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# Determining Underserved Areas of Public Transit in Rural South Carolina

Access to public transportation is particularly important for families and households with one or no cars. Surprisingly, the number of South Carolina households with no access to private transportation has increased around 4 percent in the last decade. Our research focuses on the rural portion of this population and assesses the public transit services available. A combination of SAS™ and ArcGIS™ is used to pursue the following two research questions: Job openings: An indication of the level of public transit service measured as accessibility to job opportunities. This provides an indication of which areas could benefit most from an improved service. Spatial distribution of job openings and their accessibility by job seekers based on the current rural level of public transportation service: How accessibility to the job market would change if intelligent transportation systems solutions for faster connections or even a simple increased frequency of service were implemented in these underserved areas.

## INTRODUCTION

Rural South Carolina is undergoing significant demographic and economic changes, which in concert with new transportation technologies give potential rise to new opportunities for rural transportation systems. Our research project identifies those areas that have the highest likelihood for viable rural public transport. This is a key determinant for in turn invigorating sustainable growth beyond traditional metropolitan and tourist areas. Our project combines transportation geography, economics, statistics, and geo-spatial information technology to inform local and regional decision makers throughout rural South Carolina. In the course of this project, we trained students at South Carolina State University's (SCSU) University Transportation Center (UTC) and helped UTC to become host to the largest GIS-based repository of transportation-related geospatial data and derived analyses in all of South Carolina.

Our project had the following three objectives:

1. Identification of rural areas with a larger than average populations that are disenfranchised by the lack of public transportation.
2. Transfer of GIS and statistics skills to young transportation researchers.

3. Development of a GIS repository of demographic and rural transportation data that serves rural transportation research in South Carolina in general, and around Orangeburg in particular.

This paper will concentrate on objectives 1 and 3. In the course of the project we

- assembled US Census datasets 1990 and 2000 census years,
- constructed a GIS repository for rural transportation needs,
- conducted statistical analyses of employment demand, and
- performed spatial analyses of accessibility scores.

In the following, we outline our approach and provide a detailed documentation of all the data delivered. The main part of this final report is a manual that, using a real-world example, describes how the data can be analyzed to inform rural transportation policy. Rather than making specific recommendations, we provide a template for a wide range of possible analyses that can now be conducted at the SCSU Transportation Center.

# BACKGROUND

In South Carolina, some 40% of the population is living in rural areas. Access to public transportation is important but it becomes even more important for those families and households with one or no cars. Surprisingly the number of household with no access to private transportation (e.g. cars) has increased around 4% in the last decade. Recent research indicates that "*transportation mobility, rather than residential location, is the key determinant of the degree to which low-income workers seeking economic opportunities are faced with spatial barriers*" (Shen 2001:54).

The costs of a rural society built around the car are well-known: the isolation of elderly, youth and low-income citizens who have limited or no access to the automobile; and a land use pattern that demands the use of one mode of travel above all others (TRB 2003).

The 1990s witnessed in eight of South Carolina's 22 mostly rural counties a new phenomenon, not well described by the term 'counter-urbanization'. It describes situations where the rural population grows faster than its urban counterpart. and in only four of the 22 counties did the population continue to decline. This marks a sharp reversal of decades of rural population losses. The increase is due to larger than average growth among young, elderly, and immigrant populations. This new demographic trend affects the movement of people in and between rural areas, and the capacity of public and private systems to respond effectively and efficiently to changing rural travel needs (TRCB 2001).

# DATA COMPILATION

The data compilation process (the most labor-intensive task in every GIS project) consisted of three steps. First, we needed to create a set of base maps, then add census data, and finally assemble local and regional bus routes.

## Topographic Data

Topographic information forms usually the basis for all subsequent geographic layers. It provides the user with some orientation and consists of both physical as well as man-made features. Given that our project covers the whole state of South Carolina, we compiled all datasets both by theme (e.g. boundaries, rivers, towns) as well as by county, where all themes are added on top of each other to provide a comprehensive base map for each county. This separation into themes and regional subsets fulfills two purposes. First, maps get overcrowded and difficult to read when they try to depict too much at the same time. Second, once all data layers (themes) are combined, they occupy so much computer memory that the system response becomes unacceptably sluggish.

Of particular importance was the separation of rural from urban(ized) areas (see Figure 1). Some of our analyses were restricted to the former, while the latter were sometimes used for comparison purposes and to serve as a template for what is likely to be financially viable.

Part of the topographic data is the US Census TIGER street network. ArcGIS™ currently lacks a network analysis module but even cursory visual interpretation reveals that the South Carolina street network is amazingly disconnected. Rivers and military training sites form major barriers and obstruct potential bus routes.

