Final Report

WOODRUFF ROAD CORRIDOR STUDY

Prepared for the City of Greenville in cooperation with Greenville County,
Greenville-Pickens Area Transportation Study, and the South Carolina Department of Transportation

Kimley-Horn and Associates, Inc.

July 2007





Acknowledgements

The Woodruff Road Corridor Study was a collaborative process initiated by the City of Greenville and directed by a steering committee composed of representatives from local, regional, and state agencies. The planning process solicited the input of numerous stakeholders including Greenville County, the Greenville-Pickens Area Transportation Study, the South Carolina Department of Transportation, and representatives for several private sector real estate developments. The efforts of these stakeholders to produce a functional and implemental plan are greatly appreciated. Special thanks to Stephanie Davis for organizing the charrette.

-July 12, 2007

Vision

"To create a healthy and sustainable environment that protects the access and mobility of the Woodruff Road area while **utilizing smart growth principals**, **encouraging sustainable development**, and **protecting the community character**."

Goals

- Balance access and mobility in the corridor
- Address corridor safety concerns
- Identify potential aesthetic improvements
- Integrate with planned development
- Develop functional and implementable recommendations

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Chapter 1 – Background and Planning Process

Background and History

Since its settlement as a trading post with local Cherokee tribes, the economic success and desirable way of life in the Greenville region has been tied directly to the access and mobility provided by the transportation system. The region's role as a textile and manufacturing hub for the South continues to diversify, which is evident in the Woodruff Road area with new developments attracting corporate headquarters as well as world-class education and research facilities.

Transportation in the Greenville Region

The region's modern transportation system evolved from primitive paths between farms and plantations — the locations of which often followed paths created by wildlife and first used by Native Americans. Transportation here took a step forward in the late 1700s when roads opened to link the new settlement at the falls of the Reedy River with towns such as Asheville, NC. The need to move freight to and from coastal ports was the driving force behind 19th century transportation initiatives, which included canal and road construction as well as railroad operations. Following the expansion of the region's transportation system after the Civil War, rail cars traveling through Greenville could connect to Atlanta, GA; Charlotte and Asheville, NC; Richmond, VA; and New Orleans, LA.

In the early 20th century, local leaders began to recognize the new-found popularity of the automobile. There were only five cars in the City of Greenville in 1904, but 10 years later that number already had increased to more than 1,000. By 1924, five of the 12 most traveled roads in the state were in Greenville County. Local and state leaders responded by constructing strategic roadways throughout South Carolina.

The federal government greatly expanded the construction of highways following WWII. The impact of the National Interstate and Highway Defense Act in 1956 was profound, altering travel patterns and shifting land development practices to automobile-focused suburban development. Interstate 85 created prime sites for industrial plants and textile mills. The opening of I-385 in the last few decades further expanded the regional and national roadway network.

Evolution of Woodruff Road

Woodruff Road began as a two-lane rural state road serving primarily residential traffic. In the late 1960s, the General Electric plant opened near the corridor, making turbines fired by natural gas. As textile plants and other industrial development followed, Woodruff Road continued to operate as a two-lane facility with moderate traffic. The 1978 opening of the Greenville Mall brought new traffic to the corridor and served as a catalyst for the transformation of the surrounding area from rural to suburban.

In the early 1980s, the extension of I-385 south of I-85 sparked another change, providing additional access to the region and generating more traffic in the vicinity of Woodruff Road. Not surprisingly, the improved access encouraged new residential development along the corridor. At this time, most of the corridor was zoned as either single-family or multi-family residential with commercial nodes at major intersections such as SC 14.

During this transition, most commercial development in the area occurred along Laurens Road, located west of Woodruff Road. Aside from the Greenville Mall and minor commercial development at the interchanges, Woodruff Road was envisioned primarily as a residential area with select industrial properties. However, as residential development continued, developers capitalized on the opportunity to provide shops and restaurants along the corridor. Despite the residential zoning, the corridor began to see commercial developments sprouting up as quickly as new neighborhoods.

In the late 1990s, the final step needed for conversion to a commercial corridor occurred when General Electric sold land adjacent to I-385. Wal-Mart and Sam's Club opened in this location, and several other "big box" establishments followed suit by abandoning their previous location on Laurens Road to locate in the now-thriving Woodruff Road corridor. With the completion of developments such as the Shops at Greenridge and The Point, Woodruff Road was officially transformed from its rural beginning to a commercial hub for the region. What began as a two-lane rural road grew through a series of widening projects into a five-lane suburban thoroughfare.

Early road construction in Greenville County

Road construction on Woodruff Road in 2006





Project Overview

The City of Greenville, working in conjunction with Greenville County and private sector project stakeholders, initiated the ***Woodruff Road Corridor Study*** to evaluate the transportation and mobility constraints along the corridor. The Woodruff Road corridor traverses one of the most congested commercial areas in the city, and as a result, traffic patterns are affected not only along the corridor, but also in the surrounding area. This area extends from Roper Mountain Road to the west, to South Carolina Highway 14 to the east, and Laurens Road to the south.

To solve the problems along Woodruff Road, addressing the problems at other locations throughout the study area would be necessary. These problems include congestion at interchanges along I-85 and I-385, connectivity between existing and proposed developments, alternative modes of transportation, and better governing of developments through access management and land use planning principles.

Planning Process

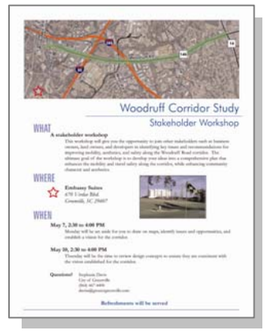
The involvement of local stakeholders was a critical component of the study's success and was accomplished through an interactive four-day design charrette. The ***Woodruff Road Corridor Study*** directly affects a number of existing and proposed developments including, but not limited to, the Shops at Greenridge, The Point, Crescent Center, International Center for Automotive Research, Millennium Campus, Verdae Development, and Carolina First.

During the charrette, input was gathered from representatives of these developments and many others, as well as City and County staff and South Carolina Department of Transportation (SCDOT) representatives. The charrette process resulted in a set of recommendations that City and County planning staff can utilize as a tool for implementing future improvements and land development within the Woodruff Road study area.

The design charrette took place May 7-10, 2007, with stakeholder input sessions held on the first and last day of the event. In between these two sessions, the project study team worked with City and County planning staff, molding the ideas of the stakeholders into a reasonable and feasible plan that could be used to implement improvements designed to reduce congestion and allow Woodruff Road to continue to thrive as a commercial hub.

Several overarching issues were addressed during the design charrette.

- **The resulting plan must enhance access and mobility.** Lack of access management leads to a struggle for mobility along the corridor. The current five-lane configuration along the corridor combined with the overabundance of driveway openings create undesirable levels of congestion.
- **Regional connectivity must be addressed.** The most successful tool for reducing congestion along the corridor will be the provision of alternate routes for through-moving traffic. Better connections through collector street planning and roadway improvements are vital.
- **Alternate modes of transport should be investigated.** Removing vehicular traffic by implementing improvements to both transit and bicycle- pedestrian mobility will directly affect both the corridor and the quality of life in the study area.
- **Connections to the Interstate should be evaluated.** Existing interchanges with I-85 and I-385 should be evaluated to determine if potential improvements might lessen the congestion along the corridor and/or increase safety at the location. Potential new interchanges should be evaluated for feasibility and resulting congestion relief.
- **Safety must be addressed.** Congestion levels along the corridor also directly affect the safety of vehicular and pedestrian activity. The recommendations of this plan must address vehicular and pedestrian safety issues along the corridor and the entire study area.
- **Changes to the corridor must be aesthetically pleasing.** Improvements to Woodruff Road should enhance — not detract from — the character of the surrounding community.
- **Plan recommendations must be functional and implementable.** Recommendations should be constructible and based on sound engineering principles. A plan based on sound engineering and planning can lead to easier implementation through phased improvements.


Woodruff Corridor Study
Stakeholder Workshop
WHAT
WHERE
WHEN

Early in the planning process, the project team worked with key stakeholders and local officials to develop a vision to guide the development of the Woodruff Road Corridor Study. The vision was supplemented by several broad goals intended to focus planning efforts on functional and viable solutions for the corridor.

Vision

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Goals

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Day 1

The charrette kicked off May 7 with a stakeholder work session at the Embassy Suites on Verdae Boulevard. This event was designed to provide a project background to the stakeholders and then allow them to voice their concerns and ideas. Some of the issues and comments developed during this session are depicted on this page.

We can't really address our transportation issues unless we address connectivity.

CREATE "BEAUTIFUL" BOULEVARDS & BRIDGES

Synchronize Signals.

Fix or modify interchanges.

BETTER WAYFINDING NEEDED — "IT'S CONFUSING"

Provide better choices for the traveling public

"It's time for a change"

Shift work hours.

Cross-acess needed for bike and pedestrains

ABANDONED RAIL LINE SHOULD BE USED AS TRANSPORTATION CORRIDOR

PROVIDE A "TOOLBOX" FOR PLANNING

Need secondary road system to relieve Woodruff.

Day 2

The second day of the design charrette focused on developing the recommendations of the stakeholders into feasible engineering and planning concepts. The issues evaluated included access management, interchange feasibility, regional connectivity, and transit improvements. Most concepts were only developed to a "trash-paper" conceptual level, allowing numerous ideas to be generated without allocating time to fine-tune the concepts.

A pin-up session was held at the Greenville County planning offices to enable the visiting stakeholders to weigh in on the proposed improvements. The "trash-paper" concepts were displayed, allowing the attendees to discuss the pros and cons of each proposed improvement. This feedback ensured that the proposed improvements were consistent with the vision of the community.

Day 3

The third day of the charrette was spent fine-tuning the proposed improvements, applying planning and design concepts to ensure each proposal was feasible and implementable. Another pin-up session allowed stakeholders to view the progress of the project team and propose final revisions to the plans before the concluding presentation.

Day 4

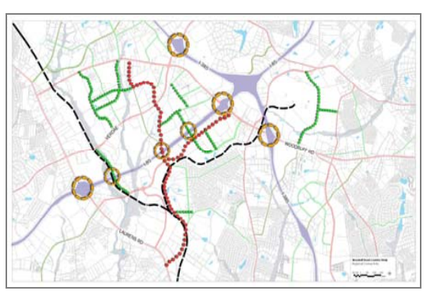
The fourth and final day focused on compiling the concepts and ideas into a concise plan that follows sound engineering and urban design principles, is functional, and is implementable. At the final stakeholder work session — which also was conducted at the Embassy Suites — exhibits with conceptual design plans, computer images, and hand renderings were displayed. Stakeholders viewed the displays and asked questions about the designs. A final presentation focused on the proposed improvements, including access management, regional connectivity, transit, and interchange design concepts. Following the presentation, a general question-and-answer session touched on several issues such as phasing and implementation plans, funding opportunities, and design feasibility.

Report Organization

The organization of the *Woodruff Road Corridor Study* mirrors the exhibits presented at the second stakeholder work session. The chapters include:

Chapter 2 – Regional Context

The report begins by placing the Woodruff Road corridor into a regional context. Chapter 2 outlines the transportation planning framework, existing traffic congestion and traffic, and planned development. The chapter concludes with a discussion of existing and proposed regional connectivity for various modes.



Chapter 3 – Access Management Strategies

This chapter presents a toolbox of strategies specific to Woodruff Road that are used to balance the mobility of the roadway with the need to provide access to adjacent properties. These strategies are placed into the context of the Woodruff Road corridor through a series of illustrative maps.

Chapter 4 – Interchange Modifications

Chapter 4 begins with an overview of typical interchange configurations and design standards before exploring existing conditions at local interchanges. Near- and long-term recommendations for interchange improvements are provided.

Chapter 5 – Land Use Considerations

The inherent relationship between land use and transportation is discussed in this chapter. This relationship is placed into a local context with descriptions of area land uses and development patterns. A policy and guidelines toolbox, coupled with a series of land use recommendations, help provide a transition from the improvements presented in the first four chapters to the implementation strategies in Chapter 6.

Chapter 6 – Implementation

A prominent goal throughout the *Woodruff Road Corridor Study* planning process was to produce a set of functional and implementable recommendations. The report concludes by detailing specific implementation and funding strategies to ensure that the vision for Woodruff Road becomes a reality.

Chapter 2 – Regional Context

Overview

Woodruff Road looks and functions very differently today than it did only 10 years ago, when it was mostly a two-lane rural highway. Today, the road traverses some of the busiest and most congested commercial areas in the city, namely those close to the I-85 interchange. The road also passes or connects to several existing and emerging developments, including as the Shops at Greenridge and The Point. Other large-scale developments in various stages of planning include the Magnolia Park Town Center, Clemson University International Center for Automotive Research campus, Millennium Campus, and Verdae Development. As denser, mixed-use developments become more common in the area, changes to Woodruff Road will clearly impact a number of local stakeholders.

Between Verdae Boulevard and SC 14, Woodruff Road is a multi-lane undivided facility, with commercial development, multiple (more than 120) curb-cuts, and 17 traffic signals. These conditions have contributed to the corridor being labeled as a dangerous, highly congested facility to avoid whenever possible. Residents describe how too much traffic throughout the day causes safety issues for both drivers and pedestrians.

This chapter begins with a discussion of the transportation planning framework, followed by a brief description of existing traffic congestion and safety. After introducing planned developments in the vicinity of the corridor, connectivity of various modes of travel are placed in a regional context.

Eastbound Woodruff Road at SC 14

Eastbound Woodruff Road approaching Miller Road

Transportation Planning Framework

An efficient transportation system connects neighborhoods and activity centers via a network of streets, paths, and trails that are safe and supportive of pedestrians, bicyclists, transit patrons, cars, and trucks. Such a system offers choice for short and long trips alike and promotes convenient movement of people and goods.

The network of streets also contributes to urban form. Narrow two-lane streets with on-street parking and safe pedestrian crossings lead to visibly different building form — and even land use — compared to a high-speed, multi-lane divided highway. Both types of facilities are needed in most cities and towns. Determining how and where to use each type of street to ensure a functional and efficient transportation system requires consideration of both land use and transportation.

The regional, long-term vision of the Woodruff Road corridor involves the traditional philosophy of street planning. This vision includes an interconnected network of community-friendly streets that provides for the safe, effective, and efficient movement of all modes of travel including walking, cycling, riding, and driving. All new and improved transportation options should respect the land use/transportation connection by supporting established neighborhoods while anticipating new growth and changing travel patterns.

For an area developing and redeveloping at the pace of the Woodruff Road corridor, linking land use and transportation can reduce capital and operating costs for the transportation system, ensure consistent economic growth, and protect social and environmental resources. In addition to balancing the urban and rural divide, the benefits of connecting land use and transportation include:

- Convenient and attractive access between work, services, and residences while reducing dependency on automobiles and the area's major thoroughfares
- Attractive, economically sound places served by an efficient and diverse transportation system

At the heart of land use and transportation planning is the relationship between access and mobility, which is particularly relevant along corridors such as Woodruff Road. Like many of its suburban counterparts emerging throughout the state and nation, Woodruff Road struggles under the weight of providing access to popular commercial establishments and offering through mobility for motorists.

Functional Classification, Access, and Mobility

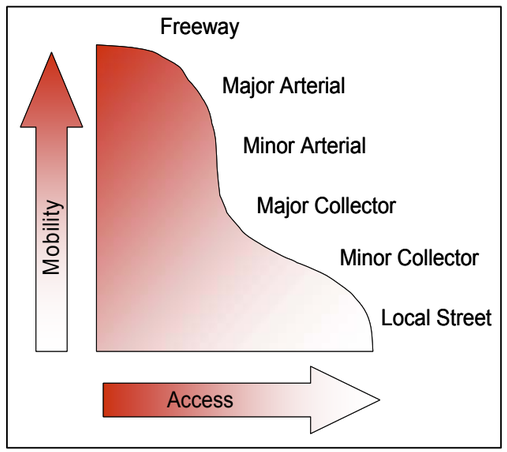
The functional classification system groups streets according to the land use served (or to be served) and provides a general designation of the type of traffic each street is intended to serve. The street functional classification system primarily defines streets in terms of design and operational characteristics for the movement of vehicles.

Two major considerations for classifying arterials and neighborhood streets are access and mobility. The primary function of local or neighborhood streets is to provide access. These streets are intended to serve localized areas or neighborhoods, including local commercial and mixed-use land uses. Local streets are not intended for use by through traffic.

The primary function of arterials is mobility. Limiting access points (intersections and driveways) on arterials enhances mobility. Too much mobility at high speeds limits access to pedestrians and bicyclists. The arterial is designed with the intent to carry more traffic than is generated within its corridor. Arterials serve a range of travel distances and traffic volumes. The existing street network in the Woodruff Road area includes several functional classifications, including:

- **Arterials** provide high mobility, operate at higher speeds (45 mph and above), provide significant roadway capacity, have a great degree of access control, and serve longer distances. Arterials include facilities with full access control, such as freeways, as well as boulevards and major thoroughfares. Arterials usually connect to one another or to collector streets. Very few arterials connect to local streets. Arterials include freeway facilities such as :
  - **Freeways** provide the most mobility and least access (only at interchanges). Local examples of freeways include I-85 and I-385.
  - **Principal arterials** typically have tightly controlled access and few, if any, individual site driveways. These arterials are typically intersected by expressways and freeways as well as minor arterials and other public streets. Laurens Road is classified as a principal arterial.
  - **Minor arterials** primarily serve a mobility function but often have more closely spaced intersections, some individual site driveways, and generally lower design and posted speeds compared to other arterials. Minor arterials within in the study area include Woodruff Road, Verdae Boulevard, and Millennium Parkway.
- **Collectors** typically provide less overall mobility, operate at lower speeds (less than 35 mph), have more frequent and greater access flexibility with adjacent land uses, and serve shorter distance travel than arterials. Collectors provide critical connections in the roadway network by bridging the gap between arterials and locals. Thus, the majority of collector streets connect with one another, with local streets, and with non-freeway/expressway arterials. Collector streets within the project study area include Market Point Drive and Smith Hines Drive.
- **Locals** provide greater access and the least amount of mobility. These facilities typically connect to one another or to collector streets and provide a high level of access to adjacent land uses/development (i.e., frequent driveways). Locals serve short distance travel and have low posted speed limits (25 mph to 35 mph). Local streets within the study area include Forest Lake Drive, Hendrix Drive, and Ketron Court.

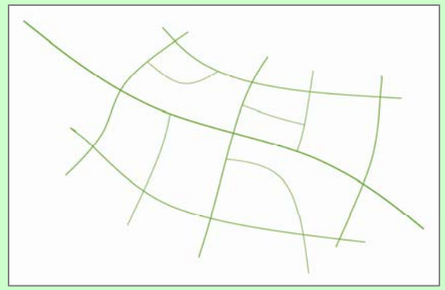
One of the unique demands in creating and sustaining a successful transportation system at the corridor level is blending access and connectivity functions with the preservation of regional mobility. Within the area surrounding Woodruff Road, neighborhoods and activity centers have varying needs and priorities. An underlying aspiration of the *Woodruff Road Corridor Study* is to create a viable plan for the corridor without losing focus on the practical concept of regional connectivity.



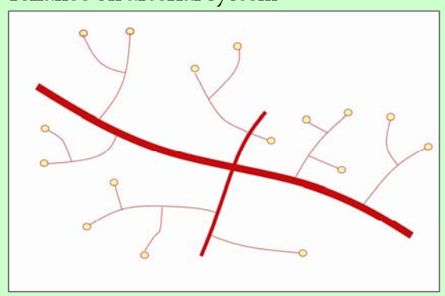
Benefits of Connectivity

- Reduced travel on major thoroughfares
- Reduced travel times without travel speed increase
- Increased route choice for all modes
- Improved access opportunities for emergency response vehicles

Well-connected system of streets



Limited connectivity resulting in heavy reliance on arterial system



Existing Conditions

A review of existing traffic conditions indicates congestion and traffic safety problems on Woodruff Road and several side streets.

Traffic Congestion

Traffic volumes and existing congestion were analyzed as part of the GPATS Long Range Transportation Plan update. Traffic volumes represent the number of vehicles that travel a given segment on an average day. Traffic volumes on Woodruff Road near Hendrix Drive were 33,500 in 2004. Not surprisingly, the interstate highways in the region have the highest volumes, with as many as 107,600 vehicles traveling on I-85 north of its interchange with I-385. At this interchange, more than 85,000 vehicles per day travel on I-385.

While traffic volumes provide a glimpse of how roadways in the area are operating, these measurements make it difficult to compare corridors of differing functional classifications, such as Woodruff Road and the area's interstates. A better measurement of corridor operations for the sake of comparison is calculated using volume-to-capacity (V/C) ratios. V/C ratios divide the actual volume of traffic carried by a roadway by the theoretical capacity of the roadway to produce a universal measurement. The following V/C categories are displayed in **Figure 2.1**:

- *Approaching Capacity* (V/C = 0.8 to 1.0) — A roadway with a V/C less than 0.8 typically operates efficiently. As the V/C nears 1.0, the roadway becomes more congested. A roadway approaching capacity may operate efficiently during non-peak hours but be congested during morning and evening peak travel periods.
- *At Capacity* (V/C = 1.0 to 1.2) — Roadways operating at capacity or slightly above capacity are heavily congested during peak periods and moderately congested during non-peak periods. A change in capacity due to incidents greatly impacts the travel flow on corridors operating within this V/C range.
- *Over Capacity* (V/C > 1.2) — The roadways in this category represent the most congested corridors in the GPATS area. These roadways are congested during non-peak hours and most likely operate in stop-and-go gridlock conditions during the morning and evening peak travel periods.

The Woodruff Road area includes several corridors that operate over capacity. These corridors include Woodruff Road between I-85 and Verdin Road/Feaster Road; I-85 north of the I-385 interchange; and Miller Road, Roper Mountain Road, and SC 14 in the vicinity of Woodruff Road. Near the interchange with I-385, the Woodruff Road V/C ratio is as high as 1.64, represented by stop-and-go traffic during peak travel periods.

