Wireless Telecommunications Facilities Master Plan

COUNTY OF FLUVANNA, VIRGINIA

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Preface

Purpose of this plan

The purpose and intent of the Master Plan is similar to the goals and objectives of other long-range plans, such as roadway improvements and the extension of water and sewer lines. The Master Plan combines land-use planning strategies with industry-accepted radio frequency (RF) engineering standards to create an illustrative planning tool that aids in making public policy decisions regarding telecommunications infrastructure. The Master Plan offers strategies to reduce tower infrastructure by improving efforts to integrate wireless deployments between the wireless service providers. Effective master planning will minimize tower proliferation by increasing colocation opportunities.

The Master Plan includes the following:

- A tutorial on the history of the industry and explanations of how the equipment works and projections of future industry trends.

- An inventory of existing antenna support facilities and buildings upon which wireless antennas are currently mounted.

- Engineering analysis of potential coverage based the existing antenna locations, County-regulated height restrictions, and other network and planning design criteria.

- Analysis of reasonably anticipated wireless facility growth over the next ten years and recommendations for managing the development of wireless structures with an emphasis on minimizing the total number of telecommunications towers throughout the County.

- Identification of publicly owned land as potential new sites for future towers.

CityScape Consultants, Inc.

Many communities are concerned about the proliferation of telecommunications tower build-outs from the standpoint of public safety issues, aesthetics, staff time involved in the site review process, fair deployment practices, and the legal implications of upholding both the public and private interests involved. Additionally, many communities respond to tower growth in an ad hoc manner, which is the most expensive and perilous way to manage expansions to existing wireless telecommunications networks. CityScape works for only public agencies to address these identified concerns. CityScape specializes in developing land use strategies to control the proliferation of wireless infrastructure, affording the maximum continuing control of local governments, while maintaining compliance with Virginia Statutes and the Telecommunications Act of 1996. CityScape Consultants, Inc. is a land-use planning, legal and radio frequency engineering consulting firm located in Boca Raton, Florida and Raleigh, North Carolina.

Chapter 1 The Telecommunications Industry

Introduction

Telecommunications is the transmission, emission and/or reception of radio signals, whether it is in the form of voice communications, digital images, sound bytes or other information, via wires and cables; or via space, through radio frequencies, satellites, microwaves, or other electromagnetic systems. Telecommunications includes the transmission of voice, video, data, broadband, wireless and satellite technologies and others.

One-way, or simplex, communication for radio and television utilizes an antenna to transmit signals from the broadcast station antenna to the receiving devices found in a radio or television.

Traditional landline telephone service utilizes an extensive network of copper interconnecting lines to transmit and receive a phone call between parties. Fiber optic and T-1 data lines increase the capabilities by delivering not only traditional telephone, but also high-speed Internet and, in some situations cable television, and are capable of substantially more. The new technology involves an extensive network of fiber optic lines situated either above or below ground locations.

Wireless telephony, also known as wireless communications, includes mobile phones, pagers, and two-way enhanced radio systems and relies on the combination of landlines, cable and an extensive network of elevated antennas, typically found on communication towers, to transmit voice and data information. This technology is known as first and second generation (1G and 2G) of wireless deployment.

Third, fourth and fifth generations (3G, 4G and 5G) of wireless communications will include the ability to provide instant access to e-mail, the Internet, radio, video, TV, mobile commerce, and Global Positioning Satellite (GPS), in one handheld, palm pilot type wireless telephone unit. Successful use of this technology will require the deployment of a significant amount of infrastructure, i.e., elevated antennas on above-ground structures such as towers, water tanks, rooftops, signage platforms, and light poles. Fluvanna County remains in the first and second stages of wireless telecommunications deployment.

Wired telephone networks

When the traditional wired, landline telephone networks were introduced in the United States, the first systems were built in largely populated cities where the financial return on the infrastructure investment could be quickly maximized. Telephone lines were installed alongside electrical power lines to maximize efficiency. As the technology improved the service was expanded from coast to coast.

Wireless telephone networks

Wireless telecommunication networks are comprised of an antenna or a set of elevated antenna arrays attached to an elevated structure and connected to the base station via the feed lines. The elevated antenna(s) transmit and receive radio signals allowing wireless telephone handsets to operate satisfactorily.

Wireless telephone networks operate utilizing wireless frequencies similar to radio and television stations. To design the wireless networks, radio frequency (RF) engineers overlay hexagonal cells representing circles on a map creating a grid system. These hexagons or circles represent an area equal to the proposed base station coverage area. The center of the hexagon pinpoints the theoretical "perfect location" for a base station. These grid systems are maintained by each individual wireless provider's engineering department, resulting in nine different grid systems in the City.

During the early 1980's, the first generation of 800 MHz band cellular systems was launched nationwide. Similar to the deployment strategy for the landlines, the 800 MHz systems were first constructed in largely populated areas. Some networks in rural areas remain underdeveloped. Originally, the 800 MHz band only supported an analog radio signal. Customers using a cell phone knew when they traveled outside of the service area because a static sound on the phone similar to the sound of a weak AM or FM radio station was heard through the handset. Later technological advancements allow 800 MHz systems to also support digital customers, providing the wireless service providers an increased number of transmissions per site.

The 1990's marked the deployment of the 1900 MHz band Personal Communication Systems (PCS). This second generation of wireless technology primarily supports a digital signal, which audibly can be clearer than the analog signal, but this comes with additional trade-offs. The technology of 2G includes a static free signal, and although with a higher rate of disconnects or dropped calls, it does allow for more expanded services such as paging devices, and the ability to send text messaging through the handset unit. Deployment of 2G also targeted largely populated areas with secondary services to much of rural America resulting in limited or no PCS coverage.