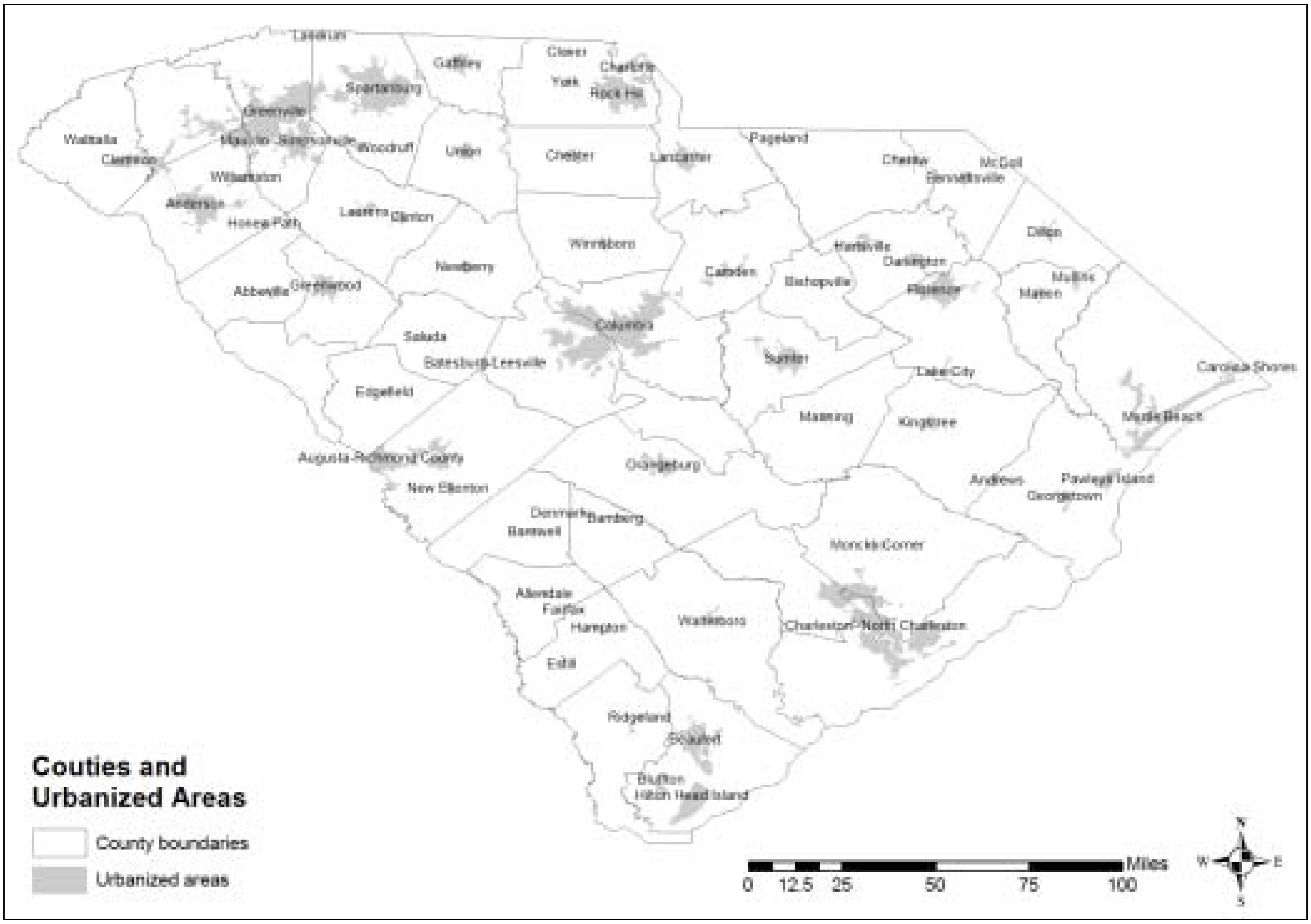



*Figure 1. Counties and Urbanized Areas*

## Population Data

In the United States, population data is collected every ten years by the U.S. Census Bureau. They started to release their datasets just as we were beginning with our project. The census bureau publishes its data in raw form and the translation into "GIS-able" data was an exercise in (large) data management. The finest resolution for most of the data is a so-called census block group, which usually comprises of several street blocks (covering in rural parts of the state rather large areas) with approximately 1170 people living in each block group. At that level of resolution, we compiled maps for over 450 different variables, (see Table 1 for an overview of the type of information collated). We concentrated our analysis efforts on employment status, journey-to-work, and vehicle availability.

*Table 1. Selection of (the more than 450) Block-group Level Census Variables*

| | |
|---|---|
| Age | Place of birth and citizenship |
| Caregivers | Place of work |
| Disability | Poverty status |
| Educational attainment | Race |
| Employment status | Rent |
| Gender | School enrolment |
| Household type and size | Tenure |
| Income | Urban/rural |
| Journey to work | Vehicle per household |
| Language | Veteran status |
| Phone service | |

## Transportation Data

This proved to be the most challenging part of our data compilation. There is no central repository of public transportation data in South Carolina. While web-presence was deficient in the first place, many transportation providers decided after 9/11/2001 to pull their information offline. South Carolina Department of Transportation (DOT) has no *current* list of public transportation providers, and there is no obvious way to access this kind of data informally as the responsibility for public transportation lies with very different agencies or companies in different parts of South Carolina. It came as a surprise to the authors that some counties have no public transportation system at all, while many others run their buses on a 'by-call' (also known as 'on-demand') basis. We ended up with the list of transportation providers given in Table 1. We digitized all available bus routes with the exception of Columbia, which is as an urbanized area falls outside the scope of this project. We are not aware of any other missing providers, however, a look at Table 2 reveals that many providers don't supply the routing information that is essential for the purposes of this project. Examples of digitized bus routes are given in Figures 2 and 3.

In the course of digitizing, we came to realize that there are major discrepancies between the maps presented by the transportation providers on one side and the TIGER network data from the US Census. This came as a surprise because the TIGER data and the bus route maps were compiled at approximately similar time.