Traffic Safety and Crash History

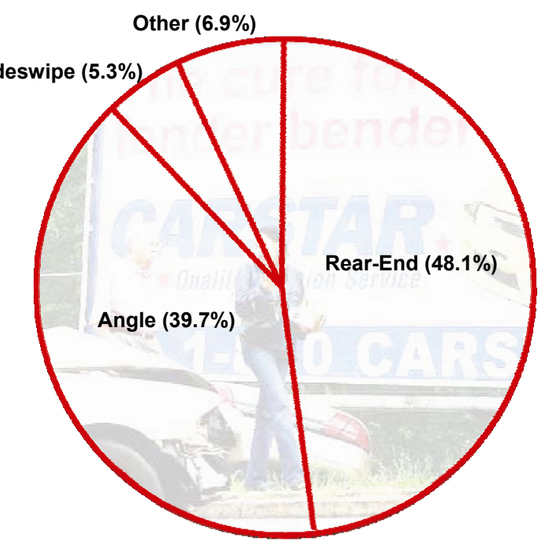
The Transportation Research Board summarizes the safety benefits of access management in the Access Management Manual. The manual cited four decades of studies that found that scaling back access points, reducing conflict points, and making driver behavior more predictable have a positive impact on the safety of a roadway. According to the Access Management Manual:

- As access density increases, crash rates increase.
- Roadways with non-traversable medians are safer than undivided roadways or those with continuous two-way left-turn lanes (TWLTL).
- U-turns are generally safer than direct left turns.
- Medians improve pedestrian safety.

An examination of the crash history on Woodruff Road between Verdae Boulevard/Roper Mountain Road and SC 14 revealed a total of 1,284 crashes during the five-year period between 2002 and 2006. Of these crashes, 189 (14.7%) involved at least one injury. Nearly one half (617 of 1,284) of all crashes were rear-end collisions. The second-most frequent crash type was angle collisions (510 of 1,284; 39.7%). These two crash types accounted for 251 (89.3%) of the 281 injuries along the corridor. The two most frequently cited causes of crashes were driving too fast for conditions (401 of 1,284; 31.2%) and failing to yield right-of-way (354 of 1,284; 27.6%). A majority (956 of 1,284; 74.5%) of the crashes occurred in clear conditions. The five-year crash history indicates a recent increase in crashes with injuries — from 27 in 2005 to 47 in 2006.

These statistics, combined with research that proves the safety benefits of access management, indicate that reducing the number of driveways and installing a non-traversable median can have an important impact on the corridor beyond improving traffic congestion and aesthetics.

Woodruff Road Crashes by Type*

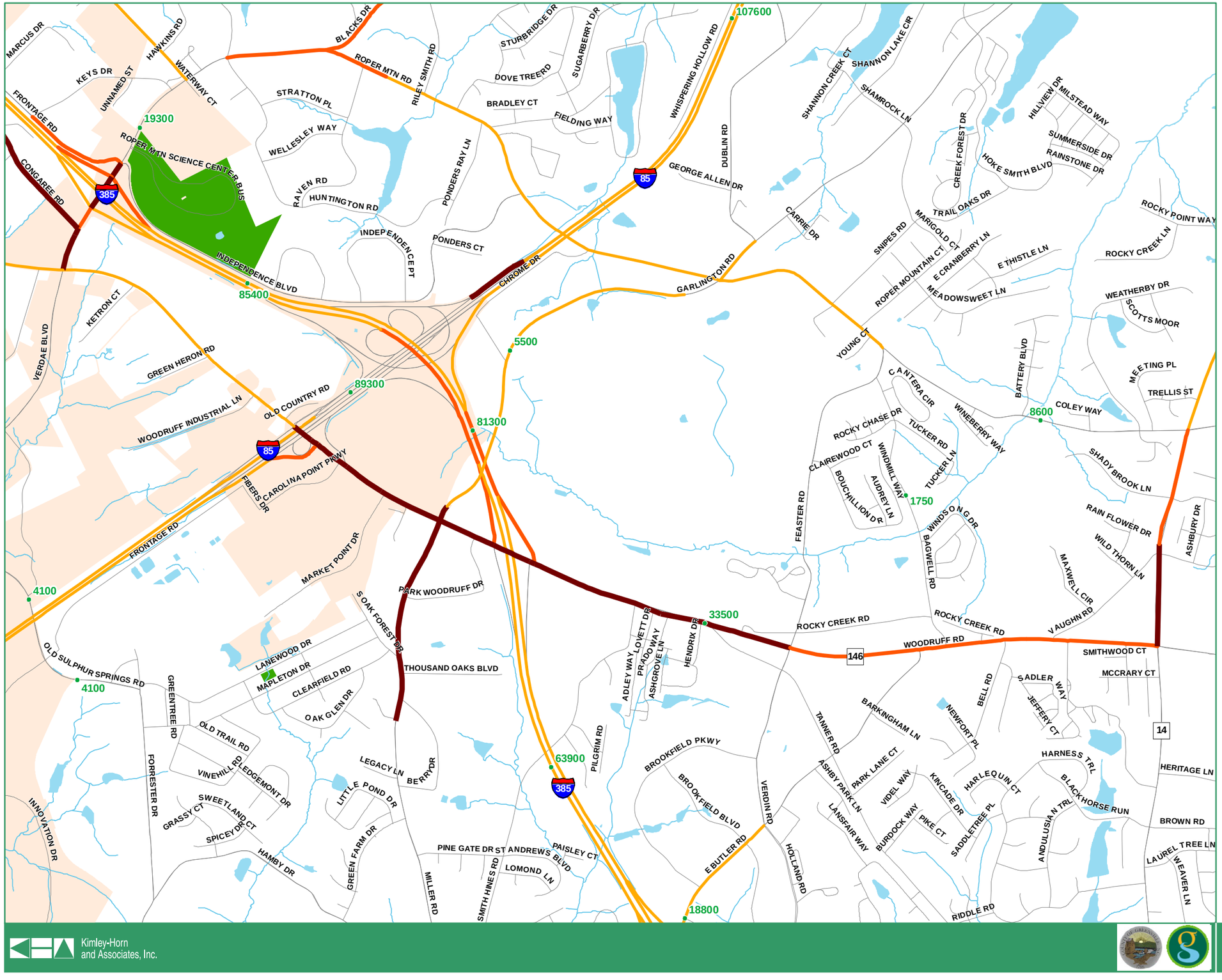


* Total crashes 2002 to 2006; From Verdae Boulevard/Roper Mountain Road to SC 14

Woodruff Road Corridor Study

Figure 2.1

Existing Congestion



- Local Street
- Streams and Rivers
- Bodies of Water
- Park
- City of Greenville

Congested Corridors (volume/capacity)

- Approaching Capacity (0.8 to 1.0)
- At Capacity (1.0 to 1.2)
- Over Capacity (1.2 and above)
- 2004 Average Daily Traffic

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0 0.3 0.6 Miles

Planned Development

When the Greenville Mall first opened in 1978, few businesses existed along Woodruff Road. The mostly rural area was expected to be a residential. Soon after the first neighborhoods were constructed, real estate developers recognized the potential of an area served by two interstates and close to thousands of homes. Today, residents and businesses continue to arrive in the Woodruff Road area.

This growth is evidenced by the plans for four large developments between Woodruff Road and Laurens Road along Verdae Boulevard, I-85, and Millennium Parkway. Together, Verdae Development, Millennium Campus, Clemson University International Center for Automotive Research (ICAR), and The Point mixed-use project will add millions of square feet of office and retail space and thousands of homes.

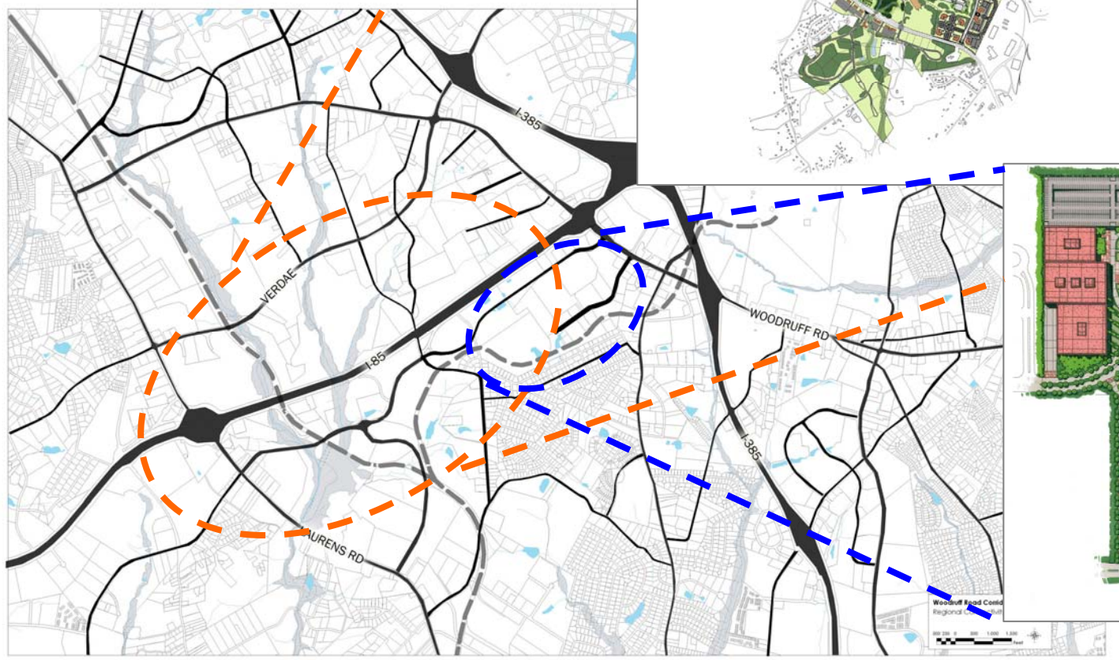
Verdae Development is a 1,100-acre master-planned, mixed-use community. The project will be implemented in phases over 20 to 30 years. The first phase intends to meet the residential needs of employees of the ICAR and Millennium Campus by providing residential housing within a traditional neighborhood development concept.

Millennium Campus is a collection of seven corporate communities ranging from 16,000 to more than 2.2 million square feet. Current estimates place build out in the range of 6 million total square feet.

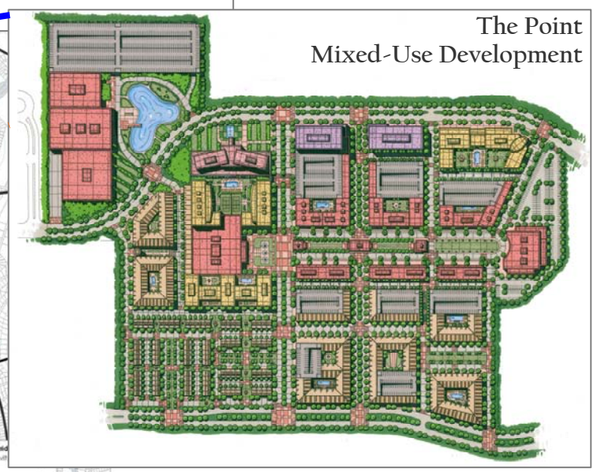
The Clemson University International Center for Automotive Research is envisioned as a premier automotive and motorsports research and education campus. Currently under construction on 250 acres, the completed site will house between 2.5 and 3.4 million square feet of research, office, and educational space.

The proposed mixed-use project at The Point will include more than 500,000 square feet of shops, 600,000 square feet of offices, a 420-room hotel, 1,225 condos, and 1,125 apartments.

Verdae Development, ICAR, Millennium Campus



The Point
Mixed-Use Development



Regional Connectivity

Healthy neighborhoods and regions include an interconnected network of different size streets. Each street in the Woodruff Road area can be placed in categories based on their intended function. The image to the right shows freeways (blue), arterials (red), and collectors (green) as well as rail corridors (black).

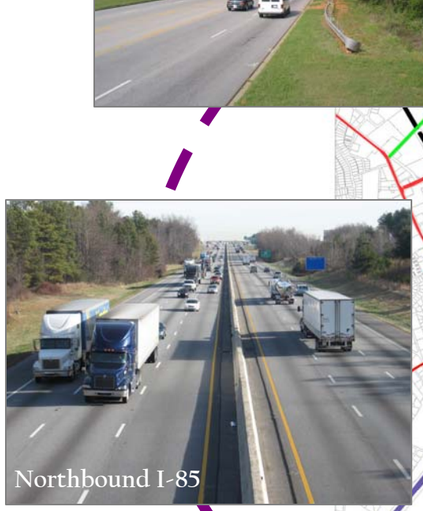
Important routes for regional connectivity in the Woodruff Road area include Interstates 85 and 385, SC 14, Woodruff Road, Verdae Boulevard, Roper Mountain Road, Laurens Road, and Miller Road.

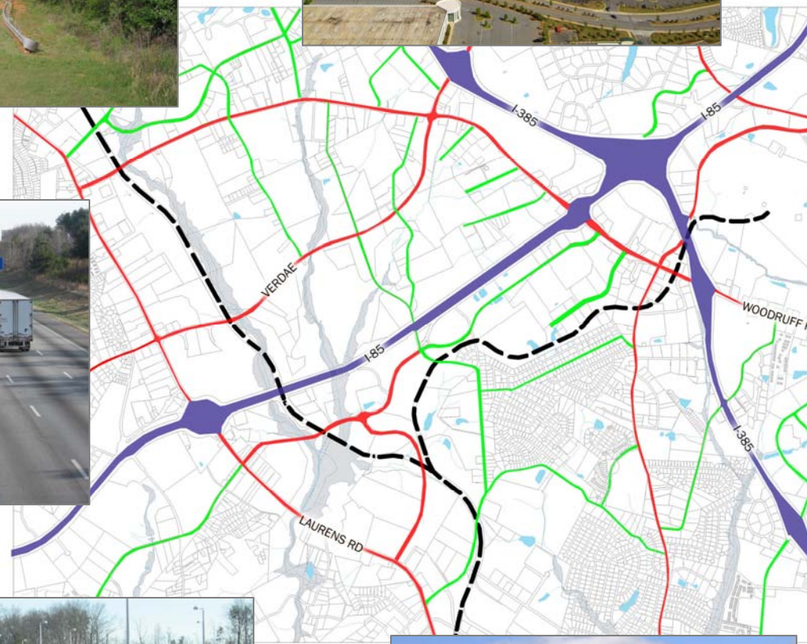
While the interstate facilities help move traffic through the area, these roadways act as barriers to connectivity. New grade-separated crossings, even without interchanges, are costly to construct. I-85 is one of many reasons the existing transportation network lacks alternatives to Woodruff Road.


Southbound Verdae Boulevard


Westbound Woodruff Road

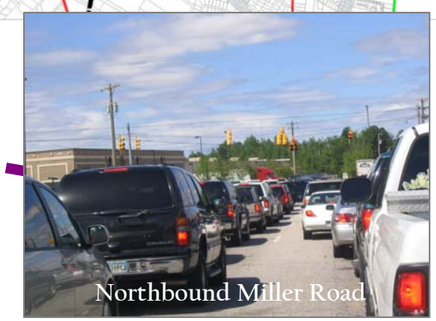

Eastbound Woodruff Road


Northbound I-85



Eastbound Tanner Road


Millennium Parkway


Northbound Miller Road


Westbound Woodruff Road

Existing and Proposed Arterials and Collectors

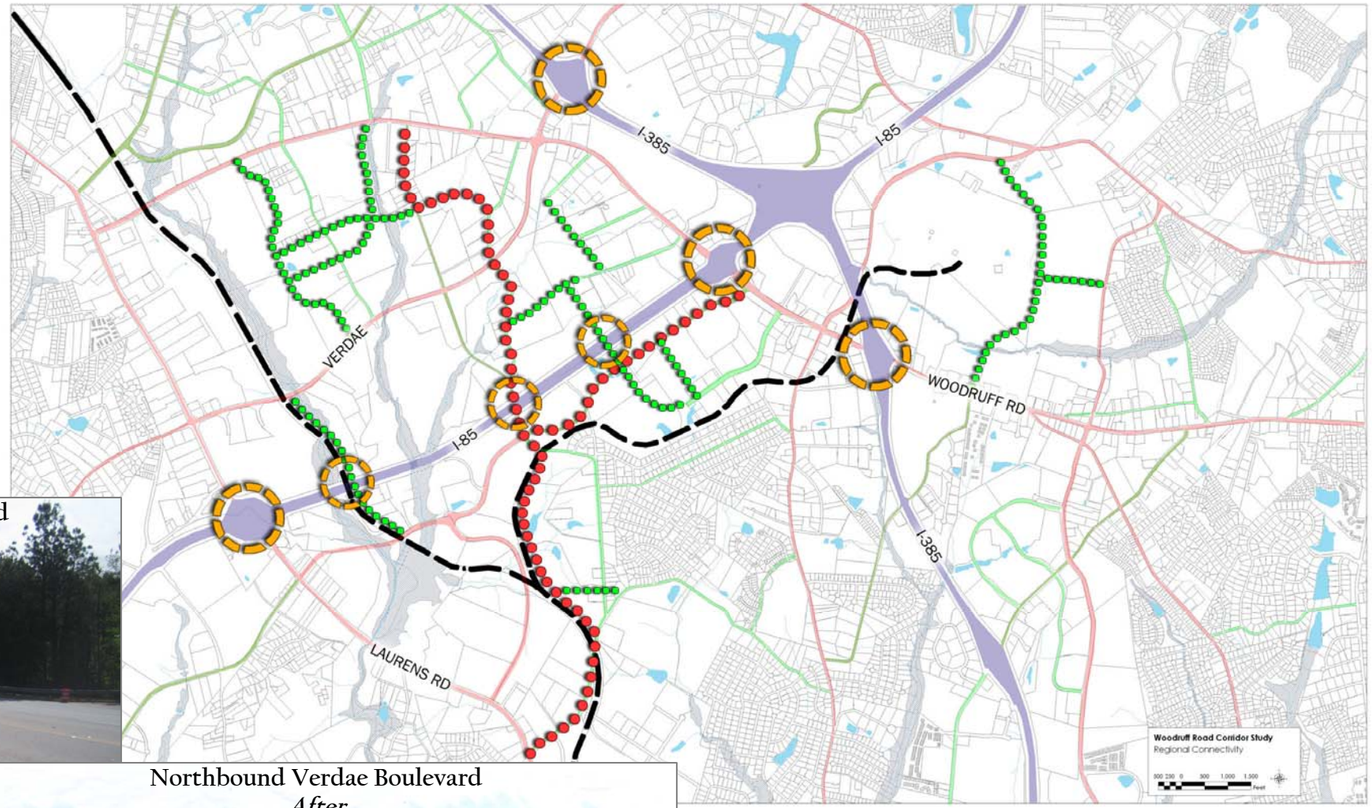
Mobility in the Woodruff Road area is limited by interchanges and grade-separated crossings of interstate facilities. At the interchanges, inefficient traffic operations result in spillover congestion along the corridor. Existing grade-separated crossings often include outdated bridges with insufficient capacity to carry future traffic volumes. Locations where the arterial and collector street network intersect the freeway system are identified in the image to the right with dashed circles and discussed in more detail in Chapter 4.

The map on this page illustrates proposed arterials and collectors with red and green dotted lines, respectively. Several recommendations involve the upgrade of existing facilities so that they can fulfill new roles within the transportation system.

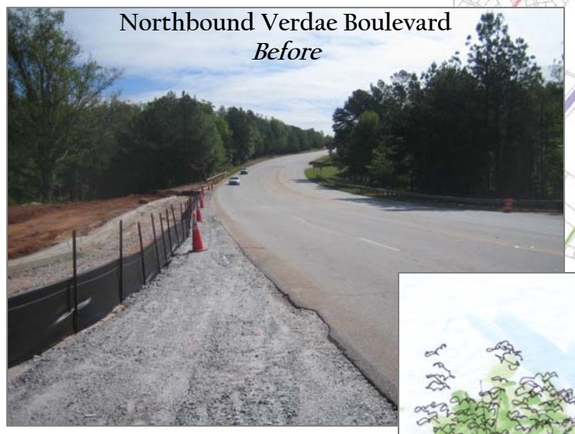
New arterials include the extension of Millennium Parkway north to Woodruff Road. This segment, currently under construction, will replace the existing I-85 frontage road. A new roadway segment parallel to the existing railroad will realign Forrester Drive with Old Sulphur Springs Road.

The proposed collector street plan shown in the diagram incorporates roads proposed as part of the Verdae Development. Other collectors include a new facility within the abandoned rail corridor between Verdae Boulevard and Millennium Parkway that utilizes the existing grade-separation of I-85. A new road also is proposed to connect Ketron Court with Woodruff Industrial Lane. Other proposed collectors provide connections to existing arterials.

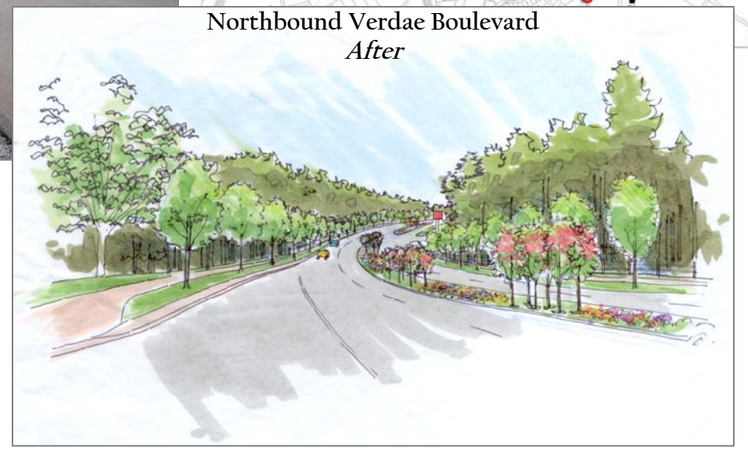
The plan upgrades Woodruff Road, Verdae Boulevard, Millennium Parkway, and Salters Road to urban boulevards with 4 lanes and a plantable median. This system of east-west and north-south spine roads will be supplemented by a network of collector streets to provide a system designed for high mobility and improved accessibility.