In addition to 800 MHz cellular services and 1900 MHz PCS services, there are additional wireless providers utilizing services in the 800 MHz and 900 MHz frequency range. This service is called Enhanced Specialized Mobile Radio (ESMR). The largest ESMR band provider is Nextel Communications. All three of these "telephone" operations (800, 900 and 1900 MHz) are specifically covered, along with some other services, in the Telecommunications Act of 1996.

Wireless infrastructure

Wireless communication facilities are comprised of four main apparatuses: 1) an antenna support structure; 2) antenna or antenna array; 3) feed lines; and 4) an electronic base station.

Support structures for the antenna

A variety of structures can be used for mounting the antenna(s) such as towers, buildings, water tanks, existing 911 tower facilities, tall signage and light poles; provided that, 1) the structure is structurally capable of supporting the antenna and the feed lines; and, 2) there is sufficient ground space to accommodate the base station and accessory equipment used in operating the network. Antenna support structures can also be concealed in some circumstances to visually blend-in with the surrounding area. Figure 1 provides examples of several antenna support structures. The flagpole and light standard are concealed towers. The antennas are flush-mounted onto a monopole and a fiberglass cylinder is fitted over the antenna concealing them from view. The bell tower is a concealed lattice tower. The antennas are hidden above the bells and behind the artwork at the top of the structure.

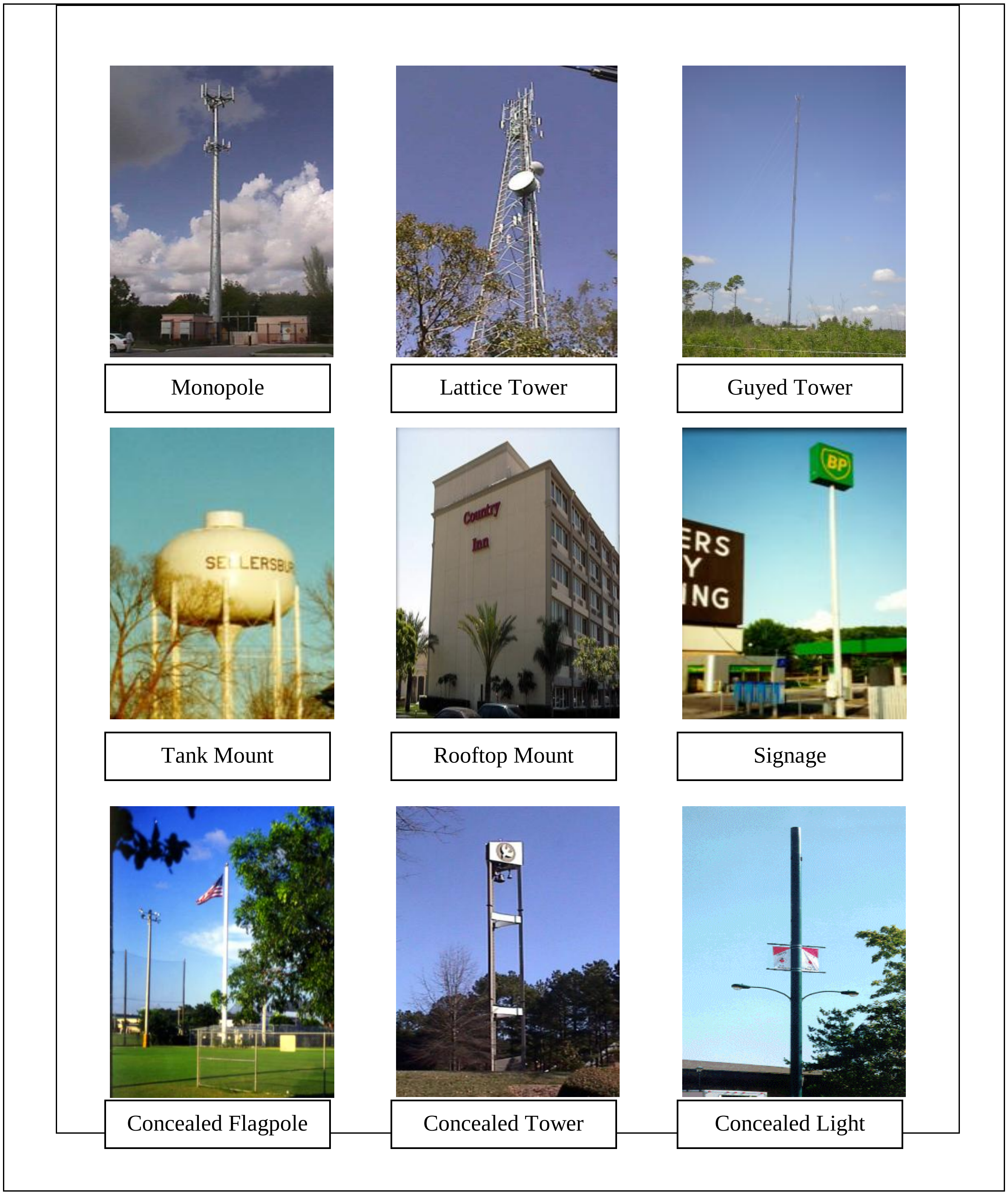


Figure 1: Examples of Antenna Support Structures

Antennas and antenna arrays for wireless telecommunications

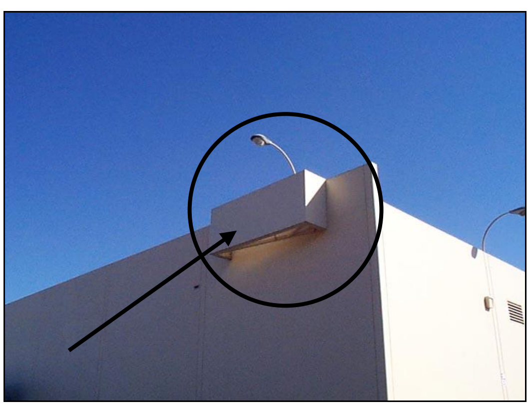
Antennas can be a receiving and/or transmitting facility. Examples and purposes of antennas include: a single omni-directional (whip) antenna or grouped sectorized (also known as panel antennas). These antennas are used to transmit and/or receive two-way radio, Enhanced