*Table 2. South Carolina Transit Links*

Abbeville County: none
Aiken: Aiken County Transit System – no fixed routes
Allendale County: Lowcountry Regional Transportation Authority – see map and schedules
Anderson County: Electric City Transit – 3 routes (see schedules, once per hour)
Bamberg County: none
Barnwell County: Generations Unlimited Transportation Services – no information
Beaufort County: Lowcountry Regional Transportation Authority – see map and schedules
Berkeley County: Rural Transportation Management Association – no service yet
Calhoun County: none
Charleston County: Charleston Area Regional Transportation Authority – no information
Charleston County: Rural Transportation Management Association – no information
Cherokee County: none
Chester County: none
Chesterfield County: none
Clarendon County: none
Colleton County: Lowcountry Regional Transportation Authority – see map and schedules
Darlington County: Pee Dee Regional Transportation Authority – see maps and schedules
Dillon County: Pee Dee Regional Transportation Authority – see maps and schedules
Dorchester County: Rural Transportation Management Association – no information
Edgefield County: Edgefield County Senior Citizens Council – no information
Fairfield County: Fairfield County Transit System – no information
Florence County: Pee Dee Regional Transportation Authority – see maps and schedules
Georgetown County: Waccamaw Regional Transportation Authority – see maps and schedules
Greenville County: Greenville Transit Authority – see maps and schedules
Greenwood County: none
Hampton County: Lowcountry Regional Transportation Authority – see map and schedules
Horry County: Waccamaw Regional Transportation Authority – see maps and schedules
Jasper County: Lowcountry Regional Transportation Authority – see map and schedules
Kershaw County: none
Lancaster County: Pee Dee Regional Transportation Authority – see maps and schedules
Laurens County: none
Lee County: Pee Dee Regional Transportation Authority – see maps and schedules
Lexington County: Central Midlands Regional Transit Authority – see CMRTA map
Marion County: none
Marlboro County: Pee Dee Regional Transportation Authority – see maps and schedules
McCormick County: none
Newberry County: none
Oconee County: none
Orangeburg County: none
Pickens County: Clemson Area Transit – see maps and schedules
Richland County: Central Midlands Regional Transit Authority – see CMRTA map
Richland County: Eastover Transit System – no information
Saluda County: none
Spartanburg County: Spartanburg Area Regional Transit Agency - no information
Spartanburg County: Spartanburg County Transportation Services Bureau – 8 routes, no info
Sumter County: Santee-Wateree Regional Transportation Authority – no info
Union County: none
Williamsburg County: Williamsburg County Transit System – no information
York County: Charlotte Area Transit System – 52 routes, click on URL