Northbound Verdae Boulevard
Before



Northbound Verdae Boulevard
After



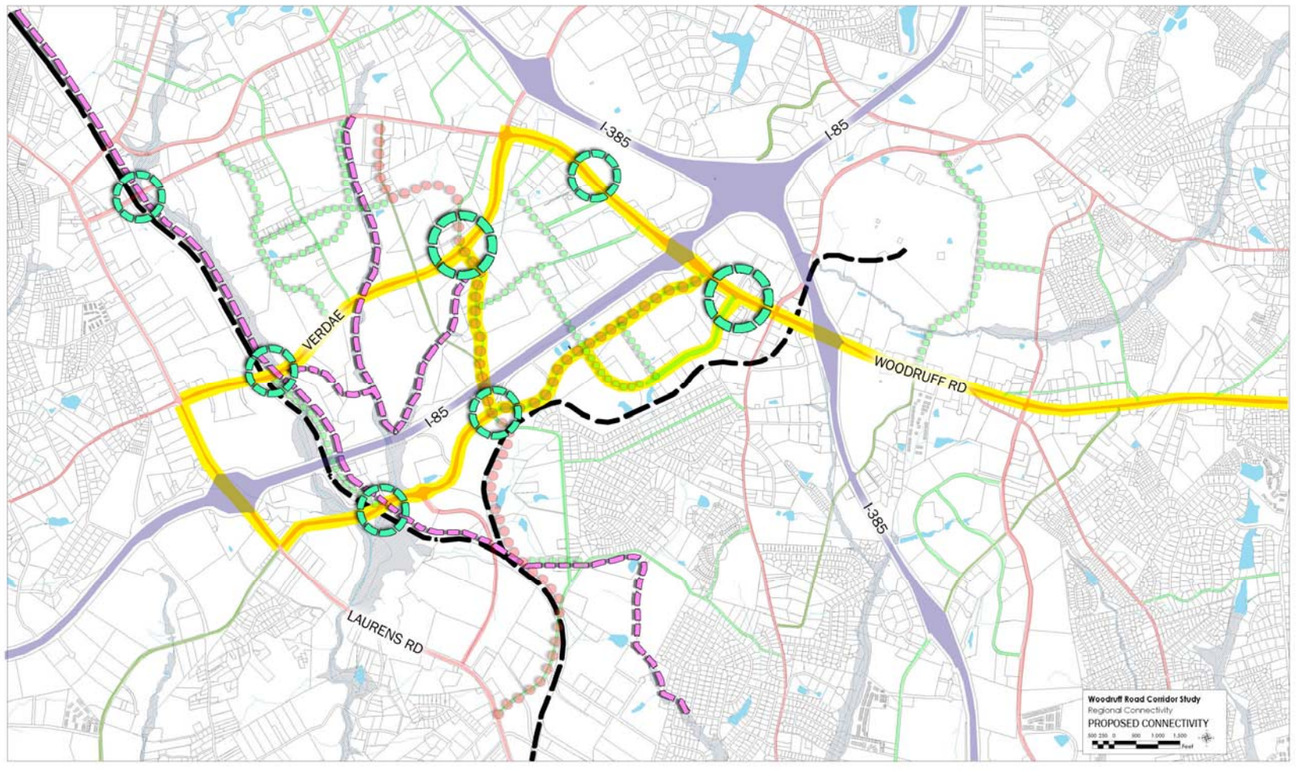
Existing and Proposed Greenways, Bikeways, and Sidewalks

An important component of regional connectivity are the corridors that accommodate non-motorized transportation. These corridors provide some combination of greenways (multiuse paths), bikeways, and sidewalks in order to connect with other travel modes and activity centers. Bicycling and other non-motorized forms of travel include utilitarian and recreational travel.

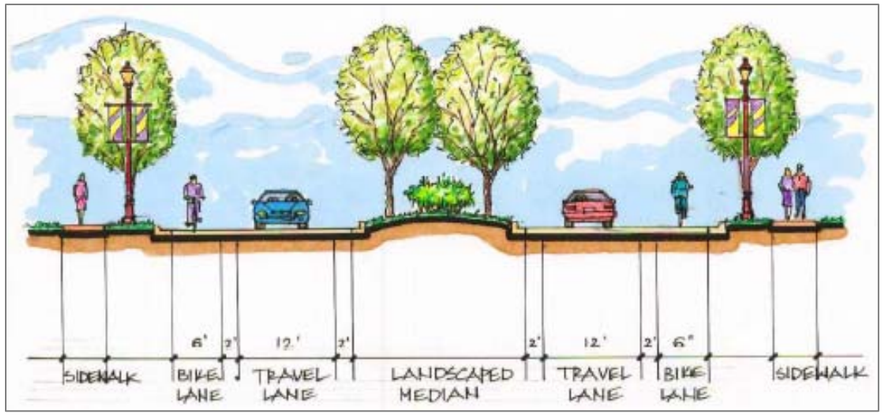
The image below illustrates locations with proposed greenways (purple dashed) and existing and proposed sidewalks (yellow). Activity nodes are identified with dashed circles. These locations include places where alternative modes intersect, multiple uses exist, and, in some cases, more intense land uses occur.

Examples of activity centers in the Woodruff Road area include the intersection of Woodruff Road and Market Point Drive (the Shops at Greenridge and The Point), ICAR, Magnolia Park Town Center, and the town center within Verdae Development.

The main feature presented here is a greenway that utilizes the existing rail corridor. The greenway will share the abandoned rail right-of-way with a transit facility and, in some places, a collector street. Overall, new collectors as shown on the previous page are expected to include sidewalks and bike lanes. A typical cross section of these roadways is shown to the right.



Typical Collector Street



Bike lanes on a two-lane divided collector street





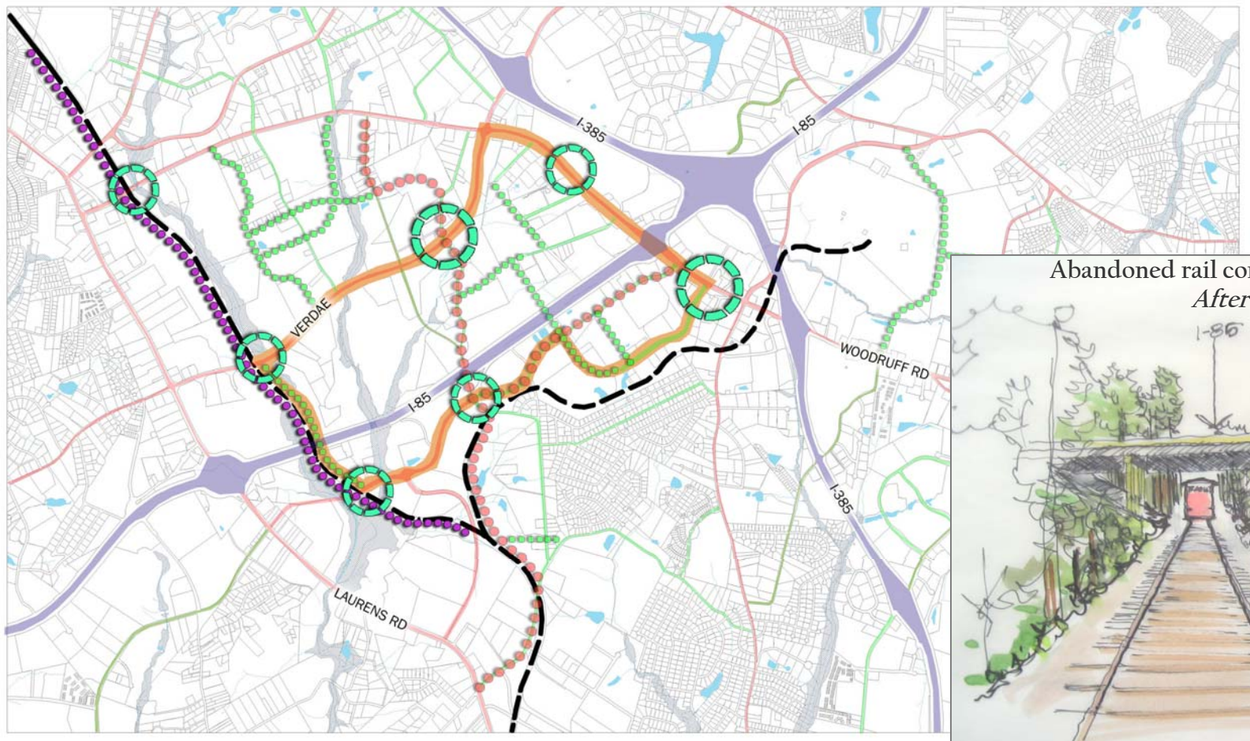
Proposed Transit Corridors

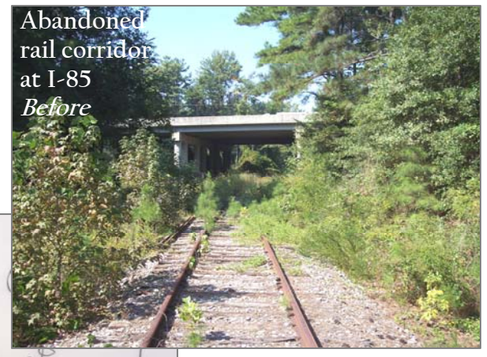
Transit relies upon a complete transportation system to operate effectively. Appropriate roads and highways must be suitable for bus traffic, and sidewalks and other pedestrian features must provide adequate access between transit stops, popular destinations, and residences. Therefore, the existing state of the transportation network often determines its suitability to transit. In the Woodruff Road area, the future of transit is dependent upon development with transit-supportive elements such as a mix of land uses at appropriate densities, interconnected roadways, and pedestrian- and bicycle-friendly streets.

Currently, the Laurens Road route (Route #8) provides transit service between the Woodruff Road area and downtown. From Laurens Road, the route proceeds north on Verdae Boulevard to Woodruff Road and the old Greenville Mall area.

However, with the influx of new jobs, homes, shops, restaurants, and activities in the Woodruff Road area, the potential exists for transit in the area. The figure on this page depicts a potential bus rapid transit (BRT) corridor (dotted purple) connecting ICAR with downtown. The corridor utilizes the abandoned rail corridor and could include a BRT line, 2-lane collector street, and a 10-foot multi-use path. Connecting to this corridor is a shuttle loop that would encircle the study area using the proposed BRT line, Woodruff Road, Millennium Parkway, and Verdae Boulevard. This system will connect the activity centers, which are shown as dashed circles.

Ultimately, the idea would be to have a circulating shuttle with frequent service and limited headway transporting office employees and patrons to the commercial activity nodes along Woodruff Road. This service would be supported by the reliable and convenient BRT line connecting the study area to downtown. Funding for the shuttle service could be supported through a public-private partnership with the office, retail, and research sectors.




Abandoned rail corridor at I-85
Before

Abandoned rail corridor at I-85
After

Example of a shuttle van

Chapter 3 – Access Management Strategies

Overview

As a regional commercial center and a key commuter route, Woodruff Road serves the dual purpose of providing access to businesses and mobility for motorists. Access management balances the needs of adjacent property owners dependent upon access to the roadway with the needs of motorists using the roadway. In a local environment with limited funds for transportation projects and competing agendas, access management in the vicinity of Woodruff Road is essential to the proper function of the transportation network and the continued economic growth of the immediate area and larger Greenville region.

The Federal Highway Administration (FHWA) defines access management as "the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed." According to the Access Management Manual published by the Transportation Research Board, access management results from a cooperative effort between state and local agencies and private land owners to systematically control the "location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway."[1]

Poor access management directly affects the livability and economic vitality of commercial corridors such as Woodruff Road, ultimately discouraging potential customers from entering the area. Signs of a corridor with poor access management include:

- Increased crashes between motorists, pedestrians, and cyclists
- Worsening efficiency of the roadway
- Congestion outpacing growth in traffic
- Spillover cut-through traffic on adjacent residential streets
- Limited sustainability of commercial development

Vehicle delays caused by poor access management also lower fuel efficiency and lead to higher vehicle emissions. But the benefits of access management are numerous for all users. A sampling of these benefits is shown in **Table 3.1**.

Table 3.1 – User Benefits of Access Management

User	Benefit
Motorists	▪ Fewer delays and reduced travel times ▪ Safer traveling conditions
Bicyclists	▪ Safer traveling conditions ▪ More predictable motorist movements ▪ More options in a connected street network
Pedestrians	▪ Fewer access points and median refuges, which increases safety ▪ More pleasant walking environment
Transit Users	▪ Fewer delays and reduced travel times ▪ Safer, more convenient trips to and from transit stops in a connected street and sidewalk network
Freight	▪ Fewer delays and reduced travel times, which lowers the cost of delivering goods and services
Business Owners	▪ More efficient roadway system serving local and regional customers ▪ More pleasant roadway corridor to attract customers ▪ Improved corridor aesthetics ▪ Stable property values
Government Agencies	▪ Lower costs to achieve transportation goals and objectives ▪ Protection of long-term investment in transportation infrastructure
Communities	▪ More attractive, efficient roadways without the need for constant road widening

As development continues in the Woodruff Road area, protecting the through capacity becomes critical to the well-being of the transportation system and economic vitality of the area. Without access management, the function and character of the corridor likely will deteriorate rapidly and the value of adjacent properties will decline. This chapter begins with a toolbox of access management strategies tailored to the needs of Woodruff Road. The list presented here is not comprehensive but rather represents strategies spanning a broad spectrum of time and monetary commitment.

Woodruff Road Today

Traffic congestion

Multiple curb cuts

[1] Access Management Manual, Transportation Research Board, National Academy of Sciences, Washington DC, 2003

Access Management Toolbox

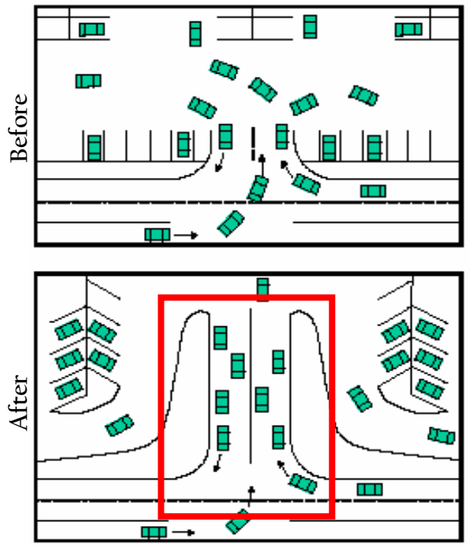
Access management cannot be considered a one-size-fits-all solution for Woodruff Road. Successful strategies will differ depending upon the traffic operations and access requirements for a given segment of the corridor. The following toolbox provides a general overview of several strategies available to improve the function of Woodruff Road. Most of the strategies in the toolbox are recommended for specific locations along Woodruff Road. Other strategies are presented in the toolbox as an option for future consideration as the conditions and needs of the corridor shift.

On-Site Traffic Circulation

The total number of vehicle conflicts can be reduced by promoting on-site traffic circulation and shared-use driveways during development application review. Such improvements should be a key consideration during the approval of redeveloped sites along Woodruff Road.

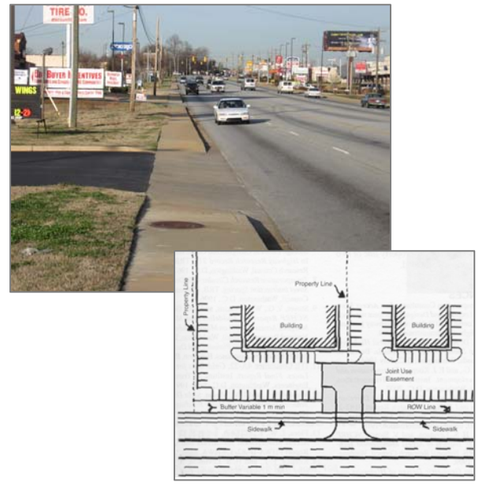
Improved On-Site Traffic Circulation

On-site traffic circulation can be improved by managing the driveway throat length, the distance from the edge of the public street to the first internal site intersection. A minimum separation of 100 feet should be provided to prevent internal site operations from affecting an adjacent public street, ultimately causing spillback problems. Approximate construction cost varies and usually is the responsibility of private development.



Number of Driveways

In many cases, new development occurs adjacent to an existing site or to another new development. In these cases, driveway permit applicants should be encouraged to seek cross access easements/agreements from an existing adjacent property ownership. Coordination between adjacent proposed developments should create interconnected internal circulation systems and shared-use external driveways. Approximate construction cost varies and usually is the responsibility of private development.



Driveway Placement/Relocation

Driveways located close to intersections create and contribute to operational and safety issues. These issues include intersections and driveway blockages, increased points of conflict, frequent/unexpected stops in the through travel lanes, and driver confusion as to where vehicles are turning. Driveways close to intersections should be relocated or closed, as appropriate. As a best planning practice, no driveway should be allowed within 100 feet of the nearest intersection.

Cross Access

Cross access is a service drive or secondary roadway that provides vehicular access between two or more continuous properties. Such access prevents the driver from having to enter the public street system to travel between adjacent uses. Cross access can be a function of good internal traffic circulation at large developments with substantial frontage along a major facility such as Woodruff Road. Similarly, backdoor access occurs when a parcel has access to a parallel street behind buildings and away from the main line. When combined with a median treatment, cross access and backdoor access ensure that all parcels have access to a median opening or traffic signal for left-turn movements.

Median Treatments

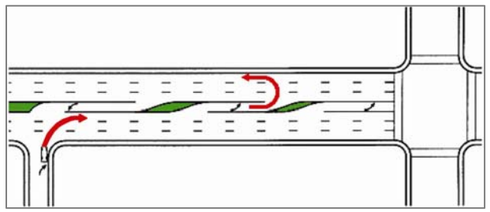
Segments of a corridor with sufficient cross access, backdoor access, and on-site circulation may be candidates for median treatments. A median-divided roadway improves traffic flow, reduces congestion, and increases traffic safety – all important goals of access management. While medians restrict some left-turn movements, access to businesses is enhanced as traffic delays are reduced. Landscaping and gateway features incorporated into median treatments improve the aesthetics of the corridor, in turn encouraging investment in the area.

Non-Traversable Median

These features are raised or depressed cross-section elements that physically separate opposing traffic flows. Inclusion in a new cross-section or retrofit of an existing cross-section should be considered for multi-lane roadways with high pedestrian volumes, high collision rates, or in locations where aesthetics are a priority. A non-traversable median requires sufficient cross and backdoor access. As these treatments are considered, sufficient spacing and locations for U- and left-turn bays must be identified. Approximate construction cost varies.

- *Advantages*—increased safety and capacity by separating opposing vehicle flows, providing space for pedestrians to find refuge, and restricting turning movements to locations with appropriate turn lanes
- *Disadvantages*—increased emergency vehicle response time (indirect routes to some destinations), inconvenience, increased travel distance for some movements, and potential opposition from the general public and affected property owners

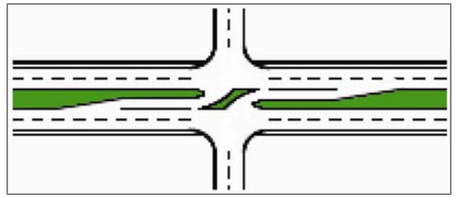
Median U-Turn Treatment



These treatments involve prohibiting or preventing minor street or driveway left turns between signalized intersections. Instead, these turns are made by first making a right turn and then making a U-turn at a nearby median opening or intersection. These treatments can increase safety and efficiency of roadway corridors with high volumes of through traffic, but should not be used where there is not sufficient space available for the provision of U-turn movements. The location of U-turn bays must consider weaving distance, but also not contribute to excessive travel distance. Approximate construction cost is $50,000 - $60,000 per median opening.

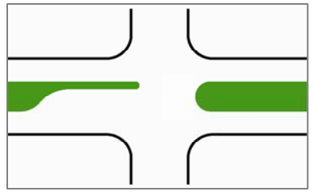
- *Advantages*—reduced delay for major intersection movements, potential for better two-way traffic progression (major and minor street), fewer stops for through traffic, and fewer points of conflict (for pedestrians and vehicles) at intersections
- *Disadvantages*—increased delay for some turning movements, increased travel distance, increased travel time for minor street left turns, and driver confusion

Directional Crossover (Left-Over Crossing)



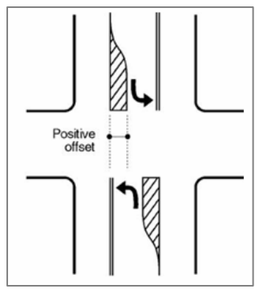
When a median exists on a corridor, special attention must be given to locations where left turns are necessary. A left-over is a type of directional crossover that prohibits drivers on the cross road (side street) from proceeding straight through the intersection with the main road. To accomplish this movement, a right turn followed by a U-turn is required. Such designs are appropriate in areas with high traffic volumes on the major road and lower volumes of through traffic on the cross road. The treatment is especially helpful in locations where traffic needs to make left turns from the main line onto the minor street. A properly implemented left-over crossing reduces delay for through-traffic and diverts some left-turn maneuvers from intersections. By reducing the number of conflict points for vehicles along the corridor, these treatments improve safety.

Left-Turn Lanes/Storage Bays



Where necessary, exclusive left-turn lanes/bays should be constructed to provide adequate storage space exclusive of through traffic for turning vehicles. The provision of these bays reduces vehicle delay related to waiting for vehicles to turn and also may decrease the frequency of collisions attributable to lane blockages. In some cases, turn lanes/bays can be constructed within an existing median. Where additional right-of-way is required, construction may be more costly.

Offset Left-Turn Treatment

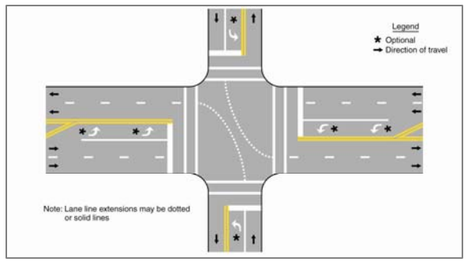


Exclusive left-turn lanes at intersections generally are configured to the right of one another, which causes opposing left-turning vehicles to block one another's forward visibility. An offset left-turn treatment shifts the left-turn lanes to the left, adjacent to the innermost lane of oncoming through traffic. In cases where permissive left-turn phasing is used, this treatment can improve efficiency by reducing crossing and exposure time and distance for left-turning vehicles. In addition, the positive offset improves sight distance and may improve gap recognition. In locations with sufficient median width, this treatment can be easily retrofitted. Where insufficient right-of-way width exists, the construction of this treatment can be difficult and costly. Approximate construction costs vary.