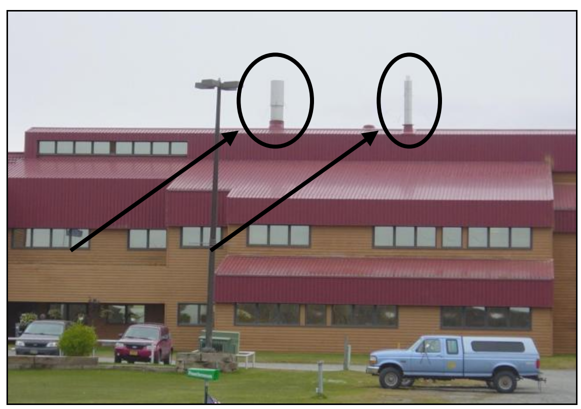
Specialize Mobile Radio (ESMR), cellular, Personal Communications Service (PCS), or Specialized Mobile Radio (SMR) signals. The single sectionalized or sectionalized panel antenna array is also used for transmitting and receiving cellular, PCS or ESMR wireless telecommunication signals.

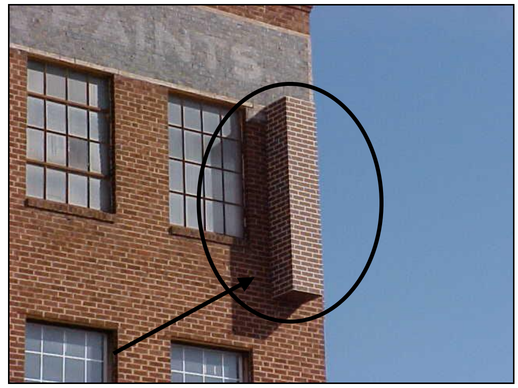
Omni-Directional
Whip Type Antenna

Sectorized (panel)
Antenna Array

The antenna can also be concealed. Concealment techniques include: faux dormers; faux chimneys or elevator shafts encasing the antenna feed lines and/or equipment cabinet; and painted antenna and feed lines to match the color of a building or structure. A concealed attached facility is not readily identifiable as a wireless communications facility (WCF). Examples are shown in the pictures below and on the following page. Concealed antennas are indicated with black arrows.







Feed lines and electronic base stations

Feed lines are the coaxial copper cables used as the interconnecting media between the transmission/receiving base station and the antenna.

Base stations are the wireless service provider's specific electronic equipment used to transmit and receive radio signals, and is usually mounted within a facility including, but not limited to: cabinets, shelters, pedestals or other similar enclosures generally used to contain electronic equipment for said purpose. The base station shown in Figure 2 is a typical model for providers operating in the 1900 MHz frequencies.