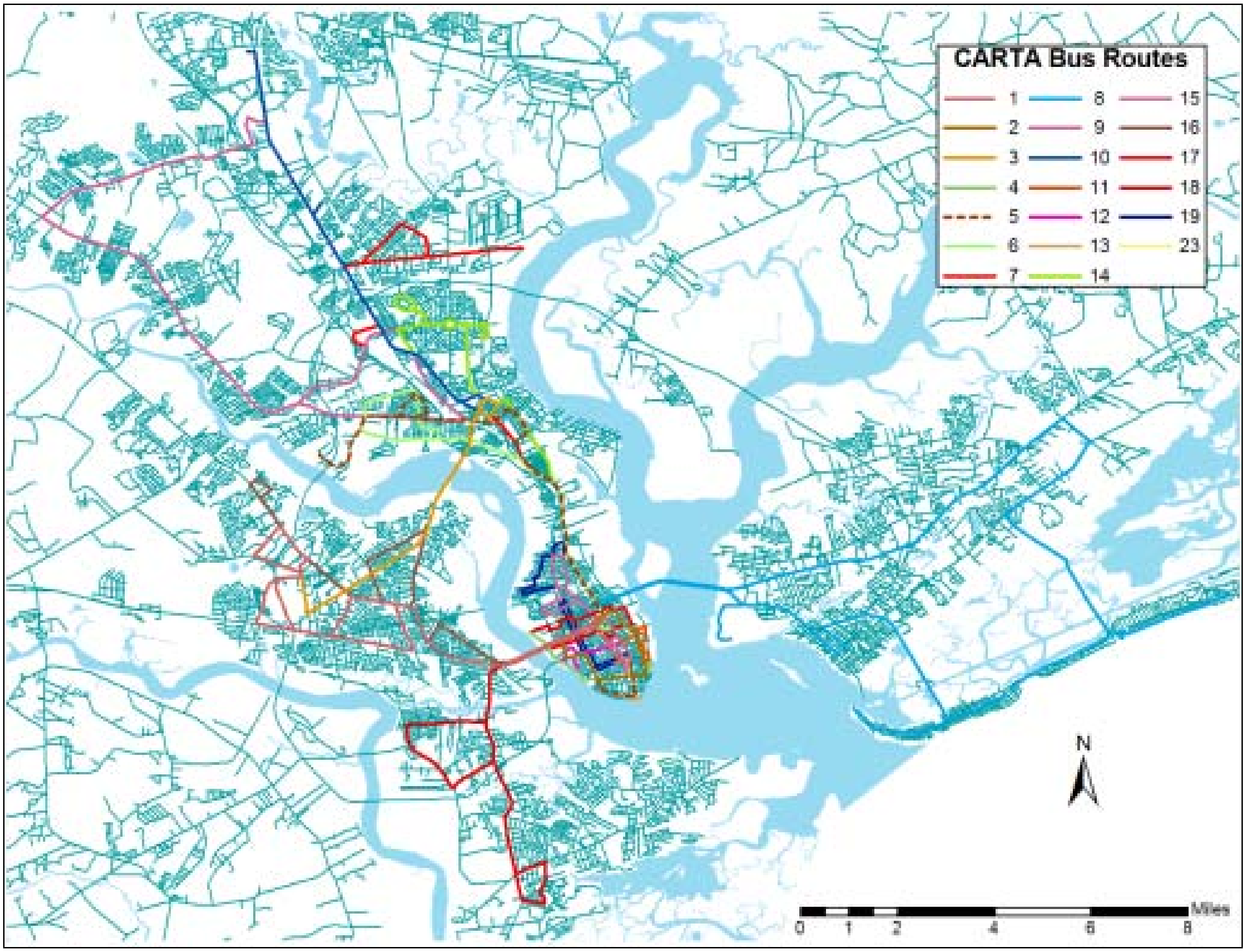



*Figure 2. The 20 Bus Routes in Charleston, SC.*

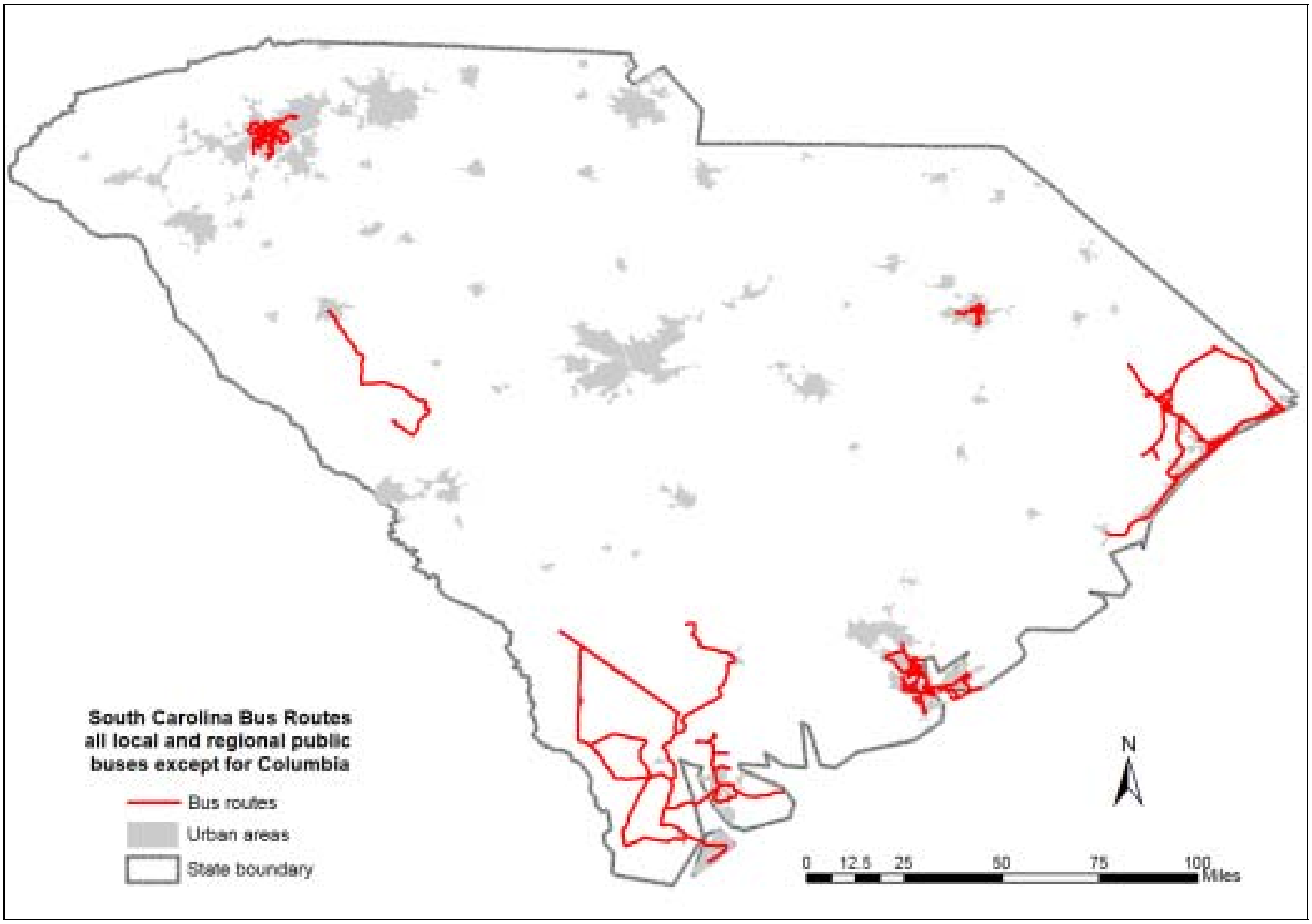



*Figure 3. All Rural South Carolina Bus Routes.*
*(Observe the large areas around and east of Orangeburg*
*that are completely void of public transportation)*

# SAMPLE ANALYSIS

With respect to unemployment, for example, one can now display thematic maps in absolute terms (Figure 4) or on a per capita or per area basis (Figure 5). At the same time, ArcGIS™ allows to freely choose class boundaries and color schemes; in case of the two figures, we depicted only block groups above the average for rural areas.