Intersection and Minor Street Treatments

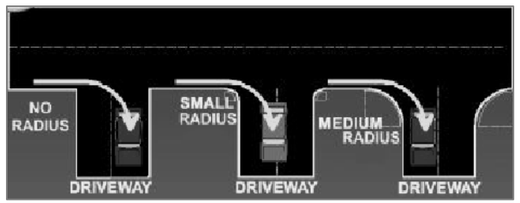
The operation of signalized intersections can be improved by reducing driver confusion, establishing proper curb radii, and ensuring adequate laneage of minor street approaches.

Skip Marks (Dotted Line Markings)



These pavement markings can reduce driver confusion and increase safety by guiding drivers through complex intersections. Intersections that benefit from these lane markings include offset, skewed or multi-legged intersections. Skip marks are also useful at intersections with multiple turn lanes. The dotted line markings extend the line markings of approaching roadways through the intersection. The markings should be designed to avoid confusing drivers in adjacent or opposing lanes.

Intersection and Driveway Curb Radii



Locations with inadequate curb radii have the potential to necessitate that turning vehicles use opposing travel lanes to complete their turning movement. Inadequate curb radii may cause vehicles to "mount the curb" as they turn a corner and cause damage to the curb and gutter, sidewalk, and any fixed objects located on the corner. This maneuver also may endanger pedestrians standing on the corner. Curb radii should be adequately sized for area context and likely vehicular usage.

Minor Street Approach Improvements

At signalized intersections, minor street vehicular volumes and associated delays may require that a disproportionate amount of green time be allocated to the minor street, contributing to higher-than-desired main street delay. With laneage improvements to the minor street approaches, such as an additional left-turn lane or right-turn lane, signal timing often can be re-allocated and optimized.

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) utilize computer technology to manage traffic flow. Successful systems include a variety of mechanisms to control signal systems and allow emergency vehicles to proceed safely through signalized intersections. A complete description of ITS solutions that can enhance the safety and efficiency of travel on Woodruff Road is provided at the end of this chapter.

Access Management Strategies

The majority of Woodruff Road between Verdae Boulevard/Roper Mountain Road and SC 14 is a five-lane section with a center two-way left-turn lane. The roadway provides access to some of the region's busiest commercial development while serving as a transitional commuter corridor between downtown and exurban areas. The dual role of providing local access and regional mobility has contributed to the congested and dangerous conditions throughout the corridor.

Currently, 18 traffic signals exist on the approximately 3.75-mile corridor. Full access crossing Woodruff Road is provided at an additional 10 locations, including minor side street intersections and parking lots that align on both sides of the roadway. An additional 121 curb cuts exist on this segment of Woodruff Road: 63 westbound and 58 eastbound. Existing curb cuts (red dots) are shown along Woodruff Road (orange line) in the diagram below.

The access management strategies that follow include general recommendations for the entire corridor as well as location-specific solutions. Existing conditions were evaluated using aerial photography and verified during on-site field work and reviews of development plans. Field work also directed the general location for cross and backdoor access opportunities as well as the potential to construct medians.

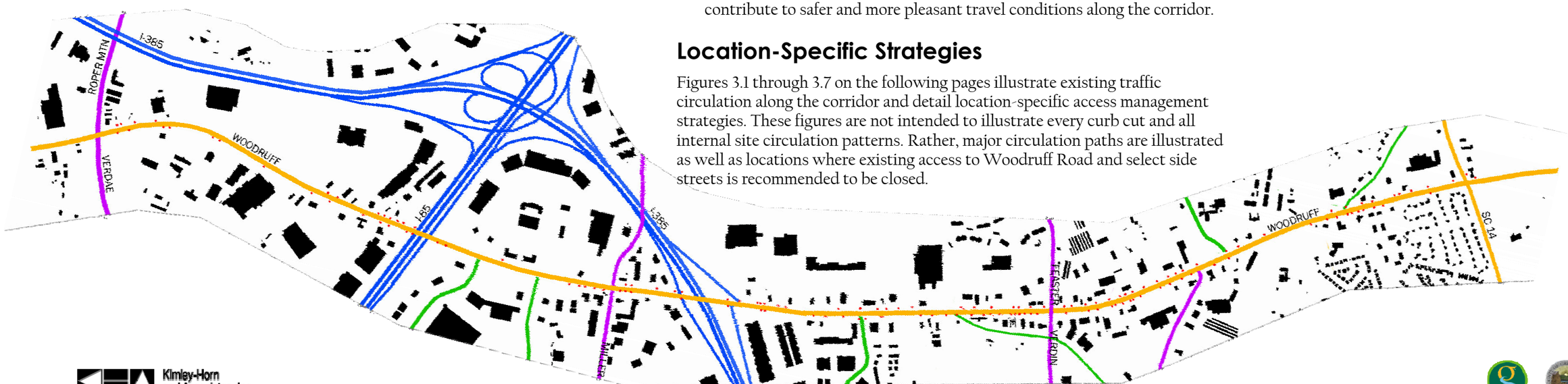
Corridor-Wide Strategies

While portions of the Woodruff Road corridor have distinctive characteristics, certain conditions exist throughout the corridor. For that reason, these recommendations could be applied to the entire length of the corridor to ease congestion, reduce driver confusion, and improve safety:

- **A progression-controlled signal system should be installed to reduce driver delay and frustration.** Currently, a progression-controlled system exists beginning at SC 14 proceeding west to Woodruff Industrial Lane. Following the completion of Magnolia Park Town Center, the system will be extended through Verdae Boulevard. A supplemental task of the ***Woodruff Road Corridor Study*** includes an evaluation and update to the existing progression-controlled signal system.
- **Pedestrian amenities should be upgraded.** Existing pedestrian amenities are inconsistent and include some sidewalks adjacent to Woodruff Road and pedestrian crosswalks and signals at select intersections (e.g., Carolina Point Parkway). Safe, convenient pedestrian crossings of Woodruff Road should be a primary focus and provided in proximity to residences and hotels.
- **Signage should be controlled and wayfinding upgraded.** Existing signage creates a clustered environment and devalues the area's sense of place. Likewise, signage for commercial properties makes wayfinding more difficult. Signage control combined with improved wayfinding will contribute to safer and more pleasant travel conditions along the corridor.

Location-Specific Strategies

Figures 3.1 through 3.7 on the following pages illustrate existing traffic circulation along the corridor and detail location-specific access management strategies. These figures are not intended to illustrate every curb cut and all internal site circulation patterns. Rather, major circulation paths are illustrated as well as locations where existing access to Woodruff Road and select side streets is recommended to be closed.



Access Management Strategies

This 1/2-mile segment carries more than 21,000 vehicles per day and provides access to Magnolia Park Town Center (under construction), large-scale industrial operations (Nutra), and smaller commercial properties. The intersection at Ketron Court is expected to be signalized to accommodate traffic at the Magnolia Park Town Center. In addition to the recommendations illustrated on this page, backdoor access should be provided between Ketron Court and Woodruff Industrial Lane to the east. Sidewalks should be constructed along Woodruff Road and crosswalks should connect Magnolia Park Town Center with properties south of Woodruff Road.

Verdae Blvd to Green Heron Dr

Figure 3.1

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

Kimley-Horn and Associates, Inc.

May 2007

1 inch = 200 feet

385

Magnolia Park Town Center
(Under Construction)

Ashley Furniture

ROPER MTN RD

FUTURE SIGNAL

BP

Control Signage

Eastbound Woodruff Road
Before

Eastbound Woodruff Road
After

VERDAE BLVD

Carrabba's

Microtel Inn

La-Z-Boy

Nutra

Gatti Town

Holiday Inn Express

GREEN HERON RD

Access Management Strategies

The short 1/3-mile segment between the signalized intersection at Woodruff Industrial Lane and the grade-separated interchange at I-85 carries more than 21,000 vehicles per day. This section will provide access to Magnolia Park Town Center from I-85. In addition to the recommendations illustrated on this page, signage should be controlled at the interchange to limit driver confusion.

Green Heron Dr to I-85

Figure 3.2

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

Kimley-Horn and Associates, Inc.

May 2007

1 inch = 200 feet

Magnolia Park Town Center
(Under Construction)

McDonald's

Flat Rock Grille

Waffle House

Nutra

Payless ShoeSource

T.G.I. Friday's

RaceWay Gas Station

BJ's Gas Station

BJ's

Target

Home Depot

Consolidate Driveways

Exit from Target
Before

Exit from Target
After

Extend channelized island to simplify merge movements and allow permitted westbound left turns

Cracker Barrel

Drury Inn & Suites

WOODRUFF INDUSTRIAL LN

85

Access Management Strategies

The 1/2-mile segment between the Carolina Point Parkway and the grade-separated interchange at I-385 carries between 25,000 and 30,000 vehicles per day. This section of the corridor provides immediate access to I-385 and provides access to shops and restaurants at the Shops at Greenridge and the Shops at the Point. In addition to the recommendations illustrated on this page, pedestrian amenities should be upgrade to allow safe crossings of Woodruff Road.

Lowe's Home Improvement

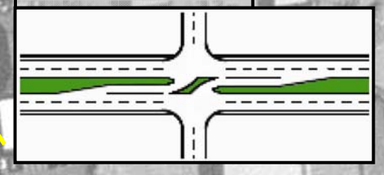
The Shops at Greenridge
(New Construction)

Install flashing signal at railroad crossing

Upgrade interchange and permit right-in/right out maneuver at the Shops of Greenridge

OLD WOODRUFF RD

Install left-over directional crossover



Wachovia

The Shops at the Point
(New Construction)

MILLER RD

WOODRUFF DR

hhgregg

West of I-385

Figure 3.3

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

May 2007

Kimley-Horn and Associates, Inc.

1 inch = 200 feet

Access Management Strategies

The 1/2-mile segment between I-385 and Hendrix Drive carries approximately 33,500 vehicles per day. This section provides a good example of cross access north of Woodruff Road between Sam's Club and Wal-Mart. This access, combined with adequate on-site circulation south of Woodruff Road, ensures existing access to signalized intersections and allows for the immediate construction of a non-traversable landscaped median.

I-385 to Hendrix Drive

Figure 3.4

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

May 2007

Kimley-Horn and Associates, Inc.

1 inch = 200 feet

Sam's Club

Kohl's

Control Signage

Proposed Cross Access

Sam's Club Gas

Chili's

Hardee's

Bojangles

Applebee's

Chick-fil-a

Ryan's

McAlister's

Sears

Wal-Mart

Perkins

Westbound Woodruff Road
Before

Westbound Woodruff Road
After

Zaxby's

The Shops at Merovan

Eckerd

Discount Tire Company

SMITH HINES RD

LOVETT DR

PRADO WAY

HENDRIX DR

DAVIS KEATS DR

DAVIS KEATS DR

New Development

New Development

Access Management Strategies

The 1/2-mile segment between Hendrix Drive and the new Rocky Creek Road connection at the ALDI grocery store carries more than 33,500 vehicles per day. Good parallel routes are provided via parking lots and Rocky Creek Road to the north and Tanner Road to the south. However, additional connections are recommended to provide a connection to the traffic signal at Hendrix Drive.

Hendrix Dr to ALDI

Figure 3.5

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

May 2007

Kimley-Horn and Associates, Inc.

1 inch = 200 feet

Wal-Mart
Hobby Lobby
FEASTER RD
ROCKY CREEK RD
ALDI
Mattress Source
Jackson's Crossing
New Construction
RadioShack
Tire Kingdom
Bonefish Grill
Wendy's
Waffle House
146
Wachovia
HENDRIX DR
KFC
Spinx Gas Station
Lube King
Sonic
SunTrust
Woodruff Square
ACE Hardware
Publix
TANNER RD
Woodruff Pointe
New Construction
New Construction
VERDIN RD
Woodruff Pointe
Existing backdoor access

Access Management Strategies

The 3/5-mile segment between the ALDI to just west of Vaughn Road carries more than 33,500 vehicles per day. Rocky Creek Road provides cross access between Feaster Road and Bagwell Road. However, the lack of potential connections south of Woodruff Road precludes the construction of a median along the entire extent of this segment. In this area, the influx of single- and multi-family housing heightens the need for improved pedestrian connections.

ALDI to West of Vaughn Rd

Figure 3.6

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

May 2007

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1 inch = 200 feet

BAGWELL RD

ROCKY CREEK RD

WOODRUFF RD

BUTLER RD

PELHAM RD

SOUTHLEDGE CT

SADLER WAY

ALDI

Mimi's

The Paddock Club

Rocky Creek Apartments

Goodwill Industries

Publix

Bi-Lo

Access Management Strategies

The 3/10-mile segment between Vaughn Road and SC 14 carries more than 33,500 vehicles per day. For westbound motorists, this section of the corridor marks a change in the character of the road to a more suburban nature.

Vaughn Rd to SC 14

Figure 3.7

- Existing Traffic Signal
- Existing Access
- Potential Access
- Closed Curb Cut
- Proposed Median

Woodruff Road Corridor Study

May 2007

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1 inch = 200 feet





Intelligent Transportation System Strategies

Intelligent Transportation Systems (ITS) have numerous benefits when implemented as part of an overall transportation management strategy. ITS solutions utilize communications and computer technology to manage traffic flow in an effort to reduce crashes, environmental impacts such as fuel consumption and emissions, and congestion due to normal and unexpected delays. Successful systems include a variety of solutions that provide surveillance capabilities, remote control of signal systems components, seamless sharing of traveler information with the public, and priority for emergency vehicles to proceed safely through signalized intersections.

ITS Toolbox

Like the Access Management Toolbox presented earlier in this chapter, the following ITS Toolbox represents only those tools relevant to the short- and long-term strategy for the Woodruff Road area. These tools include a variety of signal system advancements as well as enhanced ways to communicate with the traveling public.

Signalization

The volume of traffic attracted to some side streets or site driveways is more than can be accommodated acceptably under an unsignalized condition. Delays for minor street movements as well as left-turn movements on the main street may create or contribute to undue delays on the major roadway and numerous safety issues. The installation of a traffic signal at appropriate locations can mitigate these types of issues without adversely affecting the operation of the major roadway. Approximate construction cost is $50,000 to $60,000 per signal.

Progressive-Controlled Signal System

A progressive-controlled signal system coordinates the traffic signals along a corridor to allow vehicles to move through multiple signals without stopping. Traffic signals are synchronized so that when a vehicle is released from one intersection the signal at the next intersection will be green by the time the vehicle reaches it.

Likewise, adaptive signal control involves continuously collecting automated intersection traffic volumes and using the volumes to alter signal timing and phasing to best accommodate actual – real-time – traffic volumes. Adaptive signal control can increase isolated intersection capacity as well as improve overall corridor mobility by up to 20% during off-peak periods and 10% during peak periods. Approximate construction cost is $250,000 per system and $10,000 per intersection in addition to 25% of capital costs in training and configuration.

Emergency Vehicle Preemption

This strategy allows an oncoming emergency or other suitably equipped vehicle to change to green the indication of a traffic signal in favor of the direction of desired travel. Preemption improves emergency vehicle response time, reduces vehicular lane and roadway blockages, and improves the safety of the responders by stopping conflicting movements. Approximate construction cost is $5,000 to $7,000 per intersection plus $2,000 per equipped vehicle.

Dynamic Message Signs (DMS)

The primary purpose of DMS units on freeways is to alert motorists of congestion or an incident on the upcoming segment of a roadway. These signs give general alerts, such as “congestion ahead” or specific details as to the location of the incident or predicted travel time to a particular destination. DMS also informs the traveling public of upcoming problems and expected travel times so that they may mentally prepare. Often, drivers are more patient – and thus less likely to react in anger due to congestion – if they can anticipate how long the delay will be or how far the congestion spreads. Perhaps most importantly, DMS leads to informed drivers, who may choose alternate travel paths during heavy congestion and thereby reduce traffic on the freeway, the likelihood of additional accidents, and the average travel time for the system as a whole. Approximate construction cost is $70,000 for a pedestal-mounted DMS and $160,000 for an overhead structure and overhead-mounted DMS.

Closed Circuit Television Cameras

Comprehensive coverage of Closed Circuit Television (CCTV) cameras along the interstate and arterials provides an effective way to monitor traffic conditions and dispatch resources to efficiently clear incidents. The camera images can also be shared with other agencies and the public to improve coordination and the available traveler information. In certain areas, public safety agencies have been given secondary control of the CCTV cameras so they can effectively assess an incident scenario prior to dispatching. Approximate construction cost for a single CCTV camera installation is $35,000. This amount does not include communication between the camera and the Traffic Operations Center, which could be achieved using fiber optic or wireless connections.

Detection

Detection technology placed on the roadway can collect traffic information at multiple levels of detail. Depending on the data desired by an agency, various detection technologies can collect different types of traffic data including volumes, speed samples, and occupancy as well as detailed speed data per lane per vehicle. The data collected can be monitored at a central location to allow quicker verification of incidents and more accurate dispatching of resources. The data also can be integrated with DMS to share real-time travel times based on continuous data collection. The data also can be used to populate a regional speed map, which when shared on a traveler information website allows the public to see color coded travel conditions across a region or along a specific corridor.

Advanced Traveler Information Systems (ATIS)

Once an incident is detected and the severity and potential impact has been estimated, a key focus for an agency is to disseminate that information in effective methods. One of the most widely used methods is the development of a traveler information website that can share a speed map based on a detection deployment, camera images from the CCTV cameras, and notification of what messages are being shared on DMS. Most public agencies also can provide this data to private sector information service providers so they can develop additional information sharing techniques. These techniques can include privately developed websites, kiosks in key areas such as rest areas or welcome centers, and personal computing devices such as a pocket pc or cellular phone that can receive data. The ultimate goal with an ATIS is to provide the most accurate and timely information available to the traveler in a format that allows them to make effective decisions about the mode and route for each trip.

Woodruff Road Area ITS Development

Successful ITS deployment in the Woodruff Road area will help with the overarching goals of this study – to improve travel times, reduce crash rates, and make the driving experience more predictable. Two ITS deployment packages are proposed for the Woodruff Road area and include several ITS components, either functioning individually or in combination with other components.

- **Package A** – Queue detection systems at four off-ramp locations. Coordinated with local signal controller and warning signs on interstate
- **Package B** – CCTV cameras, DMS, detection, and enhanced ATIS for comprehensive surveillance and sharing of traveler information.

Following a description of the existing system, both packages are described in detail below. The cost of each ITS component (and deployment package) simply is the cost of implementation as well as estimated operation and maintenance costs for 10 years.

Existing ITS System Description

The existing system in the Woodruff Road area includes fiber optic communications, some closed circuit television (CCTV) cameras, dynamic message signs (DMS), and an existing closed loop signal system along Woodruff Road. A portion of the corridor lies within the Greenville city limits, but SCDOT currently operates the closed loop system. SCDOT operates the closed loop system as well as the existing CCTV and DMS from the SCDOT Transportation Management Center (TMC) located in Columbia. From this location, operators view images, post images on the web, dispatch messages to DMS, and coordinate with local public safety agencies.

Currently, CCTV camera images represent the primary method of gathering roadway information. At the TMC in Columbia, operators watch video to identify problems or incidents on the roadway such as crashes, stalled vehicles, or spills. Closed circuit televisions are located at the following locations:

- I-85 at I-385 (2 cameras)
- I-85 at Woodruff Road (1 camera)
- I-385 at mile-marker 36 (1 camera)

Once an operator verifies an incident, they coordinate with public safety agencies to dispatch appropriate resources. As a result, the cameras decrease the time necessary to identify and respond to an incident. Specifically, emergency

vehicles arrive at the scene more quickly and patrol vehicles or tow-truck can clear the incident sooner. These actions reduce the likelihood of a secondary accident and reduce the effects of congestion caused by the incident.

In addition to being used as a traffic management and incident management tool, CCTV cameras serve as a traveler information tool. When motorists view the CCTV images on SCDOT's traveler information website prior to their trip, they can avoid delays.

Finally, operators disseminate information gathered using CCTV to the traveling public via dynamic message signs. DMS located on I-385 and I-85 provide the primary method for operators to broadcast information to motorists in the vicinity of Woodruff Road. The two DMS on I-85 are located northbound approaching Woodruff Road and southbound approaching I-385. The DMS on I-385 is located westbound east of Woodruff Road.

ITS Package A

Package A proposes queue detection systems on key off-ramps where stopped vehicles can impact the capacity of the interstate. These stopped vehicles can become a safety concern just as easily as they are a capacity issue. Some of the excessive queuing on the off-ramps can be attributed to poor signal progression along Woodruff Road. Improvements to the corridor's signal timing is being addressed as a supplemental task of the ***Woodruff Road Corridor Study***, and the queue detection systems will need to be closely integrated with the new signal system

As shown in **Figure 3.8**, four locations have been identified for the installation of queue detection systems. Two queue detection locations occur on the off-ramps at the Woodruff Road interchanges with I-85 and I-385.

The system is comprised of three components – the detection, the warning sign, and the integration with the signal controller. When the detection – placed at key locations along the ramp – is activated, it indicates to the signal controller that additional green time is needed for that approach of the intersection. Multiple locations provide a means to differentiate between various queue lengths, so longer queues that create more severe safety issues would warrant a higher priority with the signal controller. Longer queue lengths also would activate the warning sign for the approaching traffic on the interstate.