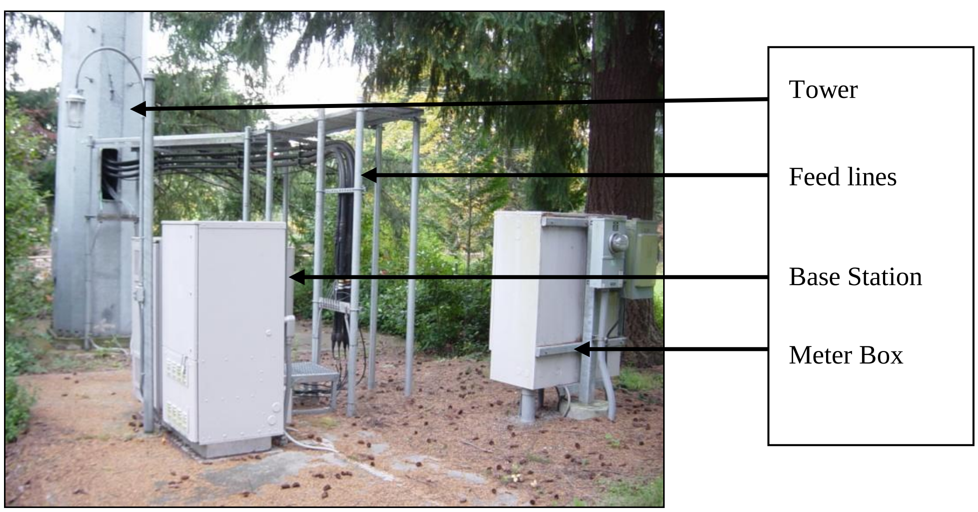


Figure 2: Wireless Infrastructure Ground Equipment

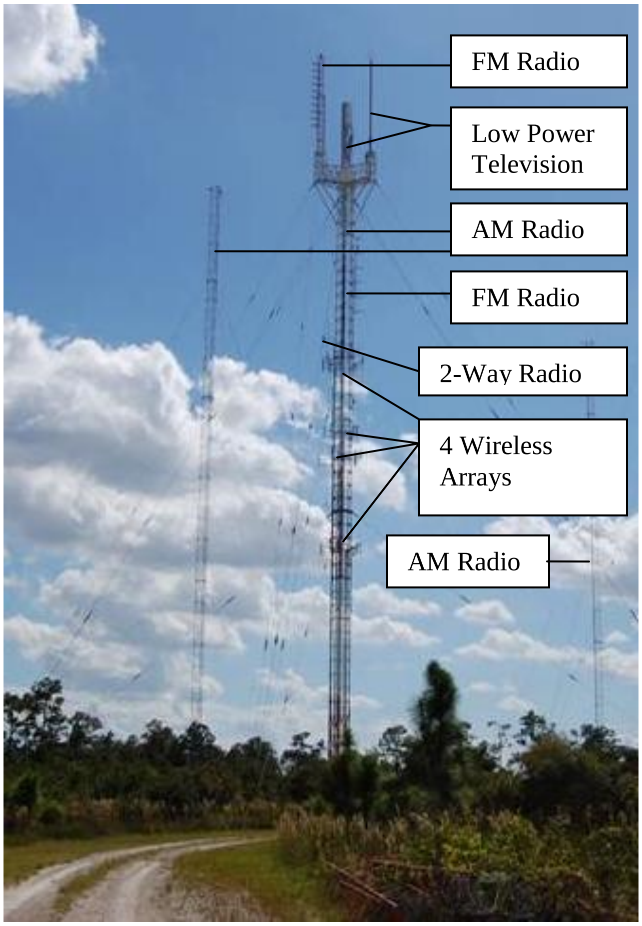
The electronics housed within the base station can generate substantial heat, especially the equipment used for operating the 800 MHz wireless systems. Therefore the base stations for providers operating in the 800 MHz frequencies are much larger and generally need an equipment cabinet a minimum of 400 square feet to house the equipment. Figure 3 shows an 800 MHz base station at a tower just outside the Fluvanna County boundary.

Figure 3: Example of 800 MHz Base Station

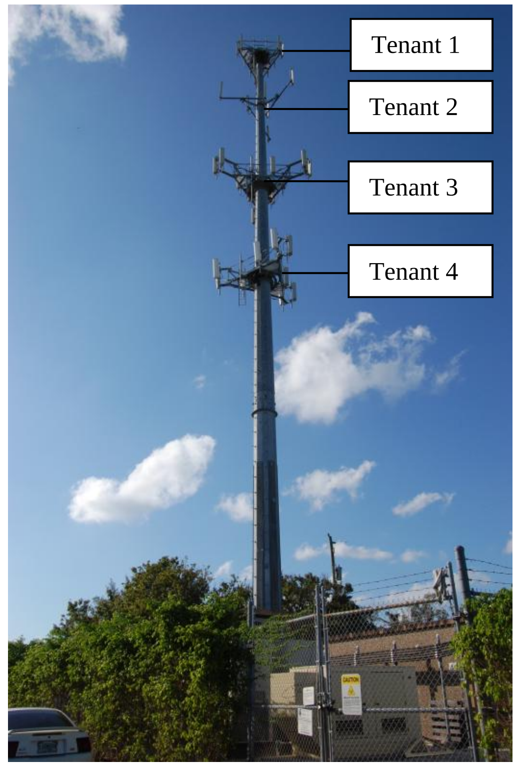
While the 800 MHz base stations can generate sufficient heat, they do not generate noise. The only noise that might be produced from the vicinity of any base station would be from an air conditioner or a backup generator which might be necessary in instances of no power or power failure.

Colocation

Colocation is the practice of installing and operating multiple wireless service providers, and/or radio common carrier licensees on the same antenna support structure or attached telecommunication facility. Each service provider uses separate antenna(s), feed lines, and radio frequency generating equipment and each different service provider is called a tenant. Colocation on towers, water tanks, and rooftops are not limited to wireless service providers. Other tenants include paging and dispatch services, wireless internet, emergency services, government agencies, and broadcast. Towers designed for colocation must be structurally designed to accommodate the weight bearing loads of the multiple tenants. Figure 4 illustrates how towers can be utilized for colocation purposes. The tower on the left is a broadcast facility and has multiple broadcast and non-broadcast tenants. The tower on the right has four wireless communication tenants on that facility. Generally taller towers can accommodate multiple different types of wireless and/or broadcast communication tenants.



Tall tower with multiple types of tenants'



Short tower with four tenants'

Figure 4: Colocation Examples

Wireless coverage and antenna mounting elevation considerations

The radio frequency of the wireless network system, height of the antenna and the location of the infrastructure are all important components to a complete network plan. One set of elevated antenna arrays does not provide service to a geographic area independently of other nearby elevated antennas, rather, each set of antenna arrays work in unison to provide complete wireless coverage. Complete coverage is only attained when the radio signal from one base station antenna array successfully transfers or hands-off the radio signal to another base station antenna array without causing an interruption in service. Successful network handoff is only possible when the geographic coverage areas from individual antenna arrays properly overlap and when the base station has available capacity. Geographic areas with good site handoff and available capacity will have good wireless coverage and generally uninterrupted services.

In wireless system evolution, a wireless provider initially built fewer base stations with relatively tall antenna support structures to maximize the network coverage footprint. These initial 1G 800 and 1900 MHz systems sought to broadcast coverage to large geographic areas utilizing minimal infrastructure. Typically, these tall towers were spaced four to eight miles apart.