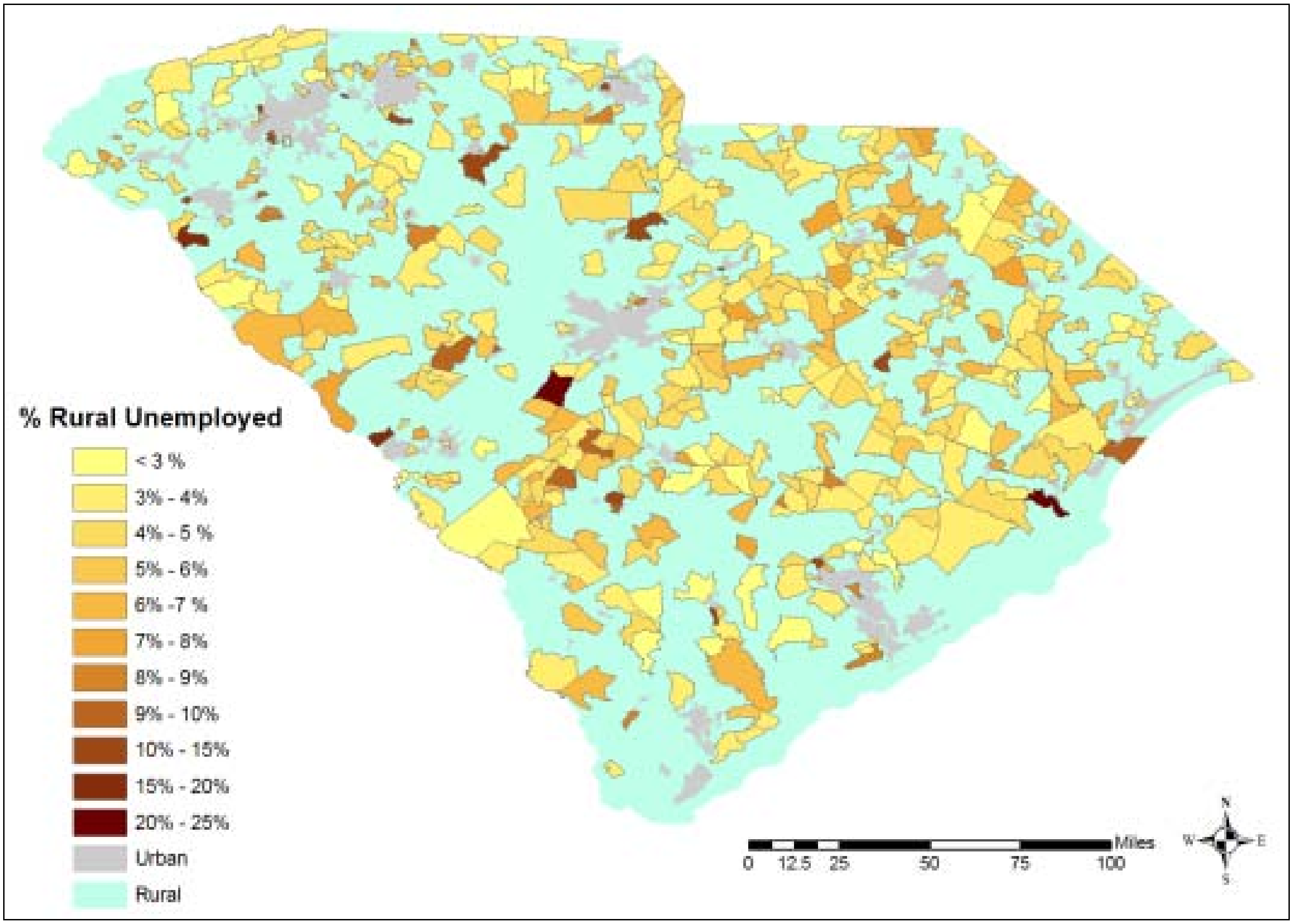



*Figure 4. Rural Unemployed in Absolute Terms.*

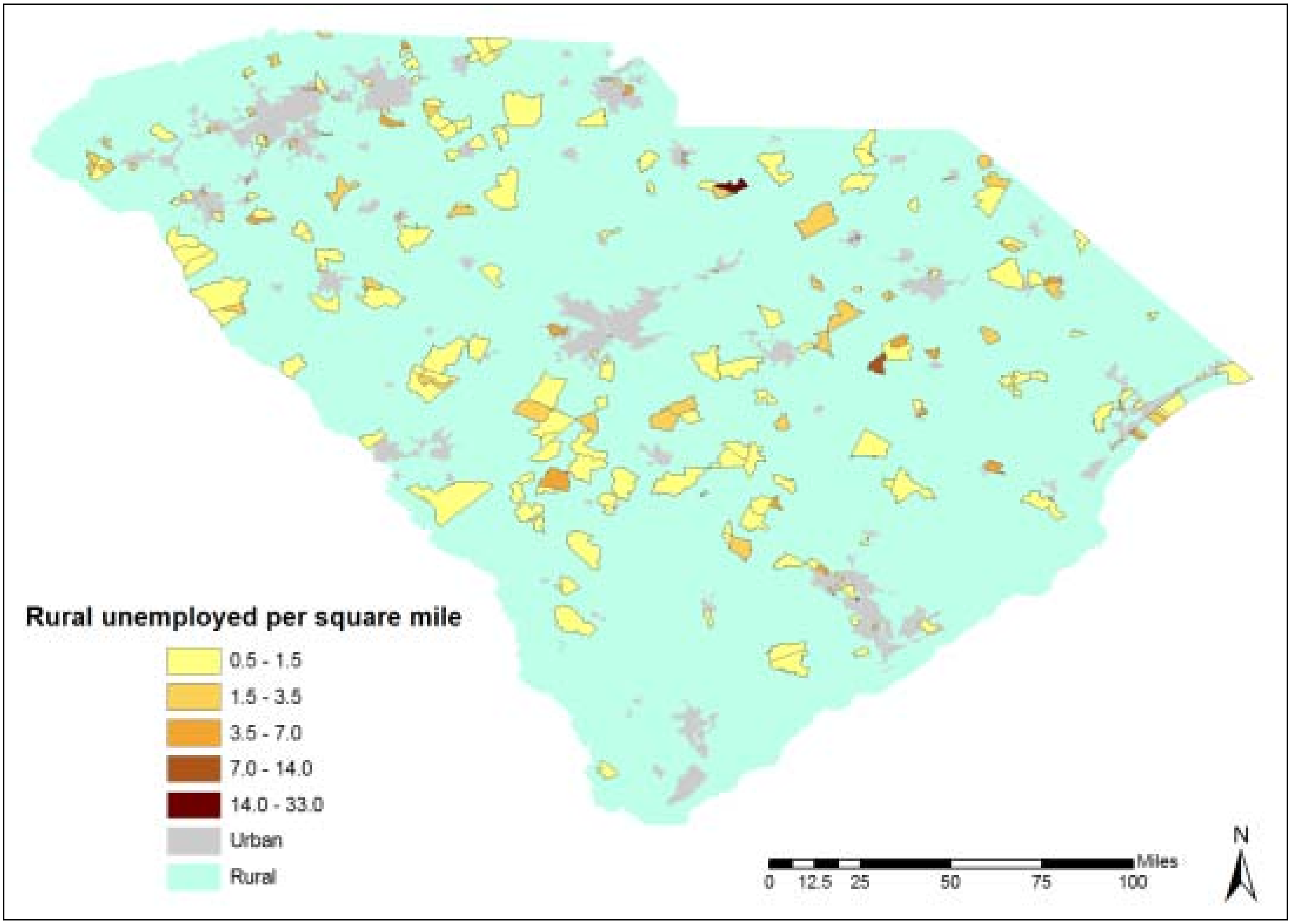



*Figure 5. Rural Unemployed per Square Mile.*

The actual analysis has to keep in mind, who the decision maker is. The analyst needs to determine whether, for example, the goal is to serve as many people (of an identified sub-group) as possible, or whether the emphasis is on a particularly remote customership. At the same time, the analyst should probably keep existing bus routes and the cost overhead of transportation providers in mind. The PIs do therefore not recommend a particular course of action but restrict themselves to a step-by-step description of how all the data provided can be successfully mined.

## Workflow

In the following we describe the analytical steps on how to process the submitted data sets to suggest new bus routes to serve rural areas with exceptionally high unemployment. We distinguish two cases: areas close to currently served areas that could easily be incorporated into the existing transit network and suggestions for a completely new network, solely based on the unemployment criterion. Figure 6 is the starting point for our investigation. It lists all areas, where unemployment is higher than 10%, identifies urban (and hence rural) areas, and displays the current transit network.