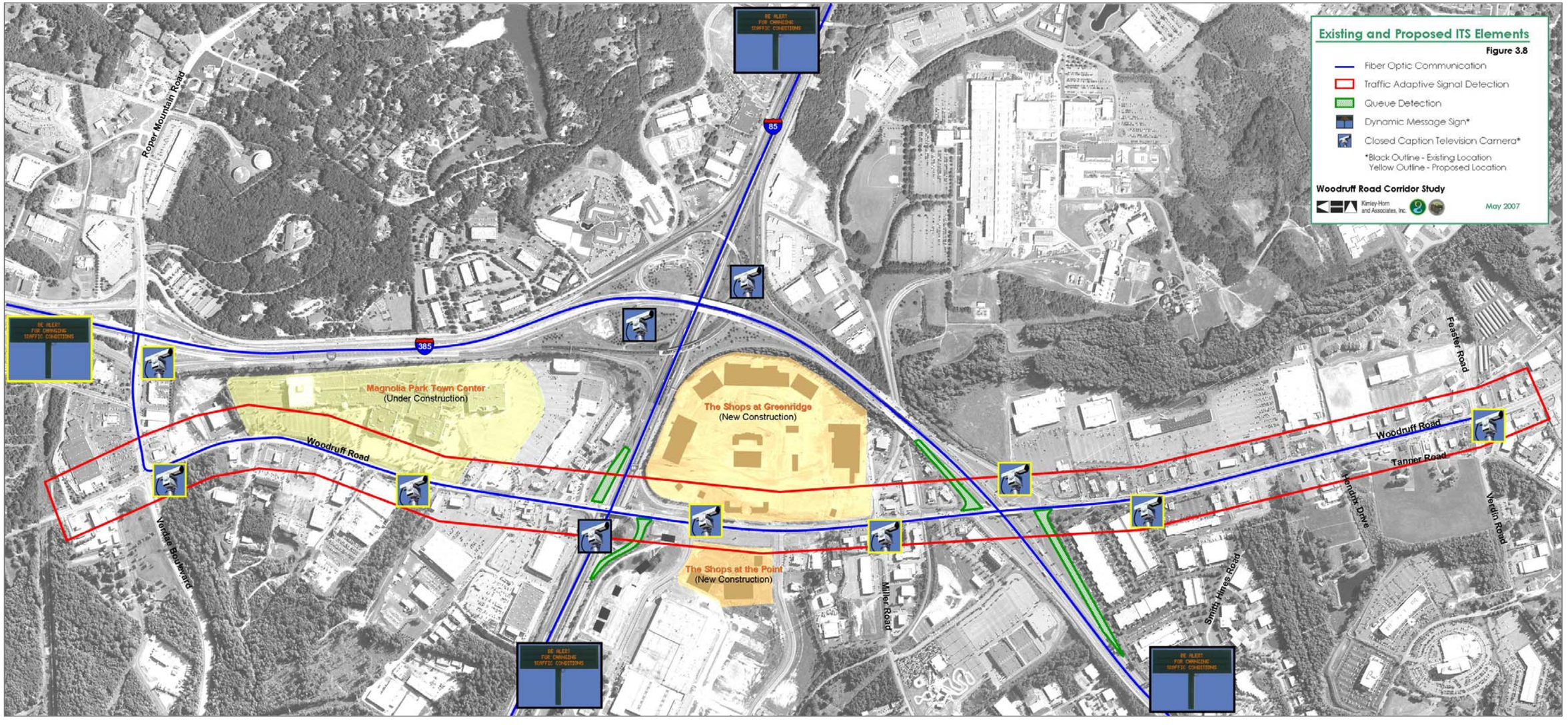
The warning sign could either be a static sign with flashing beacons or a dynamic message sign (DMS) that would receive a message for posting when the back of the queue reached the pre-determined location on the off-ramp. The integration with the signal controller would expand on the available cycles to allow the ramp approach to receive additional green time. In order to provide the additional green time to the ramp approach, the progression of the traffic along Woodruff Road would suffer and create additional congestion on the arterial. To address this issue, the Traffic Operations Center should have the functionality to adjust adjacent signal timing to accommodate changes in traffic patterns.

ITS Package B

Package B includes enhanced arterial and freeway surveillance and an enhanced advanced traveler information system (ATIS). This package includes additional CCTV camera installations along Woodruff Road to provide continuous visibility of the corridor from west of Verdae Boulevard to east of Feaster Road. An additional DMS is proposed on I-385 eastbound prior to the interchange with Verdae Boulevard. Detection technology also would be installed on I-85, I-385, and at mid-block locations to supplement existing intersection detection on Woodruff Road. The additional devices will use existing fiber where available. CCTV cameras not on existing fiber will be connected to the system via new fiber, and proposed DMS units not on existing fiber will be connected to the TMC with radio or dial-up communications.

CCTV units on arterial roads provide TMC operators with roadway information at key locations along the network. For example, cameras are useful at high-crash intersections to alert emergency vehicles to problems and enable quicker responses. DMS units on adjacent corridors alert motorists to adverse conditions on the surrounding facility and/or the freeways as well as indicate the extent and location of incidents or congestion on the interstate. The DMS units on freeways inform drivers of congestion so they can choose alternate routes.

The ATIS solution would combine the detection data, CCTV camera images, and message sign data into a single interface that would be available through a regional traveler information website. Direct connections with larger retailers along the corridor also could make this information available to customers as they leave these locations. Monitors could be installed to constantly display the travel conditions along Woodruff Road and the insterstate so customers could adjust their route according to existing travel conditions.


Existing and Proposed ITS Elements
Figure 3.8
Fiber Optic Communication
Traffic Adaptive Signal Detection
Queue Detection
Dynamic Message Sign*
Closed Caption Television Camera*
*Black Outline - Existing Location
Yellow Outline - Proposed Location
Woodruff Road Corridor Study
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May 2007
Roper Mountain Road
385
85
Magnolia Park Town Center
(Under Construction)
The Shops at Greenridge
(New Construction)
The Shops at the Point
(New Construction)
Woodruff Road
Verdae Boulevard
Miller Road
Smith Hinges Road
Hendrix Drive
Tanner Road
Verdin Road
Feaster Road
BE ALERT
FOR CHANGING
TRAFFIC CONDITIONS

Chapter 4 – Interchange Modifications

The Greenville metropolitan area is served by one major US Interstate, I-85, and two US Interstate spurs, I-185 and I-385. Within the area analyzed for this study, I-85 and I-385 are the major freeway systems and carry approximately 89,300 and 33,500 vehicles per day, respectively. Each facility has one interchange with Woodruff Road, and several other interchanges along these facilities are very close to the Woodruff Road corridor to directly affect traffic operations.

I-85 is a 668-mile US Interstate running from Montgomery, AL to Petersburg, VA. The freeway traverses five states between its termini — Alabama, Georgia, South Carolina, North Carolina, and Virginia. I-385 is a 42-mile US Interstate running from Greenville, SC to Clinton, SC. The facility is a spur of I-85, intended to provide a connection between I-85 and I-26.

Each interchange in the study area was analyzed during the course of this project to determine whether potential upgrades, both near and long term, would provide congestion relief and increased safety. Each location was analyzed based on feasibility and cost effectiveness. Recommendations are included at the end of this chapter for several of the interchanges in the study area. In addition, upgrades to existing freeway overpasses and construction of new freeway overpasses were examined to enhance cross access mobility.

The following sections provide insight on typical interchange configurations, design standards, existing conditions and problem areas at local interchanges, and recommendations for future improvements.

Typical Interchange Designs

The following interchange configurations are the most common types found in the United States. While other variations exist, these are the configurations most likely to be found in a typical freeway setting. When determining the optimal configuration for a freeway interchange, it is important to consider many factors, including projected traffic volumes, land availability, and projected area growth.

Freeway-to-Surface-Street Connections

Freeway-to-surface-street interchanges are intended to provide access to and from the freeway without interrupting its flow, usually by grade separating one of the facilities and providing directional ramps between the freeway and the surface street. A complete interchange between a freeway and a surface street requires four ramps to provide full movements between the two facilities.

The following configurations are the most common freeway-to-surface-street interchanges found in the study area and the United States.

A **diamond** interchange is the most basic four-ramp interchange configuration. This layout provides basic entrance and exit movements between the freeway system and the crossing facility. This configuration is effective when traffic volumes are not particularly high or when there are no special constraints governing the construction of the interchange. This configuration does not handle large volumes of traffic or large left-turning volumes well, often causing congestion on the ramps and freeway spillback. For higher traffic volumes on ramps and surface streets, traffic signals need to be installed to accommodate demand. The I-385 interchanges at Woodruff Road and Roper Mountain Road are diamond interchanges.

Diamond interchange configuration

An alternative to the diamond is a **partial cloverleaf** interchange, which also utilizes the four-ramp configuration. With two entrance and exit ramps, the partial cloverleaf is functionally equivalent to the diamond; however, the ramps can be configured to accommodate either adjacent property or heavy turning movements. The connection of the ramps from the freeway to the surface street still requires some form of traffic control, whether signed or signalized. As traffic volumes rise, congestion can occur on the ramps and the surface street.

Partial cloverleaf interchange

Full cloverleaf interchanges remove the need for traffic control by providing separate ramps for left-turning and right-turning movements. Traffic that would turn left at a stop-controlled intersection can simply use a loop ramp that merges with the desired direction of travel. The result is reduced delay for entering and exiting traffic. The first interchange constructed in the United States was a full cloverleaf between Routes 4 and 25 in New Jersey in 1929. The I-85 interchange at Laurens Road is a full cloverleaf interchange.

The most significant disadvantage of the cloverleaf interchange is weaving, in which traffic merging left and traffic merging right must cross paths to reach the desired travel lane. This situation becomes increasingly dangerous when volumes become higher than about 1,000 vehicles per hour. At these conditions, interference increases quickly and speeds drop on both the ramps and mainlines, increasing the likelihood of congestion.

Cloverleaf interchange configuration

The **single point urban interchange (SPUI)** is a relatively new interchange treatment that merges the principles of a diamond interchange and a typical intersection to form a configuration that can handle greater capacities with less right-of-way needs. The first SPUI was constructed in Clearwater, Florida in 1974, and today there are more than 60 in place nationwide. The I-85 interchange at SC 14 is a single point urban interchange.

The SPUI configuration resembles a diamond interchange from afar. The main difference occurs at the junction of the entrance and exit ramps with the surface street. Where a diamond interchange would have two separate intersections to move traffic, the SPUI utilizes one intersection. In this regard, the configuration operates as a normal at-grade intersection with opposing left turns moving concurrently. All movements can be handled with a three-phase traffic signal:

1. Through traffic, surface street
2. Left-turning exit traffic
3. Left-turning entrance traffic

The major advantages of the single point urban interchange configuration are its compact layout (requiring little right-of-way) and its ability to move left turns concurrently (increasing capacity). The disadvantages of this configuration include:

- Unfamiliar to drivers
- Multi-lane ramps and surface streets lead to large areas of pavement
- Larger overpasses and bridge structures can be very expensive
- Not pedestrian and bicycle friendly

Single point urban interchange configuration

Freeway-to-Freeway Connections

Freeway-to-freeway interchanges are intended to provide access between the intersecting facilities without interrupting flow on the mainline of the freeways. This is usually accomplished through a series of directional ramps and multiple grade separations. A freeway ending at another freeway requires four ramps, and two freeways crossing one another require eight ramps to create a complete interchange. The following configurations are the most common freeway-to-freeway connections found in the study area and the United States.

Northbound I-85 at Old Sulphur Springs Road

The **four-level-stack** interchange is the most common freeway-to-freeway interchange. Each freeway has a direct connection to the other roadway, with no looping or weaving required. The directional ramps cross one another in a four-level deck that can be seen for up to a mile in the approaching directions. With proper design speeds, drivers might not feel the need to decelerate when utilizing the ramps. The disadvantages of this configuration include the large footprint necessary, the high cost of construction, and local opposition.

Full cloverleaf interchanges are also very effective at handling freeway-to-freeway connections. Unlike the stack interchange, the cloverleaf only requires two levels to accommodate all eight movements. However, as with the freeway-to-surface-street full cloverleaf connection, weaving is a consideration and can cause congestion and safety-related problems. To counter the effects of weaving, a collector-distributor system may be used.

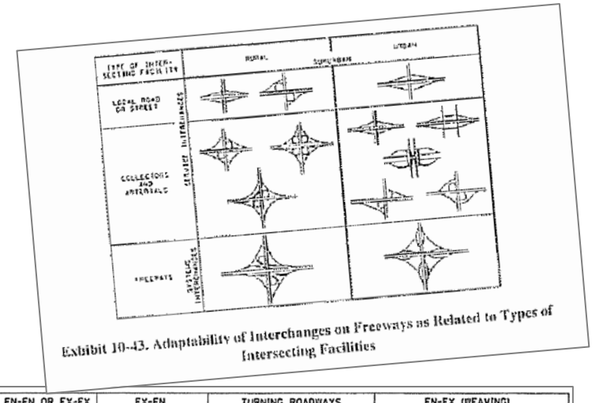
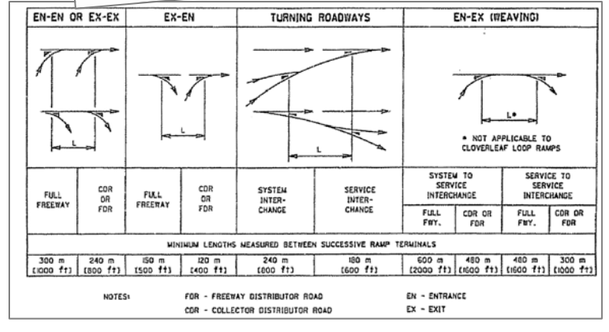


Exhibit 10-43. Adaptability of Interchanges on Freeways as Related to Types of Intersecting Facilities

Design Standards

Freeway design and operation is governed by the Federal Highway Administration (FHWA), and standards for both freeway and interchange design are provided by the American Association of State Highway and Transportation Officials (AASHTO). Published policies on design practices can be found in the AASHTO *Policy on Geometric Design of Highways and Streets*, 2004. The manual provides guidance and standards for many topics including interchange warrants, interchange designs, signing and marking, ramp design speeds, minimum ramp spacing, and minimum acceleration and deceleration distances on ramps. The tables and figures to the right are taken from the design manual and are commonly used to design the components of an interchange.







Study Area Interchanges

Within the study area, there are four freeway-to-surface-street interchanges and one freeway-to-freeway interchange. In addition, one grade separation within the study area that investigated for conversion to full interchange configuration and a new grade-separated crossing of I-85 between Salters Road/Old Sulphur Springs Road and Woodruff Road was analyzed. The following locations were evaluated to determine potential upgrades that might benefit congestion and safety along the Woodruff Road corridor and within the study area.

I-385 at Woodruff Road

The interchange at Woodruff Road and Interstate 385 is a standard four-ramp diamond interchange with signalized intersections at the ramp termini on Woodruff Road. The southbound exit ramp has recently been widened to facilitate larger capacities of traffic from I-385 to Woodruff Road. Average 2006 daily traffic volumes on the ramps are:

- Southbound exit ramp – 12,758 vehicles per day
- Southbound entrance ramp – 5,375 vehicles per day
- Northbound entrance ramp – 5,474 vehicles per day
- Northbound exit ramp – 13,524 vehicles per day

I-385 at Woodruff Road

I-85 at Woodruff Road

The interchange at Woodruff Road and Interstate 85 is a partial cloverleaf configuration with a loop ramp in the southeast quadrant and diagonal ramps in each quadrant. The loop ramp provides access to northbound I-85 from eastbound Woodruff Road. Vehicles traveling westbound on Woodruff Road have a diagonal free flow ramp that provides access to northbound I-85. The ramps feed into a collector-distributor system that carries traffic between the Woodruff/I-85 interchange and I-385/I-85 interchange. The ramp termini at Woodruff Road are signalized intersections. Within the last five years, the ramps have been upgraded to handle larger capacities, primarily from southbound I-85.

This location currently experiences heavy delay in the AM and PM peak periods. Traffic waiting to turn onto the ramps from westbound Woodruff Road experiences heavy queuing, sometimes extending into the next intersection, creating further congestion along the corridor. Average 2006 daily traffic volumes on the ramps are:

- Southbound exit ramp – 10,267 vehicles per day
- Southbound entrance ramp – 7,428 vehicles per day
- Northbound exit ramp – 17,831 vehicles per day

I-85 at Woodruff Road

I-385 at Roper Mountain Road

The Roper Mountain Road and Interstate 385 interchange is a standard four-ramp diamond interchange with a signalized intersection at the ramp termini on Roper Mountain Road. A frontage road intersects Roper Mountain Road approximately 350 feet from the northbound entrance and exit ramps causing continual spillback problems during the peak hour. The interchange is approximately 1 mile from the I-85/I-385 interchange. The section between the two interchanges experiences heavy weaving in peak hours. Average 2005 daily traffic volumes on the ramps are:

- Southbound exit ramp – 5,270 vehicles per day
- Southbound entrance ramp – 9,113 vehicles per day
- Northbound exit ramp – 5,106 vehicles per day
- Northbound entrance ramp – 10,107 vehicles per day

I-385 at Roper Mountain Road

I-85 at Laurens Road

The interchange of Laurens Road and Interstate 85 is an eight-ramp full cloverleaf configuration, with all entering and exit traffic on Laurens Road merging to and from the series of ramps. This merge operation causes a heavy weaving movement at the base of the loop ramps, creating congestion and an unsafe driving environment. Average 2006 daily traffic volumes on the ramps are:

- Southbound exit ramp (Eastbound Laurens) – 4,524 vehicles per day
- Southbound exit ramp (Westbound Laurens) – 3,232 vehicles per day
- Southbound entrance ramp (Eastbound Laurens) – 6,029 vehicles per day
- Southbound entrance ramp (Westbound Laurens) – 3,344 vehicles per day
- Northbound exit ramp (Eastbound Laurens) – 3,900 vehicles per day
- Northbound exit ramp (Westbound Laurens) – 4,130 vehicles per day
- Northbound entrance ramp (Eastbound Laurens) – 2,895 vehicles per day
- Northbound entrance ramp (Westbound Laurens) – 5,370 vehicles per day

I-85 at Laurens Road looking eastbound

I-85 at I-385

The Interstate 85 and Interstate 385 interchange is an eight-ramp, four-level-stack configuration, with a mixture of directional and loop ramps connecting the two facilities. Approach and departure ramps onto Interstate 385 have been modified in the past five years to lessen the weaving problem between the two facilities. Vehicles entering or exiting I-85 utilize a series of collector-distributor roads to separate traffic from the mainline and provide appropriate acceleration and deceleration distances between the successive interchanges. Average 2005 daily traffic volumes on the ramps are:

- Southbound I-385 to Northbound/Southbound I-85 – 12,579 vehicles per day
- Northbound I-385 to Northbound I-85 – 9,790 vehicles per day
- Northbound I-385 to Southbound I-85 – 6,061 vehicles per day
- Northbound I-85 to Southbound I-385 – 5,207 vehicles per day
- Northbound/Southbound I-85 to Southbound I-385 – 14,487 vehicles per day
- Southbound I-85 to Southbound I-385 – 8,750 vehicles per day

I-85 at I-385

I-85 at Salters Road/Old Sulphur Springs Road (Overpass Only)

The Salters Road/Old Sulphur Springs Road overpass crosses I-85 approximately 1.2 miles north of the Laurens Road interchange and 1 mile south of the Woodruff Road interchange. The current structure is aging and due for replacement. Salters Road and Old Sulphur Springs Road merge west of the overpass, and the two-lane roadway crosses the overpass and intersects the new Millennium Parkway east of the interstate.

The 2004 average daily traffic along the roadway is 4,100 vehicles. The traffic volumes along this corridor are expected to increase dramatically when the International Center for Automotive Research and the Verdae Development are fully built out. Previous planning efforts ruled out the potential for an interchange at this location due to its proximity to the interchange at Woodruff Road. At the charrette, this location was considered for full replacement as a 4-lane bridge with distinctive gateway architectural features.

Salters Road/Old Sulphur Springs Road Overpass

Recommendations

The I-85 and I-385 interchanges along Woodruff Road are some of the primary sources of congestion along the corridor, distributing large amounts of traffic onto the facility during peak hours. Initial observation indicated the Woodruff Road corridor suffers from too much access to freeway facilities. That is, I-85 and I-385 interchange spacing along Woodruff Road do not meet current federal spacing standards. The current configurations place the interchanges approximately one-half mile apart with eight traffic signals within this distance (four at the interchanges and four at commercial driveways). Traffic from the freeways coupled with traffic from adjacent developments creates an undesirable level of congestion and level of service.

I-85 at Woodruff Road

Congestion at the Woodruff Road and I-85 interchange is the heaviest of any location along the corridor, with queuing occurring on both the surface streets and ramps. In many instances, queuing stacks into the intersection and onto ramps thereby inhibiting movements from all approaches until upstream signals clear. This scenario effectively could be treated using better enforcement efforts through regular patrolling or ITS monitoring with ramp spillback detection.

Near-Term Recommendations (1 to 3 years)

A few cost-effective geometric considerations can potentially reduce congestion in the near term. These potential improvements are illustrated in **Figure 4.1** and include:

- Reconfiguring the northbound diagonal entrance ramp to provide more spacing between the intersection and the entrance to the Shops at Greenridge; Reconfiguration allows for right-in/right-out access at the Shops at Greenridge
- Extending the monolithic concrete island at the southbound entrance ramp to prohibit through movements to the northbound loop ramp at the adjacent intersection to allow southbound left turn phasing to be upgraded to protected-permitted (see inset image)
- Adding right turn lane to existing northbound exit ramp along with an additional auxiliary lane from northbound exit ramp to Carolina Point Parkway intersection.

Figure 4.1 – Proposed near-term improvements at I-85 and Woodruff Road

Long-Term Recommendations (5 to 15 years)

Potential long-term solutions include complete reconstruction of the facility, upgrading it from a partial cloverleaf with two signalized termini to a single point urban interchange. This type of interchange can handle larger capacities of traffic, which are expected as development continues along the corridor. The main cost associated with this improvement would be the reconstruction of the ramps and the large overpass structure over I-85. **Figure 4.2** depicts this potential improvement.

With the completion of one or both of these improvements, coupled with access management and signal timing improvements along the corridor, congestion levels should decrease, creating a safer and more suitable driving environment along Woodruff Road.