By nature, the 1900 MHz frequency band is higher frequency than the 800 MHz band and cannot transmit nor receive a signal at an equal distance to the 800 megahertz band. For equivalent coverage, these 1900 MHz base stations must be closer together. The mounting height of the antenna for 2G was not as critical as 1G, and these towers were shorter.

Taller structures (towers, rooftops, and water tanks) may offer more opportunity for colocation, which could theoretically decrease the number of additional towers and antennas required in an area, but capacity issues could circumvent any advantage of taller towers. The extent to which height may increase colocation opportunities must be verified by an RF engineering review on a case-by-case basis. In geographic areas where there is a larger wireless phone subscriber base or terrain variations, build-out plans may require lower antenna mounting elevations, especially in densely populated areas. Antennas mounted at higher elevations on the antenna support facility are typically indicative of wireless deployment patterns in rural areas. Excessive subscriber demand, terrain concerns, and/or the build-out plans for some areas may require very low antenna location heights, especially in densely populated areas. Antennas located at a higher elevation on a facility are more desirable for some terrains and in some rural areas, but in many densely populated urban areas the wireless providers seek to limit the antenna height.

In rural areas where initial coverage networks are incomplete, taller towers may still be more desirable to complete initial cover objectives. In more densely populated cities the antenna mounting elevations are lowering to address network capacity.

Network capacity

The number of base station sites in a grid network not only determines the limits of geographic coverage, but the number of subscribers (customers) the system can support at any given time. Each provider is different but a single carrier can process, or turn over approximately 1000 calls per minute, yet at any particular time only between 100 and 150 calls can occur simultaneously. This process is referred to as network capacity. As population, tourists and local wireless customers increase, excessive demand is put on the existing system's network capacity. When the network capacity reaches its limit, a customer will frequently hear a rapid busy signal, or get a message indicating all circuits are busy, or commonly a call goes directly to voicemail without the phone ring on the receiving end of the call.

As the wireless network reaches design network capacity, it causes the service area to shrink, further complicating coverage objectives. Network capacity can be increased several ways. The service provider can shift channels from an adjacent site, or the provider can add additional base stations with additional infrastructure.

A capacity base station has provisions for additional calling resources that enhance the network's ability to serve more wireless phone customers within a specific geographic area as its primary objective. An assumption behind the capacity base station concept is that an area already has plenty of radio signals from existing coverage base stations, and the signals are clear. But there are too many calls being sent through the existing base stations resulting in capacity blockages at the base stations and leading to no service indications for subscribers when attempting to place a call.

Wireless infrastructure and local zoning

The location of base station antennas used for transmitting and receiving radio signals and wireless data is critical in attaining an optimal functioning wireless telecommunications network. With the deployment of first generation wireless (1G), there were only two competing wireless cellular (800 MHz) providers. But with the deployment of 2G, and six competing PCS (1900 MHz) providers, the wireless marketplace became furiously competitive. "Speed to market" and "location, location, location" became the slogans for the competing 1G and 2G providers. The concept of colocation or sharing base stations was not part of the strategy as each provider sought to have the fastest deployment, so as to develop the largest customer base, resulting in a quick return on their cost of deployment. This resulted in an extraneous amount of new tower construction without the benefit of local land use management.

Coincidently, as local governments began to adopt development standards for the wireless communications industry, the industry strategy changed again. The cost associated with each provider developing an autonomous inventory of base stations put a financial strain on their ability to deploy their networks. As a result, most of the wireless providers divested their internal real estate departments and tower inventories. This change gave birth to a new industry of vertical real estate; and it includes a consortium of tower builders, tower owners, site acquisition and site management firms.

No longer was a tower being built for an individual wireless service provider, but for a multitude of potential new tenants who would share the facility without the individual cost of building, owning and maintaining the facility. Sharing antenna space on the tower between wireless providers is called colocation.

This industry change could have benefited local governments who adopted new tower ordinances requiring colocation as a way to reduce the number of new towers. But, *initially* it did not; because the vertical real estate business model for new towers is founded on tall tower structures intended to support as many wireless providers and other wireless services as possible. As a result, local landscapes became dotted with all types of towers and communities began to adopt regulations to prohibit or have the effect of prohibiting wireless communication towers within their jurisdictional boundaries.

Wireless deployment came to a halt in many geographical areas as all involved in wireless deployment became equally frustrated with the situation. Second generation wireless providers had paid a large sum of money for the rights to provide wireless services, the license agreements between the wireless providers and the FCC mandated the networks be deployed within a specific time period and local government agencies were prohibiting the deployments through new zoning standards.

This perplexing situation prompted the adoption of Section 704 of the Federal Telecommunication Act of 1996.

Federal Telecommunications Act of 1996

Section 704 of the Federal Telecommunications Act of 1996 provides local governments zoning authority over the deployment of wireless telecommunication facilities subject to several specific guidelines.

First, land use development standards may not unreasonably discriminate among the wireless providers, and may not prohibit or have the effect of prohibiting the deployment of wireless infrastructure. For example, some communities adopted development standards restricting the distance between towers to three miles. In some geographic locations with sparse populations this may have been adequate for 1G deployment; however the Laws of Physics make it impossible for 2G wireless deployments to meet this spacing requirement. Unknowingly some communities inadvertently prohibited the deployment of 2G.

Second, local governments must act on applications for new wireless infrastructure within a “reasonable” amount of time. If a community adopts a moratorium on new wireless deployment, it must be for a limited amount of time, and the community must demonstrate a “good-faith” effort to resolve outstanding issues during the moratorium time period.

Third, land use policies may be adopted to promote the location of telecommunications facilities in certain designated areas; and the Telecommunications Act encourages the use of third party professional review of site applications.

