routes go through campus. Due to this close proximity to the larger transit system, is important to provide students and employees with the ability to easily connect with the other systems. NC State already provides a discounted GoPass to students and employees, which encourages them to use the city and regional transit as a means of commuting. The Wake Transit Plan outlines upcoming changes to the area, which will have a direct impact on NC State. Specifically, the plan calls for bus rapid transit (BRT) on Western Boulevard and additional high frequency bus service on Hillsborough Street and Pullen Road.

Many Wolfline transit routes are recommended for increased frequency, and therefore will provide convenient access to the proposed Wake Transit BRT on Western Boulevard and other proposed frequent network routes. Wolfline Route 3 will provide frequent and fast service from Main Campus down to Oval Drive, which will provide an option for students and employees to use the proposed high frequency route on Pullen Road. Additionally, many Wolfline routes run along Hillsborough Street and Western Boulevard and this will provide various options for connections to the enhanced city and regional transit.

Figure 7.2: Wolfline Bus and Cyclist, NC State

The bicycle and pedestrian improvements will also provide connections from Main Campus and Centennial Campus to the proposed Wake Transit routes. The major connections from Main Campus to Centennial Campus on Pullen Road, Nazareth Street, Avent Ferry Road, and Varsity Drive provide direct connections to the Western Boulevard BRT route. Additionally, major bicycle and pedestrian improvements are proposed on Pullen Road, which will provide for easier access to stops on Pullen Road.

Reprioritize Mobility Options

A major goal for NC State is to reprioritize mobility options on campus. As mentioned in the Campus Capacity and Assessment Study, reprioritizing mobility options aims at the following: **Pedestrian > Bike > Transit > Vehicle.** The strategies put forth for implementing a park once mentality and for improving connections for NC State will help to encourage the reprioritization of mobility options.

As discussed earlier, the permitting strategy put in place in the Fall 2017 semester reduces students' ability to move around and between the campuses using their vehicles. However, this places more stress on the transit, bicycle, and pedestrian networks on campus. It is recommended to monitor the increased demand on the transit system and adjust the routes accordingly.

Additionally, by improving connections, NC state can encourage a higher usage of bicycle and pedestrian facilities. Internal to the campuses, new bike lanes and multi-use paths as well as additional bicycle storage can encourage moving around campus by walking or biking. Additionally, the implementation of the LimeBike bike share program will encourage biking on and between campuses.

Currently, it is generally inconvenient and uncomfortable to walk or bike between Main and Centennial Campus. Improving connections with multi-use paths or separated cycle tracks along Pullen Road, Nazareth Street, Avent Ferry Road, and Varsity Drive will encourage bicycle and pedestrian movement between the campuses by making it safer and more convenient.

By improving connections for the Wolfline system and the bicycle and pedestrian network to the proposed bus rapid transit (BRT) on Western Boulevard and the high frequency networks on Hillsborough Street and Pullen Road, transit ridership would be expected to increase for students and employees.

Creating a more robust TDM program can aid in reprioritizing mobility options for the University. Specifically, by providing a bicycle shop on campus and additional bicycle fix-it stations, the program can encourage bicycle usage on campus.

With the strategies put forth in this Transportation Master Plan and the Campus Capacity and Assessment Study, reprioritization of mobility options should enhance the overall campus mobility experience while reducing vehicular movement on campus.

The recommendations summarized in this report reflect a plan that will help improve the multimodal operations for NC State over the next 5 years. The recommendations convey the importance of the guiding principles of the plan: park once, improve connections, and reprioritize mobility options.