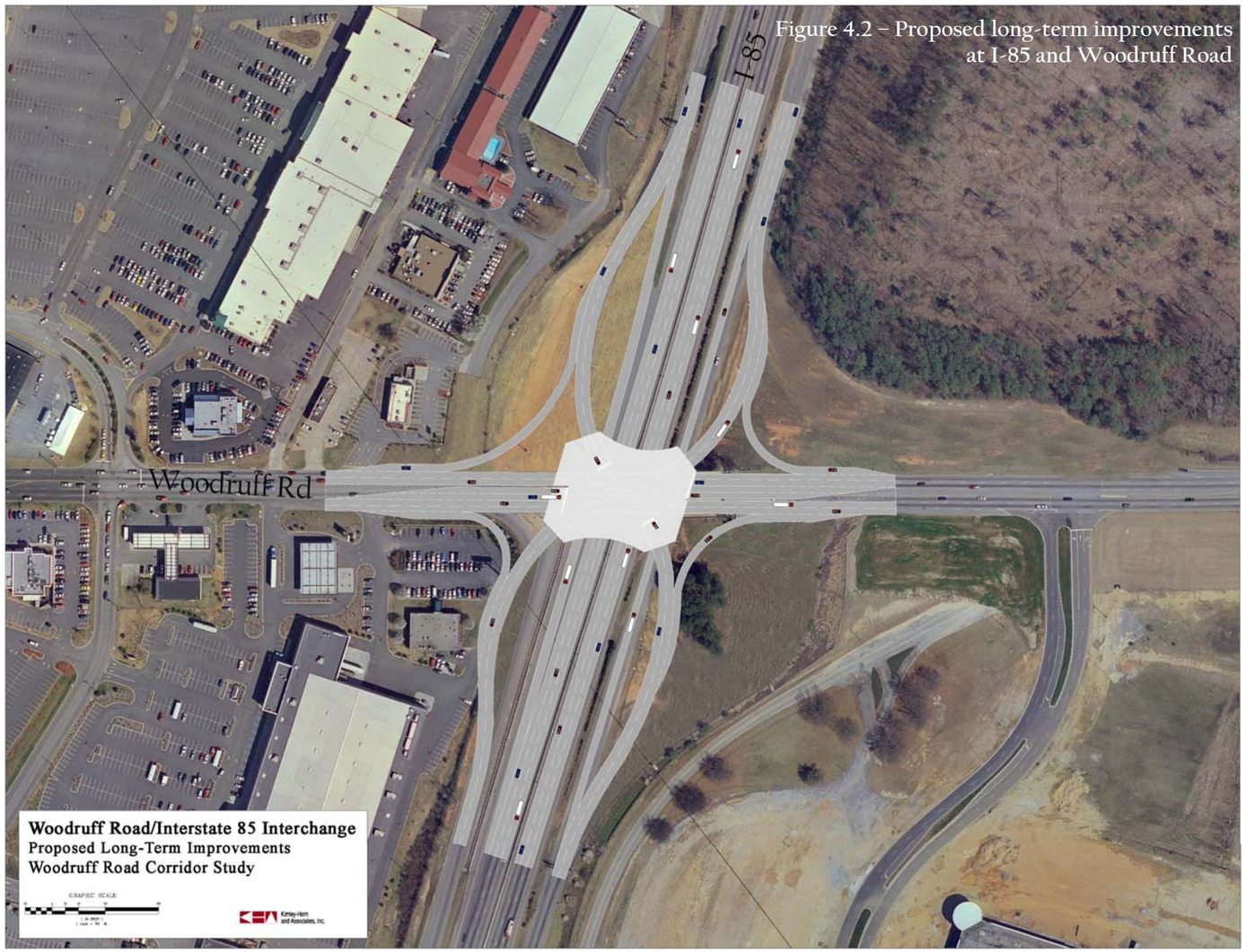
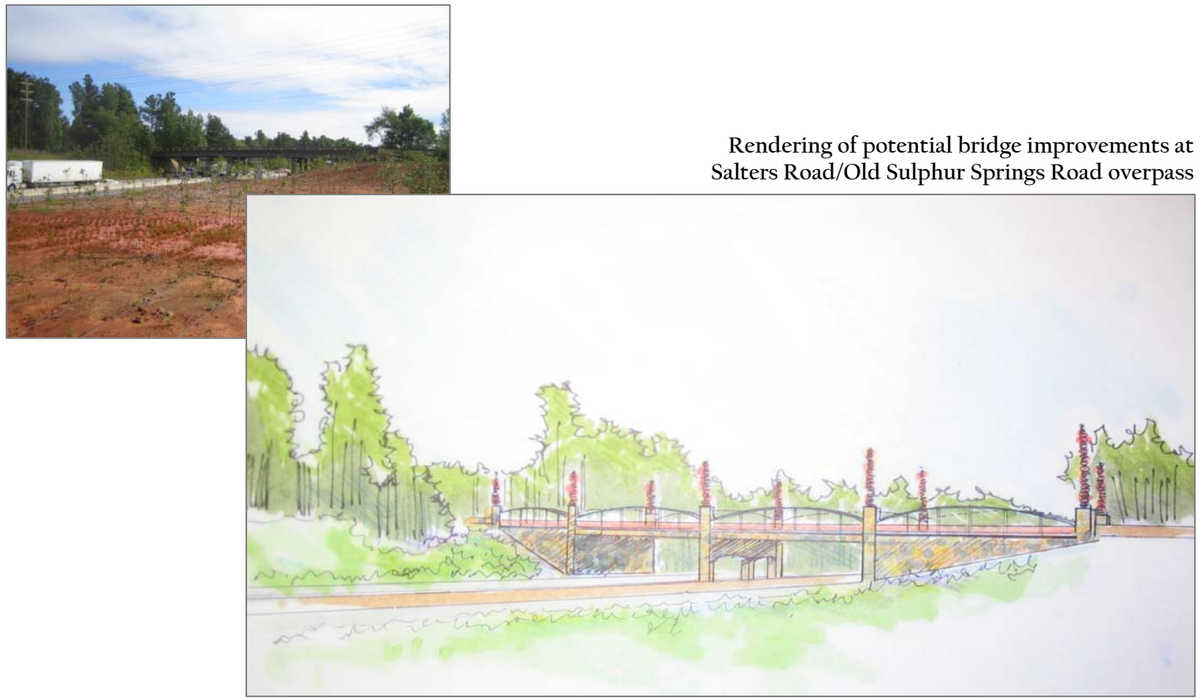


Figure 4.2 – Proposed long-term improvements at I-85 and Woodruff Road

I-85 at Salters Road/Old Sulphur Springs Road (Overpass Only)

South of the Woodruff Road and I-85 interchange, the overpass at Salters Road and Old Sulphur Springs Road is in need of upgrades to carry increased traffic volumes generated by the International Center for Automotive Research and the Verdae Development. The rendering to the right depicts potential upgrades to the overpass as it is rehabilitated.



Rendering of potential bridge improvements at Salters Road/Old Sulphur Springs Road overpass

Alternative Cross Access between Salters Road/ Old Sulphur Springs Road and Woodruff Road (Overpass Only)

An alternative cross access point could be created north of the Salters Road overpass, allowing for a parallel route from the Verdae Development to the proposed developments at The Point. Based on planning level analysis conducted at the design charrette, an overpass at this location would provide necessary cross access but would be difficult to implement due to its potential impact to current development plans. As shown in the rendering below, construction of this overpass would require considerable approach distances due to elevation differences between the east and west sides of I-85.

Profile view rendering of proposed new grade separation at I-85

I-85 at Laurens Road

Further south of the aforementioned overpasses, the interchange of Laurens Road and I-85 and its related weaving problem create safety risk to drivers as well as moderate congestion during peak hours. The acceleration and deceleration lanes shared by the loop ramps onto I-85 do not provide adequate room for merging traffic to and from Laurens Road. This short weave distance combined with the speed of vehicles entering and exiting has contributed to many crashes at this location.

Near-Term Recommendations (1 to 3 years)

A potential near-term solution would remove one set of opposing loop ramps, eliminating the weave problem altogether. The diagonal ramps in each quadrant would remain, and the two remaining loop ramps would have to be altered to handle left-turning traffic from their respective directions. The left-turn movement would require some paving in the median to provide a left-turn acceleration lane for traffic to merge with through traffic. This operation would also require a two-phase signal to provide a protected turning movement. Through traffic on the opposing side would be allowed to operate continuously while the turning movements were operating. **Figure 4.3** provides a conceptual rendering of the proposed improvements.

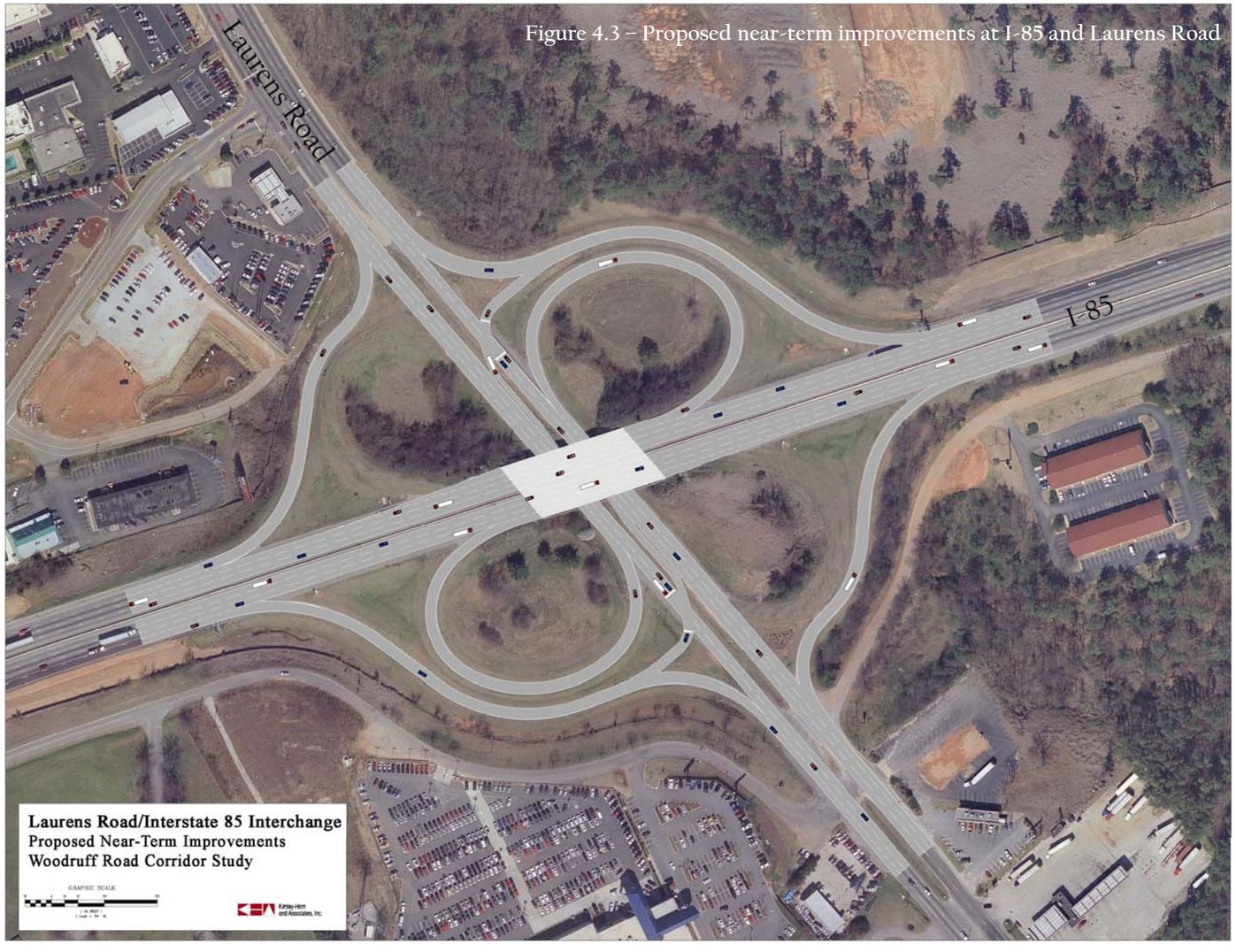


Figure 4.3 – Proposed near-term improvements at I-85 and Laurens Road

Long-Term Recommendations (5 to 15 years)

Potential long-term solutions include converting the cloverleaf facility into a single point urban interchange. Because the traffic on I-85 currently travels above the movements on Laurens Road, the turning movement operation of the SPUI would operate under the overpass at a new signal. This potential improvement would require complete reconstruction of the ramps and replacement of the bridge structure to allow additional vertical clearance to accommodate the new signal. **Figure 4.4** provides a conceptual rendering of the proposed improvements.

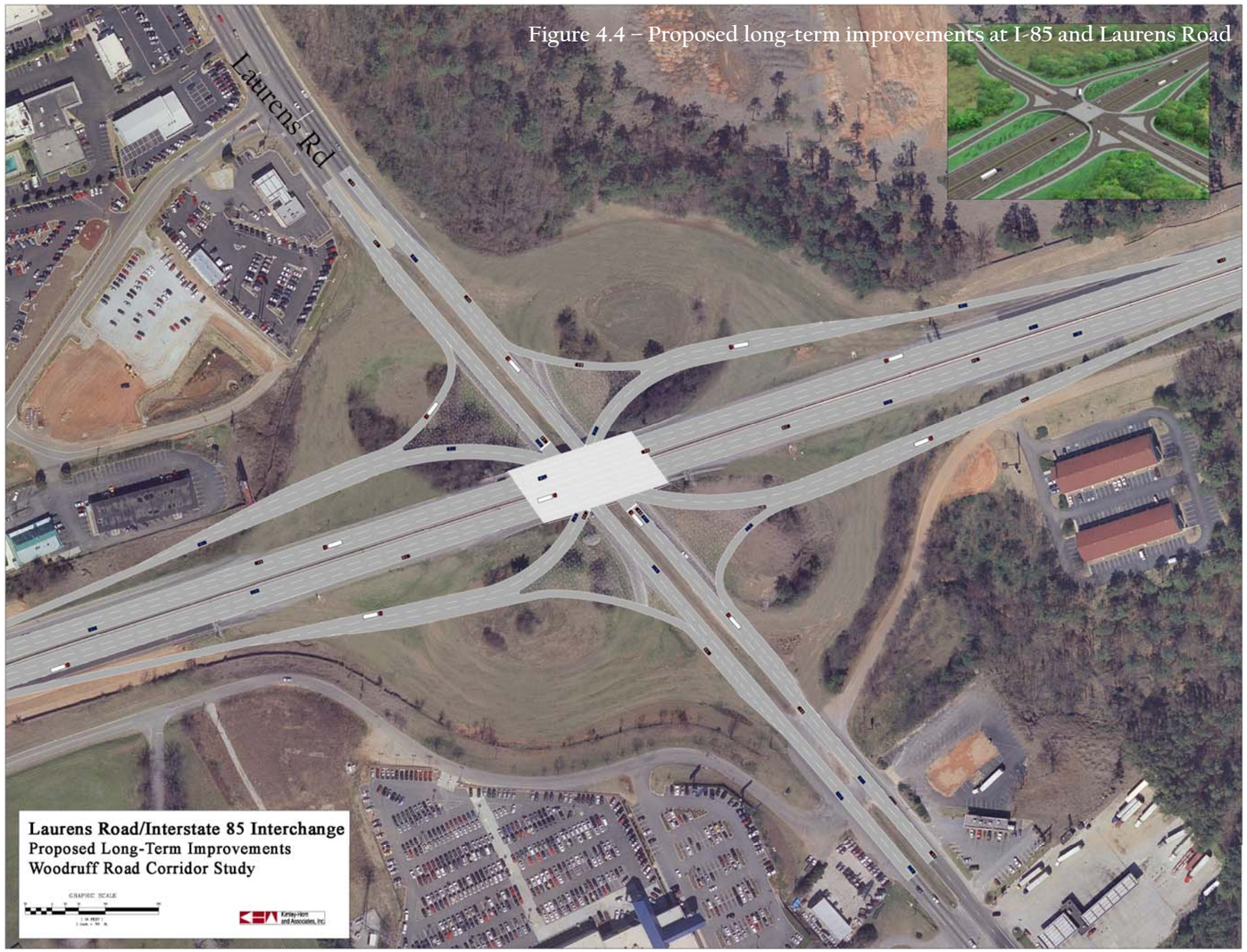


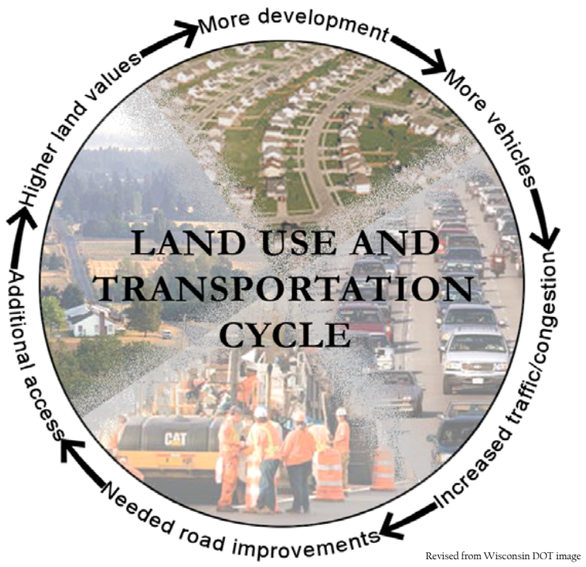
Figure 4.4 – Proposed long-term improvements at I-85 and Laurens Road

Chapter 5 – Land Use Considerations

Overview

While land use planning traditionally has been a stand-alone process, it does not exist in a vacuum. Transportation systems and land use patterns tend to influence each other in a cyclical pattern. Elements of transportation — including roads and pedestrian, bicycle, and transit facilities — can impact how land is developed in terms of density and even types of use. Further, where land uses fall and how they are distributed inevitably impacts decisions regarding where people travel and how transportation facilities are prioritized. If low-density development is spread out, residents must rely almost entirely on automobiles to get from one location or use to another. On the other hand, denser centers that combine complementary land uses near each other enable greater choice in transportation.

Because of this relationship between land use planning and transportation systems, the ***Woodruff Road Corridor Study*** must strive to strike a delicate balance. Plans, policies, and programs not only must preserve mobility through effective transportation, but also must reinforce a "sense of place" through land use that truly reflects the community.



Revised from Wisconsin DOT image

Vision, Goals, and Guiding Principles

The vision of the ***Woodruff Road Corridor Study*** recognizes the need for new development patterns by focusing on smart growth principles, sustainable development, and the community's character. Sustainable development — which can be measured by environmental stewardship, economic prosperity, and an equitable distribution of community resources — will be challenged by the growth in residences, office parks, research centers, shops, and restaurants over the next several decades. Accommodating these new residents and businesses will require a combination of focused development and redevelopment of existing underutilized parcels.

To fulfill the corridor's vision, local leaders have begun to join with the private development community to rethink the components of the area as well as the spatial relationships between them. Reorganizing the landscape into a more sustainable development pattern will require an evaluation of the four Ds commonly associated with the relationship between land use and transportation — density, diversity, design, and destinations. The four Ds have helped communities across the country balance the mobility and livability offered by land use and transportation.

Vision

"To create a healthy and sustainable environment that protects the access and mobility of the Woodruff Road area while utilizing **smart growth principals, encouraging sustainable development,** and **protecting the community character.**"

Goals

- Balance access and mobility in the corridor
- Address corridor safety concerns
- Identify potential aesthetic improvements
- Integrate with planned development
- Develop functional and implementable recommendations

Land Use and Development Patterns

To formulate a vision of sustainable growth and development within the Woodruff Road area, it is necessary to examine the existing land use profile, development patterns, and transportation system that serve the surrounding community.

Land Use Profile

During the 1970s, Woodruff Road existed as a rural two-lane highway. The land that surrounded the roadway was envisioned to develop into residential neighborhoods, with commercial nodes at major intersections such as SC 14. But as these neighborhoods filtered in from the east and new access was provided by Interstates 85 and 385, the role of the corridor began to shift. The Greenville Mall opened in 1978, and by the time Wal-Mart and Sam's Club opened in the 1990s, the corridor's role had transitioned. Despite being zoned for residential development, the corrior became a hub of commercial activity.

The land use pattern at Woodruff Road today is the result of planning decisions spanning more than two decades. Between 1982 and 2006, 12 rezoning petitions along Woodruff Road have been denied by the Planning Commission only to be approved by County Council — evidence of the influence that private development has on the area. The diagram below illustrates the variety of uses found along the corridor today. The diagram shows each building's use, including residential (yellow), commercial (red), office (blue), and industrial (purple). Though a mixture of uses is evident, development patterns to date have resulted in a segregation of these uses.

Development Patterns

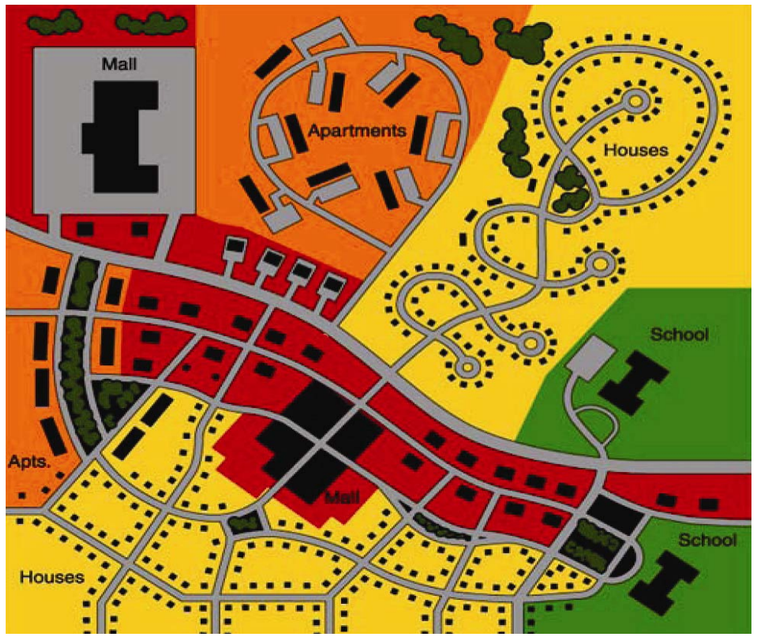
Throughout the Woodruff Road corridor, the separation of land uses and sprawling development patterns demonstrate a suburban form. (Scholars explain urban form as "the spatial footprint of our cities; measured by street patterns, block length, mix of land uses, maximum building height, average residential density, and non-residential intensity [Floor Area Ratio].") Residential, commercial, office, and industrial uses in the Woodruff Road area are generally isolated or, when located near each other, not well-connected. This means that most residents, employees, and visitors spend significant amounts of time and money driving around to accomplish even their day-to-day activities.