Fourth, local government cannot deny an application for a new wireless facility or the expansion of an existing facility on the grounds that radio frequency emissions are harmful to the environment or to human health (provided Federal standards are met by the wireless provider).

Exposure to radio frequency emissions

The Federal Communications Commission has rules for human exposure to electromagnetic radiation. Electromagnetic radiation should not be confused with ionizing radiation.

Ionizing radiation has sufficient energy to remove electrons from atoms and cause changes to the molecular structure. This type of radiation can be found from many sources, including health care facilities, research institutions, nuclear reactors and their support facilities, nuclear weapon production facilities, and other various manufacturing settings, just to name a few. Some high-voltage beam-control devices, such as high-power transmitter tubes can emit ionizing radiation, but this is usually contained within the transmitter tube itself. Overexposure to ionizing radiation can have serious effects, including cancers, birth deformities and mental illness.

Electromagnetic radiation is non-ionizing radiation, which ranges from extremely low frequency (ELF) radiation to ultraviolet light. Some typical sources of non-ionizing radiation include lasers, radio antennae, microwave ovens, and video display terminals (VDT). However, any electrical appliance or electrical wiring itself emits ELF radiation. Cellular and PCS installations must confirm Federal compliance with published standards on RF exposure levels.

Radio frequency radiation attenuates very rapidly with distance from a wireless services antenna, and most wireless sites not accompanying broadcast facilities will easily comply.

The RF exposure rules adopted by the FCC are based on the potential for RF to heat human tissue. Basically, the level at which human tissue heating occurs has been studied, and rules are set such that humans are not to be exposed anywhere near the level that can cause measurable heating. Cellular telephones and their supporting equipment have now been in use worldwide for nearly 30 years. During that period there has not been a single documented health issue to be traced to this industry.

There have been extensive long-term studies and at best they are inconclusive as to any harmful effects. Debate continues and may never be concluded on whether or not there might be biological effects associated with "non-thermal" causes, such as magnetic fields. Based on these findings the Federal Government has maintained jurisdiction on such issues. The FCC publication, "A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance" is included as Appendix A.

In addition to the RF study and interpretation by the FCC, the World Health Organization (WHO) has conducted a study on RF and written a brief that details their findings that is published in an article dated May 2006, entitled, "Electromagnetic fields and public health; Base Stations and wireless technologies." The conclusion states, "Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects." The WHO Fact Sheet is provided as Appendix B.

Third Generation and future wireless generations

At the onset of this millennium economists and telecommunication forecasters debated the actuality of third, fourth and fifth generations of wireless coming to fruition in the United States. Skepticism that customers would have little demand for the emerging wireless services appeared in articles and newsrooms, while others recognized the infrastructure in the United States was significantly behind schedule as compared to European and Asian deployments. Predictions were that consumers would demand the 3G products once network upgrades were completed. Third generation upgrades to 800 MHz and 1900 MHz infrastructure has been accomplished primarily through software improvements at existing base stations. Third generation has come to fruition and wireless handsets are 3G compatible. Third generation handsets feature text messaging which is similar to e-mail. The messages are usually direct phrases with minimal words. Wireless customers can send text messages through the wireless handset and the message can be delivered anywhere at any time. Text messaging can operate on 700, 800, 900, 1900, and 2100 MHz networks.

Handsets for future 4G will not be limited to voice and short data text messaging capabilities. Most handsets will include banking, video streaming, and access to cable television. 4G is scheduled to launch in urban markets in 2013.

Satellite technologies

Satellite growth has surpassed the highest expectations of only a few years ago. The reason is simple; cost. Previously, relaying information, data, and other related materials were cumbersome and required many relay stations in very specific locations and relatively close together. Initially, satellite use was expensive because of the rarity and limited amount of available airtime needed. Satellite airtime has become more affordable with the deployment of additional satellites and advanced technologies which allow more usage of the same amount of bandwidth. Competition always holds down cost, and that is what has occurred. In addition, satellite services are in the early stages of designing more localized networks; contributing to the already rapid growth.

Satellite technology has its limitations, which are all based on the Laws of Physics. Some licensee's of satellite services such as XM Radio, Sirius Radio and satellite telephone services petitioned the FCC and has been allowed additional deployment of land-based supplemental transmission relay stations for the ability to compete more aggressively with existing ground base services, and overcome obstacles typical to satellite technology. Subscribers found the delay in talk times unacceptable along with fade and signal dropout. The FCC is looking favorably upon this request, even though the existing land-based services are strongly objecting for various reasons. Both XM Radio and Sirius Radio were successful in obtaining ground base supplemental transmitters, and is rapidly becoming one of the largest users of ground base transmitters. This will place more demands on governmental agencies as another service begins to construct a land-based infrastructure.

Enhanced Specialized Mobile Radio

Enhanced Specialized Mobile Radio (ESMR) systems operate similar to standard cellular type communications; in addition they can easily operate like a two way radio system (similar to walkie-talkies) whereby two or more handsets are linked together by repeaters. Digital networks offer voice, data, messaging, and dispatch on one handheld unit similar to most wireless handsets. The technology used for ESMR networks has been problematic to adjacent frequency channels used by other service providers through no fault of the service provider in most situations. In order to reduce any potential for future interference issues, ESMR network operators successfully petitioned the FCC to shift frequencies from the 800 MHz and 900 MHz band to the 2500 MHz band. The reallocation from 800 MHz to 900 MHz is still in transition. Once again this frequency shift will cause the need for additional support structures and create additional impacts to local governments.