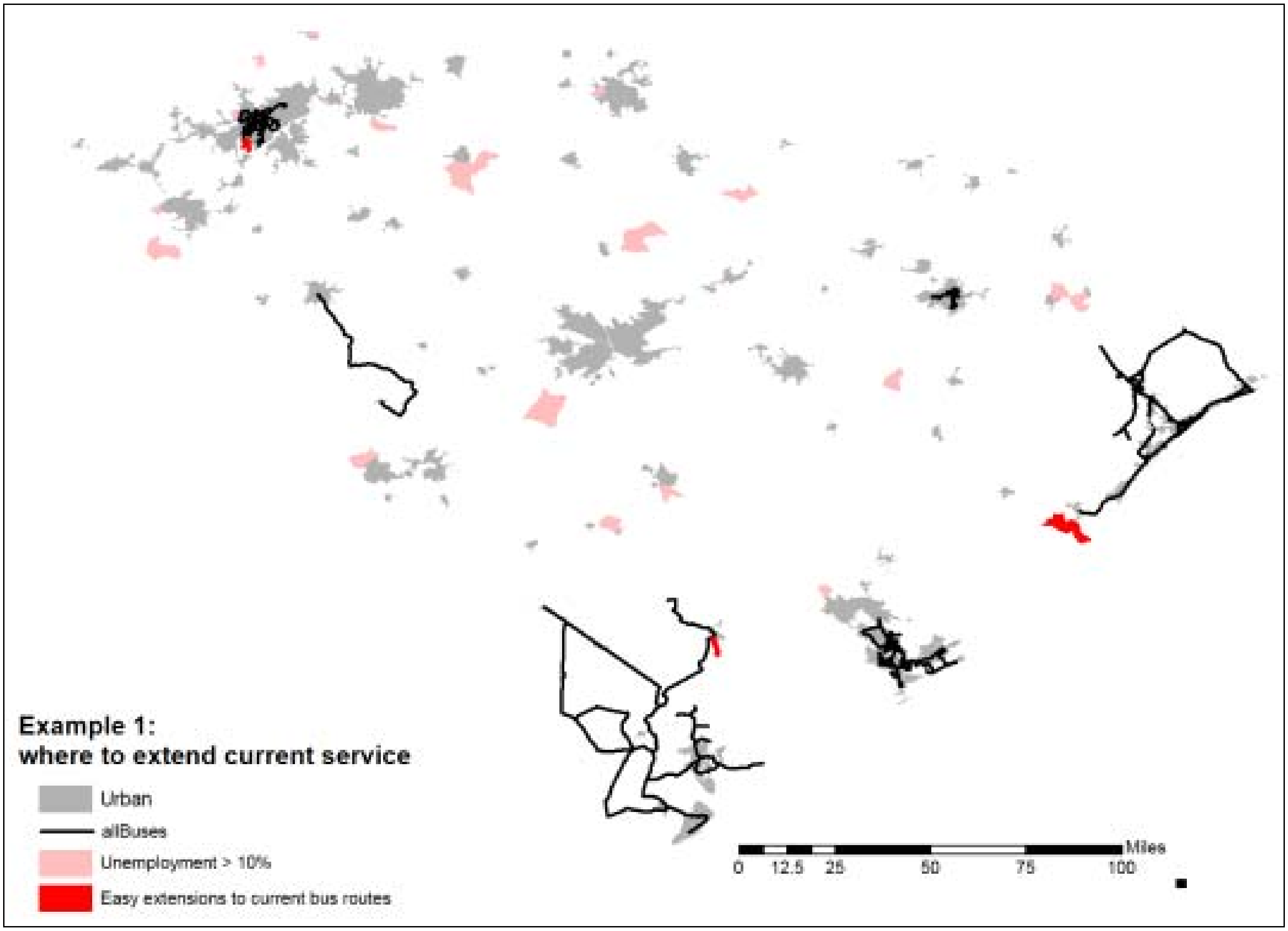



*Figure 6a. Identification of rural areas with high unemployment (>10%) that could easily be served with little additional efforts of current transportation providers.*

I. Processing steps required to arrive at example 1 (Figure 6)

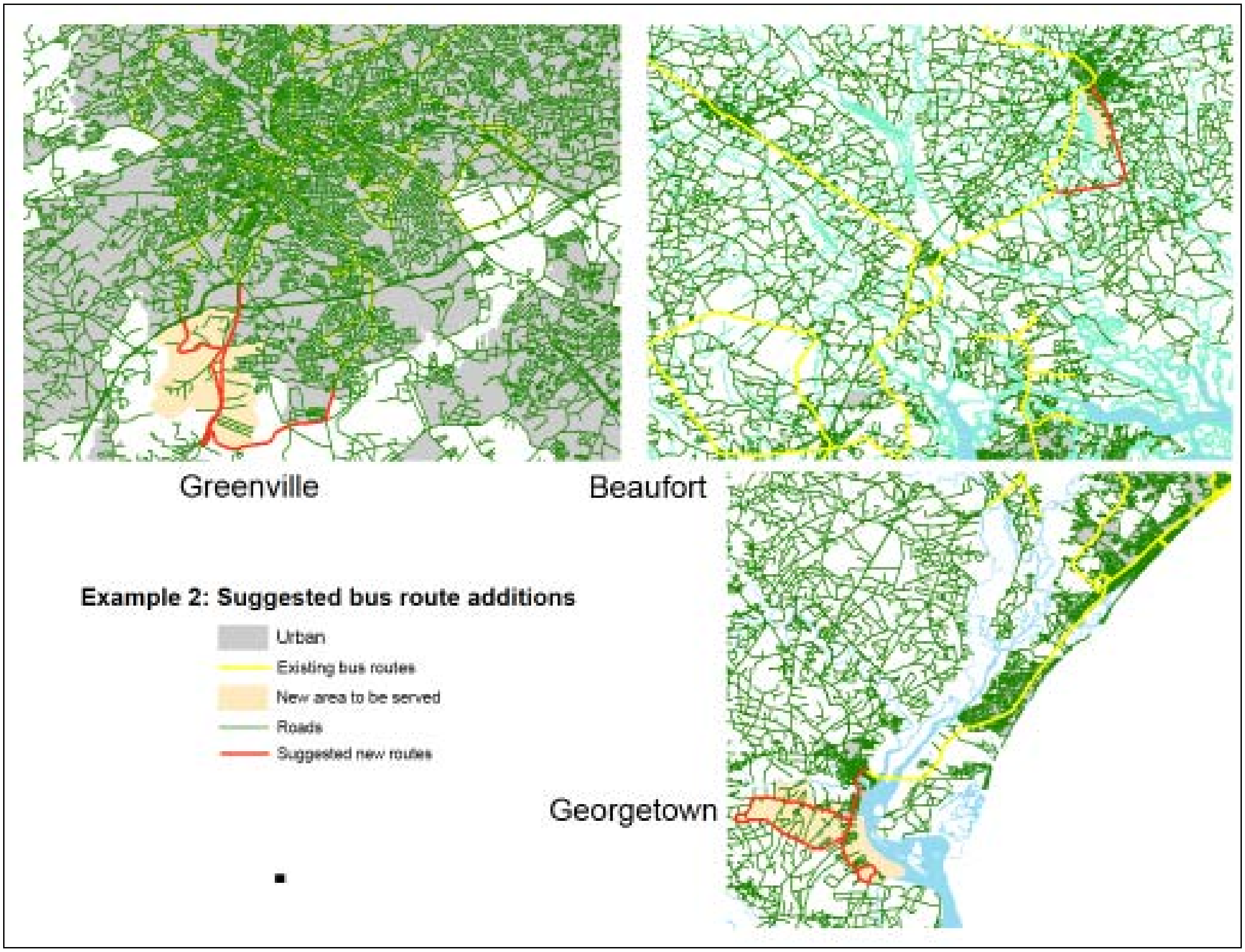
1. Load ① urban, ② bus routes, and ③ unemployment layers
2. Select all areas, where unemployment is higher than 10%
3. Sub-select those that lie outside of urban areas

II. Processing steps required to determine feasible additions to the current transit network

1. Load street network layer (possibly also load hydrology layer to understand network gaps).
2. Sub-select from step 3 of the previous map those block groups that are within 10 miles of existing bus routes.