This physical distance between complementary land uses in a suburban setting tends to promote automobile travel, particularly since safe, convenient facilities are not readily available to pedestrians and bicyclists. The area's lack of connectivity between adjacent properties also forces traffic traveling between developments to use arterials such as Woodruff Road, thus contributing toward congestion. Increased traffic means less mobility for citizens and others traveling through the region.

Often, low population density contributes to development patterns that actually increase traffic. Because walking, bicycling, or public transit is rarely an option in the area, the average single-family, detached household is expected to generate five separate vehicle trips per day. That means more cars are on the road, for longer periods of time, trying to access their destinations. This suburban organization is similar to a street hierarchy popularized during the 1950s. Across the country, local, collector, and arterial streets were developed, favoring large block lengths, limited connections between adjacent developments, and single-point entry/exit points to the transportation network.

The top portion of the illustration on this page shows how each land use type is isolated from other uses, which for the most part represents what Woodruff Road looks like today. In the image, apartments, houses, the mall, and the school are all separated and forced to use a single route to connect to the larger road (i.e. Woodruff Road). This larger road, or arterial, was intended to accommodate travel between surrounding communities. Because the local traffic is now forced onto this single road, travelers experience congestion throughout the day, whether they are traveling to a neighboring community or just to the local mall. Such a configuration often is a product of zoning ordinances that separate uses and discourage mixed-use developments.

The traditional road network that existing before the 1950s included a grid network of different size streets. This well-connected network supported alternative choices for travel – different modes and different routes. Ultimately, the network placed less reliance on the arterial system. The lower portion of the diagram illustrates this traditional approach to transportation planning, which is a viable alternative to Woodruff Road. The same land uses are offered as in the suburban development, but the network of interconnected streets offers more options to travelers and reduces congestion on the arterial. The diversity of local travel options encourages better distribution of trips, thereby reducing the number of cars all traveling on the same route. This configuration also provides a safe environment for pedestrians and bicyclists to travel from one land use to another.



Source: Congress for the New Urbanism, 2006

> The first complaint one always hears about suburbia is traffic congestion. More than any other factor, the perception of excessive traffic is what causes citizens to take up arms against growth in suburban communities.
>
> - Andres Duany, Suburban Nation (2000)





Policy and Guidelines Toolbox

The following policies and guidelines should serve as a toolbox. The tools provide guidance to establish a more comprehensive, coordinated set of plans, programs, and policies that better balances land use (accessibility) and transportation (mobility) needs within the community. These tools were selected following discussions with City and County planning staff and a review of local land development and zoning ordinances.

Tool 1: Promote Sustainable Land Development

A development can have a positive or negative impact on the transportation system, either creating more congestion or providing alternate routes for traffic. The City and County should not only consider how a mix of land uses will relate when considering development opportunities but also keep in mind the way each use is accessed. If sustainable land development principles are followed, local officials can plan for land use and developments that reduce congestion. Offering smart alternatives will help limit the number and lengths of local trips as well as provide alternatives to the already congested Woodruff Road.

Efficient travel between land uses can be encouraged by promoting development patterns that favor higher densities and intensities, a mix of land uses, and an environment that accommodates pedestrians. In turn, the transportation system should connect complementary land uses and focus on more efficient travel behavior defined by mode and route choices.

To encourage on-site improvements for promoting a more sustainable land development pattern, the Woodruff Road area's transportation system should favor efficient travel between interior destinations and safe, predictable connections to adjacent properties. The orientation of buildings and parking lots should favor a "park once" mentality, whereby the design, location, and supply of parking promote a more balanced transportation environment that facilitates walking once arriving to the site.

By not providing excessive parking, the City and County will encourage pedestrian and bicycle travel and discourage automobile travel. Pedestrian walkways within a newly or re-developed site should connect building entrances and provide safe crossings. Locating parking and vehicle driveways away from building entrances also will encourage pedestrian activity. At the edges of development, rules and standards should be adopted that require purposeful connections to the public sidewalk and greenway system for promoting alternative modes of travel for accessing the site.

Compact, Mixed-Use Development

Newer developments such as the mixed-use project at The Point recognize the benefits of increased density, mixture of land uses, and pedestrian-friendly design.

Parking Once Districts

To promote sustainable land development, buildings should be oriented and parking located to favor a "park once" mentality. Excessive parking should be discouraged.

Internal pedestrian circulation at the Shops at Greenridge

"Sea of parking" at Wal-Mart

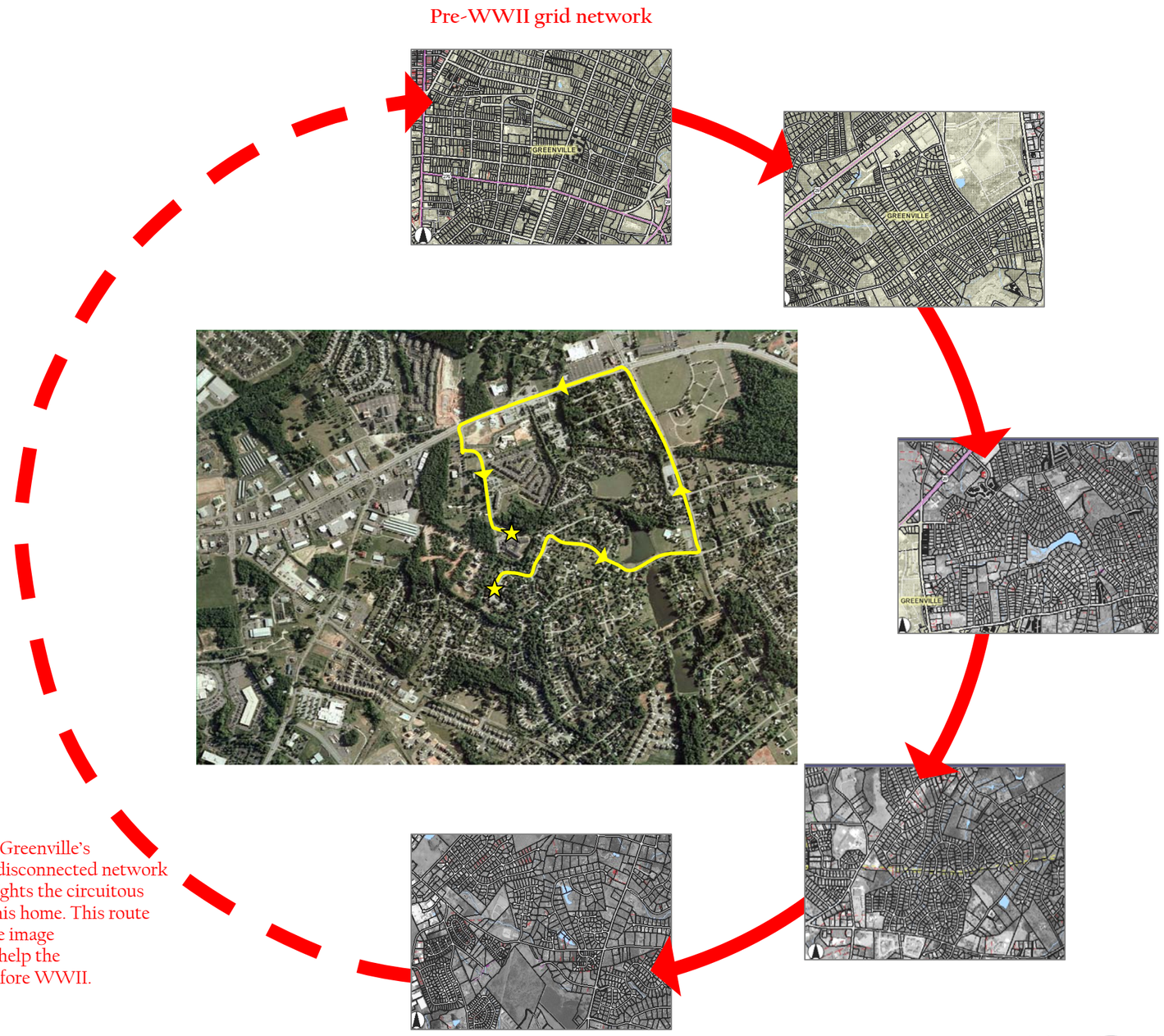
Tool 2: Support Efforts to Increase Connectivity Within and Between Developments

Street connectivity refers to the directness of routes and the density of connections (i.e., intersections) within a transportation system. As connectivity increases, travel distances decrease and route options increase, allowing the transportation system to be used more efficiently by pedestrians, bicyclists, transit, and automobiles. When the local street network is not sufficient, a thoroughfare such as Woodruff Road often becomes the preferred travel route. Unfortunately, this reduces regional mobility for through traffic.

A highly connected transportation system includes several options for entering or leaving a new development. Whenever possible, these options are located on secondary roads rather than highways. The number of street systems without access to other roads should be limited, just as cul-de-sacs would be restricted to areas where topography, environment, or existing development make other street connections prohibitive. Stub-outs should be encouraged and signed to accommodate future street extensions and connections with neighboring parcels. The City and County also should encourage developments to include regulations that require minimum street spacing, which will support efforts to more easily connect with other streets and developments.

Connectivity in the area should not be limited to automobiles, however. Encouraging a network of connected pedestrian and bicycle facilities can offer more transportation alternatives, especially when that network provides access to a variety of land uses, roadways, and developments. Greenway and pedestrian connections are highlighted in Chapter 2.

Connections need to be not only planned but also implemented during the development review process. Promoting a highly connected transportation system through implementation will require revisions to local zoning and subdivision ordinances.



The series of five images on the peripheral shows the historical transition of Greenville's development pattern – from a well-connected grid before WWII to today's disconnected network of arterials and cul-de-sacs. In the center of the diagram, a yellow line highlights the circuitous route a local resident must take to drive to a destination only 500 feet from his home. This route requires travel on both SC 14 and Woodruff Road. The circular nature of the image conceptualizes the idea that supporting efforts to increase connectivity can help the transportation network return to the more efficient network that existed before WWII.

Tool 3: Promote Development Design to Manage Access and Reduce Congestion Levels on Major Roadways

For the area to truly achieve transportation efficiency, the City and County will need to consider the potential conflicts between the transportation system's mobility (transportation) and accessibility (land use). Access management will help balance mobility and accessibility.

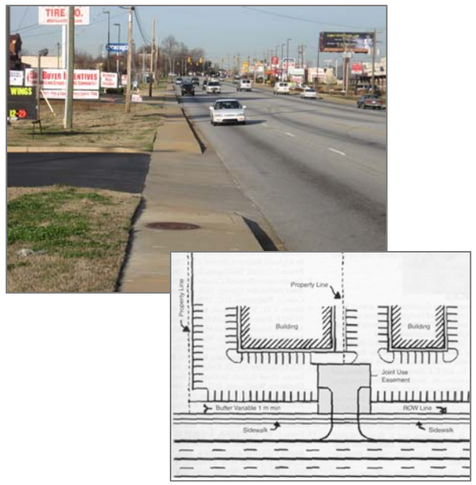
From a land use perspective, the number, location, and spacing of driveways along the street network significantly impact vehicular movements and levels of congestion. Land use and transportation professionals agree that the number of driveways or curb cuts serving a property should be minimized and that regulations and incentives can be used to encourage shared-use driveways. Greenville can promote greater street network efficiency through cross access agreements, which limit the number of driveways and allow roadway access for multiple parcels across a single property.

Building on the momentum of this collaborative planning process, local leaders should partner with SCDOT to review the state's current access management guidelines and local ordinances that regulate access to the street network. Following this review, a formal access management overlay ordinance should enforce consistent access management standards that ensure the proper function of Woodruff Road. In particular, minimum spacing and maximum driveways per development should be regulated. Strengthening and enforcing minimum lot frontage requirements will prevent the establishment of small frontage lots along the corridor. In addition, regulations should encourage the construction of parallel routes for backdoor access. These routes can be integrated into the local street system when small frontage lots are unavoidable.

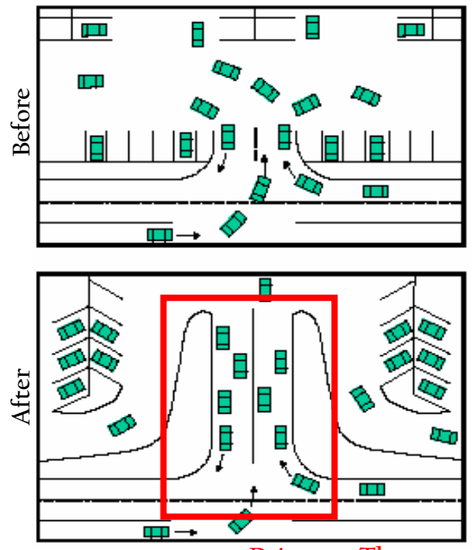
Implementation of access management tools can be accomplished in a number of ways — changing local zoning ordinances, developing an access management overlay ordinance, or approving rules and regulations for the subdivision and site plan review process to include application of access management solutions. More detailed access management techniques are discussed in Chapter 3.

Access Management Examples

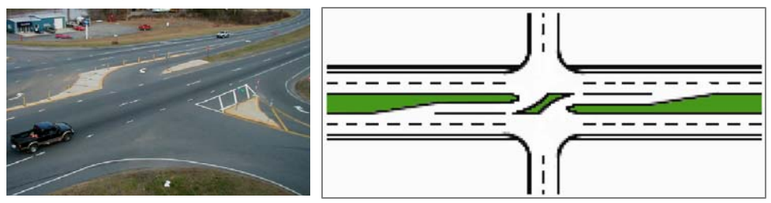
Shared Driveway Use



Internal Site Circulation



Regulating Left Turns (i.e. left-over treatment)







Recommendations

> Great streets do not just happen. Overwhelmingly, the best streets derive from a conscious act of conception and creation of the street as a whole. The hands of decision makers are visible.
>
> - Allan B. Jacobs

As mentioned, one of the key issues for addressing the necessary balance between land use and transportation priorities within the community is how various authorities work at different levels of government. SCDOT, the City of Greenville, and Greenville County have vested interests and responsibilities in the combined transportation and land use plan. In general, land use is the responsibility of the local government, while the responsibility of the transportation system falls on SCDOT. Building on the Policy and Guidelines Toolbox, the following recommendations are intended to improve the relationship between land use and transportation. These recommendations require a commitment by local and state government as well as private developers.

Desired Outcome: Improved coordination between land use and transportation

Transportation facilities can impact the density, intensity, and types of land uses. The location and type of land uses, in turn, influence where and how people travel. Promoting development patterns that favor higher densities and intensities, a mix of land uses, and an environment that accommodates pedestrians helps encourage the efficient use of the transportation system. These developments should be supported by a comprehensive transportation system that connects complementary land uses.

Recommended Action: **Adopt a special overlay district for the corridor.**

The development of a corridor-based special overlay district requires stakeholder involvement and public outreach focused on the specific strengths, opportunities, and needs of a given corridor. The preparation of the ***Woodruff Road Corridor Study*** included processes devoted to gathering such information. A special overlay district for Woodruff Road will unify two planning districts with differing regulations for the same types of uses. Such unification is critical given the frequent changes of the municipal boundary. A task force should be formed to explore and help facilitate the development of an overlay district.

Recommended Action: **Require sidewalks as the rule and waiver as the exception.**

Existing land development regulations leave sidewalk requirements to the discretion of the planning commission. Such practice inhibits the consistent development of pedestrian facilities. These regulations should be changed to require sidewalks on new streets and within existing developments.

Special Overlay District Ordinance Example

(c)Terminal islands, a minimum of 5-feet wide, shall be provided at the ends of all parking bays. Terminal islands shall contain at least one shade tree that may count toward required the number of trees for the site.

(d) For every two full parking bays (each including two aisles of parking and a lane) or as required in the table, a 5-foot wide divider median is required. The number of divider medians are required as follows (See Figure 2):

Number of Parking Bays	Number of Required Divider Medians
2	0
3-4	1
5-6	2
7-9	3
More than 10	1 divider median for every 3 bays

The divider median shall form a continuous strip between abutting rows of parking spaces. Shade or flowering trees within a divider median shall be planted at 30-foot intervals, unless the divider median is designed to function as a pedestrian path providing access from the parking area to the primary building entrance. The maximum spacing of trees shall not exceed 50 feet.

(e) Parking areas adjacent to the public right-of-way shall be screened from view from the public right-of-way. Screening shall be accomplished by a landscape buffer or a streetwall 30 to 54 inches high.

(f) Driveways providing access to the public roadways should not be placed along the front facade of the primary structure to minimize conflicts with pedestrians in the parking areas unless driveway placement is restricted by Georgia Department of Transportation or the City of Thomasville Engineer.

(g) Access Management/Connectivity

1. Driveways/Entrances per property are permitted as follows and must be consistent with the requirements of the Georgia Department of Transportation:

Property Frontage	No. of Driveways
Less than 100 feet	1
Greater than 100 feet	2

2. Properties with frontage less than 100 feet are encouraged to enter into an agreement with adjacent properties for shared access to minimize the number of driveway openings to maximize landscaping along the Overlay District corridors and median opportunities within the right-of-way.
3. Driveways/Entrances shall meet the minimum width of the Georgia Department of Transportation requirements, but not greater than 30 feet wide.
4. Provide a five foot wide sidewalk along public right-of-way, if sidewalk is not present at time of construction. Provide a five foot wide pedestrian connection between public sidewalk and the main entrance to all buildings.

Figure 1: Parking

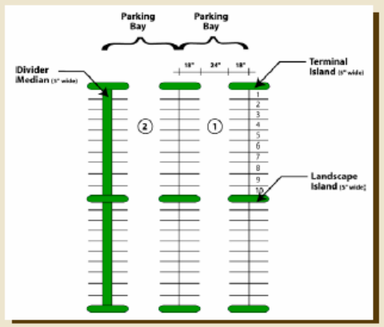
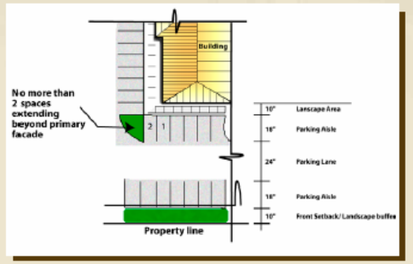


Figure 2: Parking Bays



SEC 22-94 OVERLAY DISTRICT DEVELOPMENT REQUIREMENTS- Landscaping/tree preservation

The landscape requirements within the Overlay Districts shall comply with the following provisions, unless within an historic district:

(a) Clear cutting of undeveloped properties is prohibited prior to submittal of an approved tree survey and approval of a landscape plan for the property.

(b) Existing tree cover and natural vegetation shall be preserved, whenever possible, or replaced with suitable native landscaping. All existing, healthy deciduous and hardwood trees with a caliper of ten or more inches at a point of three feet above the ground shall be retained, as indicated in an approved landscape plan.

(c) For new developments, all development applications shall include a tree survey for the project site. Trees which meet the requirements of exceptional trees as defined by the zoning code shall be preserved in accordance with the requirements of Section 20-29. All other hardwoods and deciduous trees including, but not limited to, ash, beech, cedar, crabapple, cypress, elm, hemlock, magnolia, maple, oak, and tupelo, with a

Kimley-Horn and Associates, Inc.

Recommended Action: **Examine parking standards.**

The City of Greenville requires off-street parking for all zoning districts except C-4 Central Business District (Sec. 50-198). However, some references in the regulations indicate that the number of spaces shall not exceed more than 125 percent of the total amount required, implying that oversupply of parking is permitted and exists. Parking standards tailored to the peak hours of the year should be revised.

Likewise, mixed-use developments require the minimum number of parking spaces to be equal to the sum of the required spaces for each type of use. This requirement does not account for "park once" districts in which a resident, employee, or visitor arrives in a vehicle but walks to multiple destinations within the development. Regulations that govern the orientation of buildings and parking lots can contribute to a "park once" mentality. By allowing fewer parking spaces and ensuring their proper location, the City and County will encourage pedestrian and bicycle travel and discourage excessive automobile travel.

Revisions to parking standards as they apply to the unique conditions of Woodruff Road can be accomplished during the development and adoption of the special overlay district and access management overlay district.

Recommended Action: **Define common design elements along the corridor.**

The City and County should work together to define common design elements that collectively reinforce a sense of place for the Woodruff Road corridor. These design elements then should be used to promote effective decisions regarding appropriate land use and development patterns for the area. In addition, a streetscape plan for Woodruff Road should be developed as a community initiative for protecting the long-term sustainability of the community. Elements of the streetscape plan may include plantable medians, street trees, highly visible crosswalks, pedestrian countdown signals, pedestrian-level lighting, and utility consolidations. This plan should be coordinated with the access management strategies presented in the ***Woodruff Road Corridor Study***.

Desired Outcome: Efficient use of the transportation system

An efficient transportation system includes an interconnected network of different size streets that offer varying levels of access and mobility depending upon their intended function. Connections to and between these streets should be planned in order to decease travel distances and increase route choice. This allows the transportation system to be used more efficiently by pedestrians, bicyclists, transit, and automobiles.

Recommended Action: **Adopt an access management overlay ordinance.**

Access management overlay ordinances have been adopted across the country to complement existing local zoning and subdivision regulations. An overlay ordinance will not change any of the rules and requirements associated with the underlying zoning district. The ordinance will provide a legal framework for the City and County to administer and enforce consistent access management standards along the corridor.

The ordinance should contain rules and requirements for the "core" components of a comprehensive access management strategy, including minimum spacing standards for traffic signals, median openings, and driveways; provisions for corner clearance, joint access, and connectivity; and design requirements for building access connections. The ordinance also should require cross access between adjacent properties, consolidation/elimination of excessive driveways, and retrofitting site access to the side and rear portions of the site. These standards will be applicable to properties abutting the corridor.