The FCC announced it would permit the phasing out of analog compatibility requirements for cellular phones. This project was to be completed by the end of year 2008. The FCC's action still allows providers the option to continue analog services as needed to meet customer needs. According to the International Association for the Wireless Telecommunications Industry (CTIA) about 85 percent of all wireless subscribers are presently using digital technology, and wireless users generally replace their phones every eighteen months. Thus, the analog system will be phased out eventually and the remaining analog users will migrate to digital, which also has the added benefit of increasing cell site capacity, as a single analog channel can be converted to multiple digital channels.

Third, fourth and fifth generations of wireless deployment will bring the next phases of wireless technology and place great demands on network capacity. With voice, text, digital music, digital video, GPS and data all competing for spectrum space, providers will need to maximize their spectrum allocations by creating more compact base station facilities at closer intervals.

700 MHz

The decision by the FCC to convert the United States television systems to digital or High Definition only service, created a new Table of Allotments. The first phase of the transition was the elimination of TV channels 51 and above. These TV channels operated from 700 MHz to 806 MHz. By the late 1990's most of the TV channels on 51 and above were migrated to lower channels. The FCC found benefits of making additional spectrum available. Initially the spectrum was to go to public safety; however lobbyist successfully convinced the FCC and Congress to divert most of the new spectrum to the wireless industry. There have already been assignments to the 700 MHz band and in some locations new facilities are in service.

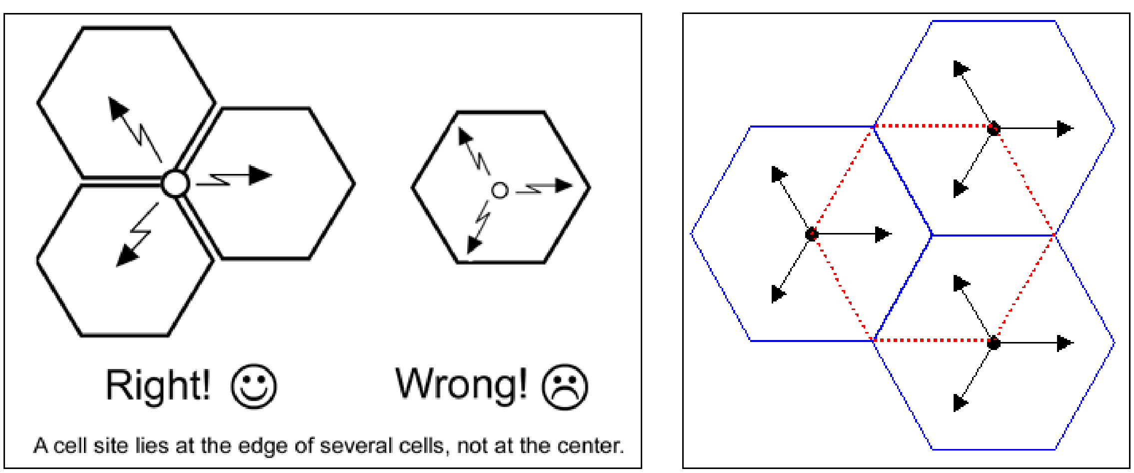
Chapter 2 Wireless Technical Issues

Brief Overview

Cellular and PCS wireless providers attain service coverage through a network of ground equipment base stations and elevated antennas located on towers, water tanks, buildings or other similar elevated structures. As explained in Chapter 1, the height and location of the elevated antenna platform on the elevated structure is critical to two aspects of radio frequency engineering, coverage and capacity. Generally, the higher the antenna is mounted on the support structure, the larger the geographic area that will be served by the wireless signal. Base stations located in geographic areas where wireless subscribers are significant and the usage of airtime minutes is higher, operate at maximum capacity, and on some occasions are over-capacity, causing busy signals and direct-to-message incoming calls for many subscribers. To help remedy this situation, smaller antenna configurations and/or the antenna are mounted at lower elevations than would be necessary for coverage. This is defined as "capacity" planning.

As demonstrated in Figure 5, base station network design is founded on the principles of a grid system that is maintained by each wireless provider's engineering department. The hexagonal cells on the grid represent the radius equal to the proposed cells' coverage area. Common points of adjoining hexagons pinpoint the theoretical perfect location for a prospective new base station. For these reasons, deviation from these specified locations can significantly affect the wireless provider's deployment network.

"Most people see the cell as the blue hexagon, being defined by the tower in the center, with the antennas pointing in the directions indicated by the arrows. In reality, the cell is the red hexagon; with the towers at the corners…the confusion comes from not realizing that a cell is a geographic area, not a point."



(Courtesy of Tom Farley http://www.telecomwriting.com/index.html)

Figure 5: Network Grid

Search area within proposed coverage areas

The search area for new wireless infrastructure is ideally specified in a document provided to site search consultants in pursuit of a lease for property on which to place their facilities, whether a new tower, a rooftop or some other existing structure that could accommodate wireless antennas. From an engineering perspective, any location within the proposed search area is considered to be acceptable for the provider, with certain considerations based on terrain and sometimes population balance.

Search Area Radii

Search areas for the 800 MHz (cellular and ESMR) frequencies and 1900 MHz (PCS) frequencies are computed in the Tables 1 and 2. The tables utilize the "Okumura-Hata" propagation path loss formula for 800 MHz, and the "COST-231" formula for 1900 MHz. Maximum coverage radii for typical in-vehicle coverage is calculated for various tower heights, and is de-rated by 20 percent to account for a reasonable handoff zone, then divided by four to obtain a search area radius for each tower height. Thus, for an 800 MHz antenna mounted at the 100-foot elevation, the search area would have a radius of 0.72 miles, and 0.36 miles for 1900 MHz, again sometimes more restrictive due to terrain. Okumura-Hata and COST 231 coverage predications are illustrated in circular patterns to demonstrate the hand-off areas between the antenna(s) mounted on various towers within designated geographic study areas.