This identifies three areas; one each near ① Greenville, ② Beaufort, and ③ Georgetown.

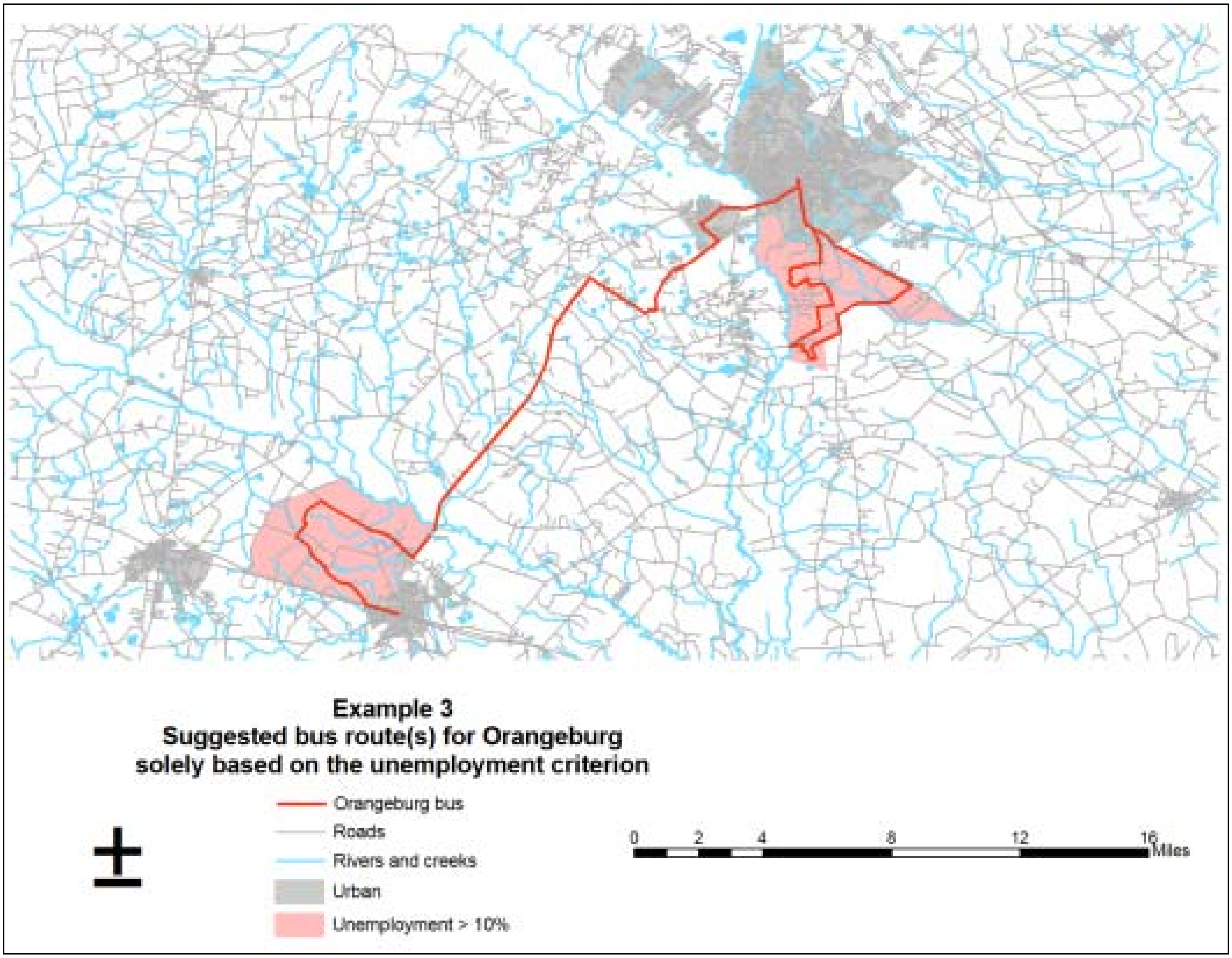
3. Digitize the new bus routes. Additional objectives might be: ① minimization of way traveled, ② serving urbanized areas if they happen to be on the way, or ③ minimize time to urban areas, which are likely to be destinations for potential employment.




III. <u>Processing steps required to identify possible routes in currently under-served areas such as Orangeburg</u>

1. Load ① urban, ② street network, and ③ unemployment layers.
2. Identify the areas to be served by selecting those with high unemployment rates that are within 10 miles of urbanized areas, (which are likely destinations).
3. Create a new (empty) shape file in ArcCatalog™ for the new bus route(s).
4. Load the new bus route layer.

5. Digitize new route starting in the center of the urbanized area (in the Orangeburg case near the SCSU campus) and follow the street network ① to the areas identified in step 2, and ② covering as much of these areas using the objectives outlined in II. 3.




**Example 3**
**Suggested bus route(s) for Orangeburg solely based on the unemployment criterion**

Again, it needs to be stressed that these are purely pedagogical examples. The authors of this report do not propose that South Carolina transportation planners use the criteria employed in the examples.

# CONCLUSION

The authors are not advocating old-fashioned centralized transit systems modeled after their urban counterparts. Instead, there now exist fine examples of intelligent transportation systems for rural transit that address problems such as low population densities, small fleet size and the different service requirements of rural residents (Florida DOT 2001). This project will identify rural areas in South Carolina (such as Orangeburg County) that are now holding promise for the introduction of intelligent rural transit systems and at the same time address the requirements of the Americans with Disabilities Act (ADA).

## ACKNOWLEDGMENTS

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