Recommended Action: **Adopt a formal connectivity ordinance.**

One of the guiding principles for the ***Woodruff Road Corridor Study*** came from a stakeholder who commented, "We can't really address our transportation issues unless we address street connectivity." A formal connectivity ordinance will increase the connections between existing and new developments and redevelopments by requiring coordination between the vehicular and non-vehicular circulation systems. Such ordinances have been instituted in cities and counties across the nation, including several localities in the Carolinas.

> *"We can't really address our transportation issues unless we address street connectivity."*

A standard connectivity ordinance embraces connections as a way to reduce the burden on arterial streets by offering a variety of routes between two destinations. In Cary, NC, connectivity is calculated by dividing the number of street links by the number of street nodes and intersections. A development must have a connectivity index of 1.2 or greater. This requirement can be waived by the Director of Development Services if it is deemed unreasonable to require such connections. However, when the requirement is waived, a six-foot pedestrian trail must be provided to link cul-de-sacs within a residential development. (See Section 7.10 at http://vic.townofcary.org/index.htm)

Street connectivity ordinances have been adopted throughout the United States, including the following localities in the Carolinas:

- Lancaster County, SC
- Rock Hill, SC
- Cary, NC
- Conover, NC
- Cornelius, NC
- Huntersville, NC
- Raleigh, NC

A blanket statement in the City of Greenville's regulations (Sec. 50-212) requires interconnectivity:

> Adjacent non-residential uses shall provide for vehicular and pedestrian circulation between their sites, through alley or parking lot connections, hard surface walkways, and similar measures. The Zoning Administrator may waive this requirement if, in his opinion, the requirement cannot reasonably be met.

While a connectivity policy has been in place for the County since the early 1990s, the policy is often ignored as evidenced by an increasingly disconnected transportation network. Though the policy remains in effect, a formal ordinance was never adopted.

A connectivity ordinance should be adopted by the City and County, using one of several numerical standards. The ordinance should limit the number of cul-de-sacs to areas where topography, environment, or existing development make other street connections prohibitive.

Recommended Action: **Revise land development regulation for cul-de-sacs.**

A major barrier to connectivity is the presence of cul-de-sacs. Currently, local ordinances allow cul-de-sacs up to 1,200 feet in length. The length of these dead-end streets can be extended beyond 1,200 feet as long as they provide bulge outs for U-turns. A review and revision of cul-de-sac design and location standards as permitted in local land development regulations should result in fewer and shorter cul-de-sacs, and thus improved connectivity. In locations that require cul-de-sacs due to topographic or environmental constraints, a six-foot pedestrian and bicycle trail should be constructed.

Revised land development regulations should prevent the construction of long cul-de-sacs such as the one formed by Market Point Drive.

Chapter 6 - Implementation

Implementation Plan

Completion of this study symbolizes an important step toward implementing mobility, safety, and aesthetic improvements within the Woodruff Road study area. Most of the recommendations outlined in this report will require limited amounts of right-of-way for dedicated improvements. The nature of the recommendations does not require that all improvements are completed in unison. This should allow the City and County the flexibility to work in partnership with the development community to implement the vision of the plan in several phases as development occurs and funding sources become available.

Media reports highlight local citizen's frustrations over the lack of funding sources and the time needed for implementing improvements to the Woodruff Road corridor. Unfortunately the planning, design, and construction of publicly-funded transportation projects typically takes ten years in environmentally sensitive areas.

All indications point to a paradigm shift in the way the City of Greenville does business. Much like downtown Greenville, the Woodruff Road area has reached a "tipping point", where local incentives for the development community aren't necessarily protocol. The quality of private investment in both design and community amenities has had a profound impact to the "attractiveness" of the area. Continued success and sustainable development, while absorbing the level of planned development will only come through a cooperative effort between public and private ventures.

Local, state, and private partnerships offer strategic advantages to implementing improvements on a timely basis, especially considering the level of impeding development within the Woodruff Road study area. The purpose of this implementation plan is to recognize these challenges and suggest strategies to address each challenge. Following are general recommendations and action strategies offered by the consultant.

General Considerations

The following recommendations apply to the overall vision for the corridor as expressed by the local planning and engineering staff, SCDOT, development community and elected officials. These recommendations can be initiated throughout the planning process and prior to any physical infrastructure improvements.

- Use this plan as a tool to review proposed development projects and plans as they locate and are implemented within the Woodruff Road study area.
- Integrate future bikeways, greenway, and trail networks (i.e., Osgood Canal greenway) with the Woodruff Road study area to create an interconnected network.
- As the transportation corridor is improved and expanded minimize impacts that negatively affect the character and integrity of adjacent neighborhoods by introducing gateways or traffic calming improvements.
- Promote alternative modes of transportation through better street design and developer participation.
- Promote interconnectivity and cross-access between existing and proposed developments.

Site Access Mitigation Measures

Many of the recommendations in this report require the closure and/or consolidation of existing driveways for successful implementation. Site driveways should be configured to minimize negative effects of traffic flow along the corridor. For new developments this can be accomplished through good site design and by limiting the number of new access points along the roadway. For existing sites it may be necessary to close one or more driveways to consolidate the flow of traffic to and from the development. This can be accomplished by promoting interconnectivity and cross-access between existing and proposed developments. Additional tools include:

- **Driveway throat length**— is the distance from the edge of the public street to the first internal site intersection. An adequate separation should be provided (minimum 100 feet) to prevent internal site operations from affecting an adjacent public street.

- **Number of driveways**— in many cases, new development occurs adjacent to an existing site or adjacent to another new development. In these cases, driveway permit applicants should be encouraged to seek cross access easements/agreements (from an existing adjacent property) or coordinate with an adjacent proposed development to create interconnected internal circulation systems and shared-use external driveways.
- **Driveway placement/relocation**— driveways located in proximity to intersections create and contribute to operational and safety issues. These include intersections and driveway blockages, increased points of conflict, frequent/unexpected stops in the through travel lanes, and driver confusion (as to where vehicles are turning). Driveways in proximity to intersections should be relocated or closed, as appropriate.
- **Signalization**— the volume of traffic attracted to some site driveways is more than can be accommodated acceptably under an unsignalized condition. Delays for minor street movements as well as left-turn movements on the main street may create or contribute to undue delays on the major roadway and numerous safety issues. The installation of a traffic signal at appropriate locations can mitigate these types of issues without adversely affecting the operation and progression of the major roadway.

Right-of-Way Requirements

Generally, the recommendations presented herein can be accomplished within available right-of-way, with three exceptions.

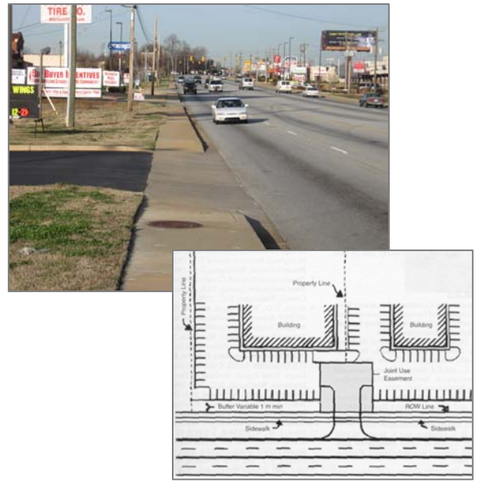
- The proposed cross-access improvements (see access management plans) along the Woodruff Road impact several businesses, most of which can be accomplished with no impact to structures. Most likely these improvements will only be realized through redevelopment and rezoning opportunities (i.e., as a requirement of the rezoning process).
- New collector streets (i.e., 2-lane facilities) would be required as a part of the development review process, ultimately providing an interconnected system of well-design streets. In some cases, stub-outs of the new connections will be constructed to adjoin with adjacent undeveloped property. These stub-outs should be signed as "future street connection" to avoid confusion and ensure future connections.
- The third exception involves the planting of street trees along Woodruff Road and the implementation of the multi-use path (greenway system) along tributaries and the abandoned SCL Railway right-of-way. These improvements would not necessarily require additional right-of-way to be purchased by the City or County, but rather would require an agreement between the City and the adjacent land owners allowing the City to utilize this portion of the property. The concession should require the City to maintain the facilities after their implementation.

Probable Construction Costs

As part of the corridor planning process, probable cost estimates were developed for each of major elements of the corridor improvements. These cost estimates were prepared in year 2007 dollars and do not include right-of-way costs. The probable construction cost figures are based on unit cost values provided by SCDOT. The cost associated with development and redevelopment activities is not included in this estimate. The total cost estimate for each element included the following categories:

- Roadway and pavement
- Landscaping
- Traffic signal upgrades
- Pedestrian level improvements
- Design services
- Contingency

A summary of construction by phased improvement is provided in subsequent sections.



Responsible Agencies

The agency responsible for the implementation of the recommended corridor improvements also was identified. Some of the proposed improvements within the study area cross over right-of-way that is owned by different public and private agencies. Some improvements will occur as a result of development opportunities. The majority of responsibility for implementing the freeway infrastructure and access management improvements along the Woodruff Road corridor will be a coordinated effort between SCDOT, the City and the County. Some access management improvements will be the responsibility of private property owners looking to redevelop their investment.





Construction Phasing

The timeframe needed for implementation was a consideration for the study area improvements. Factors that can affect the timeframe may include:

- Funding availability
- Permitting
- Right-of-way acquisition
- Public support or opposition

With this in mind, not all of the improvements can be made at one time. When preparing construction documents for the recommended improvements, City and County officials may still want to consider design treatments for select intersections (such as curb-casing around corners) to protect their investment from heavy truck traffic that remains in the corridor for serving local destinations (e.g., delivery trucks for area businesses).

The following information provides the proposed timeframe of implementation. The timeframe of project recommendations is addressed in three phases. Projects in Phases I and II are identified for short to near-term implementation prior to 2013. Phase III projects are identified for long-term implementation and may require investment by the development community.

Phase I – Short-Term Improvements (1 – 3 year implementation)

- **Signal System Improvements** — implement study recommendations for improving the existing signal system. A progression-controlled signal system upgrade was developed as a part of this study and includes recommendations for signal timing, phasing and intersection geometric improvements. Improve pedestrian signals at all major intersections. Probable construction cost is $X,000,000 [to be determined during the supplemental Signal Timing Optimization task].
- **I-85 at Woodruff Road Interchange** — reconfigure the northbound diagonal entrance ramp to allow for right-in/right-out access at the Shops at Greenridge. Extend the monolithic concrete island at the southbound entrance ramp to prohibit through movements to the northbound loop ramp at the adjacent intersection to allow southbound left turn phasing to be upgraded to protected-permitted. Add right turn lane to existing northbound exit ramp along with an additional auxiliary lane from northbound exit ramp to Carolina Point Parkway intersection. Probable construction cost is $600,000
- **Multi-use Path Improvements** — construct a 10' multi-use path from Verdae Boulevard to Millennium Point Parkway. This improvement involves utilizing the abandoned SCL rail line and existing underpass located at I-85. Probable construction cost is $600,000.
- **Access Management Improvements (section 1: I-385 to Hendrix Drive)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figure 3.4.
- **Pedestrian amenities upgrade** — existing pedestrian amenities are inconsistent and include some sidewalks adjacent to Woodruff Road and pedestrian crosswalks and signals at select intersections (e.g., Carolina Point Parkway). Safe, convenient pedestrian crossings of Woodruff Road should be a primary focus and provided in proximity to residences and hotels.
- **Access Management Improvements (section 2: I-85 to I-385)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figure 3.3.
- **Signage should be controlled and wayfinding upgraded** — existing signage creates a clustered environment and devalues the area's sense of place. Likewise, signage for commercial properties makes wayfinding more difficult. Signage control combined with improved wayfinding (along Woodruff and freeway corridors) will contribute to safer and more pleasant travel conditions along within the study area.

Phase II – Near-Term Improvements (3 – 6 year implementation)

- **I-85 at Salters Road/Old Sulphur Springs Road (overpass)** — replace the overpass from a 2-lane bridge to a 4-lane bridge with bike lanes, sidewalks and ornamental gateway treatments consistent with ICAR and Verdae development design characteristics. Probable construction cost $3,000,000.
- **Collector Street Improvements** — construct a 2-lane collector street from Verdae Boulevard to Millennium Point Parkway. This improvement includes utilizing the abandoned SCL rail line and existing underpass located at I-85. Probable construction cost is $2,000,000.

Short-term access management improvements

Near-term improvements at I-85 and Salters Road/Old Sulphur Springs Road

- **Access Management Improvements (section 3: Vaughn Road to SC 14)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figure 3.7.
- **Access Management Improvements (section 4: Verdae Boulevard to Green Heron Drive)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figure 3.1.
- **I-85 at Laurens Road Interchange** — reconstruct the interchange by removing one set of opposing loop ramps, eliminating the weave problem altogether. The diagonal ramps in each quadrant would remain, and the two remaining loop ramps would have to be altered to handle left-turning traffic from their respective directions. The left-turn movement would require some paving in the median to provide a left-turn acceleration lane for traffic to merge with through traffic. This operation would also require a two-phase signal to provide a protected turning movement. Through traffic on the opposing side would be allowed to operate continuously while the turning movements were operating. Probable construction cost is $800,000.
- **Transit Shuttle Service** — initiate transit service within the Woodruff Road study area by providing a shuttle loop that would encircle the study area using the proposed BRT line (i.e., SLC Rail line), Millennium Parkway, Woodruff Road and Verdae Boulevard. The idea would be to have a circulating shuttle with frequent service and limited headway transporting office employees and patrons to the commercial activity nodes along Woodruff Road. Funding for the shuttle service could be supported through a public-private partnership with the office, retail, and research sectors. Probable capital (shuttles, benches) cost is $90,000. Probable annual operating cost is $120,000.

Phase III – Long-Term Improvements (6 – 15 year implementation)

- **Access Management Improvements (section 5: Green Heron Drive to I-85)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figure 3.2.
- **Access Management Improvements (section 6: Hendrix Drive to Vaughn Road)** — construct access management improvements including planted median (where applicable), driveway consolidation, intersection upgrades, street trees, gateway and crosswalks. See Figures 3.5 and 3.6.
- **I-85 at Woodruff Road Interchange** — reconstruct the interchange, upgrading it from a partial cloverleaf to a single point urban interchange (SPUI). This improvement would most likely not require additional right-of-way. Probable construction cost is $20,000,000.
- **I-85 at Laurens Road Interchange** — reconstruct the interchange into a single point urban interchange. The turning movement operation of the SPUI would operate under the overpass at a new signal. This potential improvement would require complete reconstruction of the ramps and replacement of the bridge structure to allow additional vertical clearance to accommodate the new signal. Probable construction cost is $20,000,000.
- **Verdae Boulevard Improvements** — reconstruct the road from Woodruff Road to Laurens Road from a 5-lane cross-section to a 4-lane boulevard with a plantable median and sidewalks. This improvement would not require additional right-of-way and would be consistent with proposed Verdae development plans for a mixed-use town center. Probable construction cost is $1,700,000.
- **Transit BRT Service** — initiate bus rapid transit (BRT) service connecting ICAR with downtown (8 miles). The corridor utilizes the abandoned SCL rail corridor and could include a BRT line. This would involve constructing the BRT facility including one bridge and additional right-of-way. Probable capital (BRT line, 4 buses, and ROW) cost is $25,000,000. Probable annual operating cost is $1,000,000.

Near-term improvements at I-85 and Laurens Road

Long-term improvements at I-85 and Woodruff Road





Action Plan/Funding Strategies

A concurrent step to identifying the phasing of transportation system improvements within the Woodruff Road study area is to explore financing alternatives for the recommendations. However, a limited range of funding options is available to implement recommended improvements.

Although funds are limited and generally programmed well in advance, there are a few funding categories that are potential sources or financing for these improvements. Some funding options require local matching funds. Some of the traditional or "typical" funding categories include:

- **C-Funds** — Funds allocated to each county by South Carolina Department of Transportation (SCDOT) for the purpose of transportation improvements; law requires that improvements be tied to transportation and that 25 percent of the funds be spent on the state highway system.
- **Enhancements** — Environmentally-related activities that improve the transportation experience through landscaping, bicycle and pedestrian facilities, historic preservation, and other visual amenities related to the transportation system.
- **Guide Share** — Funding available to each of the South Carolina Metropolitan Planning Organizations (MPO) and Councils of Governments (COG) for System Upgrade projects. This dollar amount is calculated by taking the MPO's and COG's specific proportion of the state population and applying it to the total available funds for System Upgrade projects. SCDOT is currently revisiting this formula, which may change in the near future. The Grenville-Pickens Area Transportation Study (GPATS) annual Guideshare allocation is approximately $8,000,000.

Because the list of recommended improvements contains a variety of projects, it is recommended that the "typical" funding types be explored and exhausted for each individual improvement. For example, all sidewalk and gateway improvements should seek "enhancement" funds and all roadway improvements should seek State funds, at a minimum.

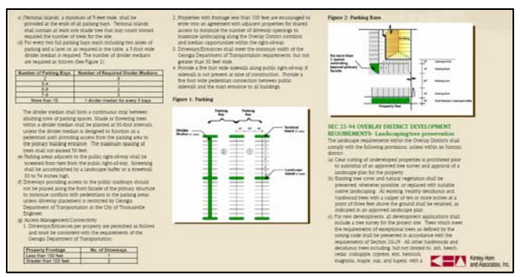
Public-private venture agreements also can be leveraged to implement a specific improvement, especially if there are identified benefits or incentives to both parties. The following list identifies "action items" that should be initiated by the City-County to begin the process of improving the Woodruff Road study area.

Ultimately, a new funding source may be needed to bring forward some or all of the near- to long-term improvements like the I-85/Woodruff and I-85/Laurens Road interchange redesign. The City and County are currently evaluating the support for a new Sales Tax referendum as a part of the long-range transportation plan update. With this in mind, these interchange redesign projects would be a prime candidate for the Sales Tax based on the safety, access, mobility and economic development potential benefits received by the region.

Priority Action Items

- Pursue plan adoption by implementing agencies including the City and County of Greenville and the South Carolina Department of Transportation (SCDOT).
- Utilize the Transportation Plan Advisory Group (TPAG) and the Woodruff Road Steering Committee to meet regularly and aid in the implementation process.
- Adopt a land development ordinance that requires developers to implement the "intent" of recommended improvements for the *Woodruff Road Corridor Study*, building in flexibility for access and design to fit their individual development schemes.
- Adopt a special overlay district for the corridor. A special overlay district for Woodruff Road will unify two planning districts with differing regulations for the same types of uses. Such unification is critical given the frequent changes of the municipal boundary. A task force should be formed to explore and help facilitate the development of an overlay district.
- Adopt an access management overlay ordinance. The ordinance will provide a legal framework for the City and County to administer and enforce consistent access management standards along the corridor. The ordinance should contain rules and requirements for the "core" components of a comprehensive access management strategy, including minimum spacing standards for traffic signals, median openings, and driveways; provisions for corner clearance, joint access, and connectivity; and design requirements for building access connections. The ordinance also should require cross access between adjacent properties, consolidation/ elimination of excessive driveways, and retrofitting site access to the side and rear portions of the site.

Special overlay district sample







- Examine parking standards to limit over-parking and encourage "park once" mentality and shared parking. Revisions to parking standards as they apply to the unique conditions of Woodruff Road can be accomplished during the development and adoption of the special overlay district and access management overlay district.
- Adopt a formal connectivity ordinance. A formal connectivity ordinance will increase the connections between existing and new developments and redevelopments by requiring coordination between the vehicular and non-vehicular circulation systems.
- Revise land development regulation for cul-de-sacs. A major barrier to connectivity is the presence of cul-de-sacs. Currently, local ordinances allow cul-de-sacs up to 1,200 feet in length. A review and revision of cul-de-sac design and location standards as permitted in local land development regulations should result in fewer and shorter cul-de-sacs, and thus improved connectivity.
- Lobby SCDOT and members of the State legislature to include partial funding of improvements in the next Transportation Improvement Program (TIP) to design and implement.
- Pursue SCDOT STP-Enhancement grant funding to install 10' multi-use path from Verdae Boulevard to Millennium Point Parkway along the abandoned SCL rail line as well as complete sidewalks along Woodruff Road. These funds are administered through a grant program with a 20% local match requirement. More information is available on the SCDOT website http://www.scdot.org/community/tep.shtml
- Solicit SCDOT District Office "Spot Safety" improvement monies to implement safety improvements at key intersections along Woodruff Road corridor.
- Consider a Sales Tax referendum, local impact fees, or vehicle registration fees to complete "gaps" along the Woodruff Road corridor as well as interchange modifications.
- Consider providing a tax incentive to existing property owners and developers located along the Woodruff Road corridor for converting to "shared" driveways and constructing cross- access connections.
- Require dedication of connector street right-of-way for redevelopment or rezoning applications along the Woodruff Road corridor.

Conclusion

There are a variety of funding strategies to implement the recommended improvements for the ***Woodruff Road Corridor Study***. These funding strategies include state and local monies, which are often limited or committed well into the future. Grant funding from the state typically requires a local match, but these monies may be used to cover many of the capital and operating expenses identified in the recommendations for the corridor. Some of the improvements will be made in partnership with the private sector.

An incremental funding approach would be possible, but is not as attractive because the full benefit of the collective improvements would not be realized for quite some time. Alternative funding sources for expediting construction include special assessments and/or a locally-adopted transportation bond.

Ultimately, decision-makers will need to partner with the local development community to make this plan a reality. Traditional efforts of relying on public investments to enhance safety and mobility within the Greenville region have become less desirable and reliable. If change is to occur and sustainable development is to be realized for the Woodruff Road study area, it will have to be accomplished through a meaningful and cooperative effort between public and private sectors.

One thing is certain, with the current transportation funding shortfall the most critical steps toward implementation will be carried by "champions" or leaders identified within the community. In collaboration with state and local officials, their collective efforts will lead to a safe, aesthetically-pleasing community through the heart of the Woodruff Road study area.