Okumura-Hata Coverage Predictions

Antenna mounting height	50'	80'	100'	115'	150'	180'
Radius, miles	2.53	3.20	3.60	3.88	3.91	4.40
Allow for handoff	2.03	2.56	2.88	3.10	3.60	4.00
Search area, miles	0.51	0.64	0.72	0.78	0.90	1.00

Table 1: Okumura-Hata Coverage Predictions for 800 MHz

COST 231 Coverage Predictions

Antenna mounting height	50'	80'	100'	115'	150'	180'
Radius, miles	1.33	1.64	1.82	1.95	2.32	2.45
Allow for handoff	1.07	1.31	1.46	1.56	1.79	1.96
Search area, miles	0.27	0.33	0.36	0.39	0.45	0.49

Table 2: COST 231 Coverage Predictions for 1900 MHz

Wireless telephone search areas are usually circles of approximately one-quarter the radius of the proposed cell. In practice it is fairly simple to determine whether the search area radius is reasonable. The distance from the closest existing site is determined, halved, and a handoff overlap of about 20 percent is added. One fourth of this distance is the search area radius.

Global System for Mobile Communications

Wireless providers are presently deploying new technology equipment in the United States to support data services over the wireless interface. One example of this type of deployment has been a Global System for Mobile Communications (GSM) overlay on top of existing facilities, in recognition of GSM's data-handling capability. GSM is a digital cellular technology that is open and can transmit voice and data. GSM differs from older technology because the system divides each channel into eight time-slots which allow the same phone to be used around the world. Using a GSM phone provides the user access to the same services on the phone whether in the United States or Europe or anywhere else there is a signal. This allows use of the same telephone number and same access in the user's hometown and in more than 200 hundred countries. This is important because a GSM world cell phone gives the user the ability to have only one phone to travel around the world. The cell phone user does not have to worry about changing SIM cards and other elements of the phone or the dreaded necessity of carrying a second cell phone. For the vast majority of travelers, these cell phones will be the only cell phone needed.

In certain cases, the GSM overlay is on 1900 MHz, where signals only cover about half the distance of the existing system, implying more wireless facility locations will be required to meet coverage and network capacity objectives.

Some service providers are now evolving into Universal Mobile Telecommunications Systems (UMTS) networks. Third generation (3G) networks use HSDPA/UMTS (High Speed Downlink Packet Access/Universal Mobile Telecommunications System) technology. The 3G network is also based on the GSM standard, the most widely used technology in the world. More than 2.7 billion people use wireless devices powered by GSM, representing more than ninety percent of the world's wireless users.

Subscribers who use a GSM phone can take their device with them when they travel abroad and can benefit from worldwide access through the GSM standard, and have the ability to browse the web and perform other data functions in more than 135 countries, and they can make a phone call in more than 190 countries and territories.

The 3G network also provides the simultaneous delivery of voice and data, a capability not offered by all wireless providers. One example of a 3G service is Video Share, which enables users to share live video over wireless phones while carrying on a voice call; providing a new way to share personal moments and key events beyond the capabilities of voice and text. Users can allow others to "see what I see, when I see it."

Among several other benefits, the simultaneous data and voice capability allows customers to participate on a conference call from their 3G device while they download a presentation or access the Internet.

Chapter 3 Engineering Analysis

Plan design process

This chapter of the Master Plan evaluates wireless coverage for the County, and is accomplished by:

- Designing an engineered search radii template and applying it over the jurisdictional boundary of the County to evaluate theoretical build-out conditions.
- Researching the inventory of existing antenna locations on support structures and buildings and evaluating the possible 800 MHz and 1900 MHz coverage from those sites.
- Forecasting future infrastructure needs based on the status of the existing deployments and population trends.

Basic coverage predictions and wireless coverage handoff

CityScape provides a series of maps to help visualize the number of antenna locations that would be necessary to provide wireless communications coverage County-wide. To accomplish this task, CityScape has created a series of root mean square (RMS) theoretical coverage and handoff maps by randomly selecting existing antenna locations throughout the County. This hypothetical network demonstrates the minimum number of base station locations required for one provider to provide complete coverage County-wide. In order to complete this analysis an antenna mounting elevation must be determined. The County's current zoning regulations encourage a maximum tower height of 125 feet. For this reason, 125 feet was chosen for the mounting elevation for the RMS theoretical maps.

Figure 6 illustrates that it requires about twenty towers centrally located County-wide to provide complete 800 MHz cellular coverage to the defined geographic study area. This site represents a theoretical build-out for antennas mounted at the 125-foot elevation at equal dispersion, in a perfect radio frequency environment, with no consideration of adjacent community wireless deployment for a single cellular provider *and excluding topographic and population variables*. The black dot within the circle indicates the antenna location. The smaller circle shown within the larger circle represents the limits of the search area for locating the tower. The twenty telecommunication facilities would theoretically provide wireless service coverage throughout the study area for one provider. This scenario does not address network capacity objectives.

Figure 7 illustrates it would take about sixty-one 1900 MHz telecommunication facilities locations to cover the same geographic area as in Figure 6. These 1900 MHz PCS sites represent a theoretical build-out of one antenna mounted at the 125-foot elevation at equal dispersion for one PCS provider; *with*; *with no consideration of terrain, demographic or network capacity variables.*

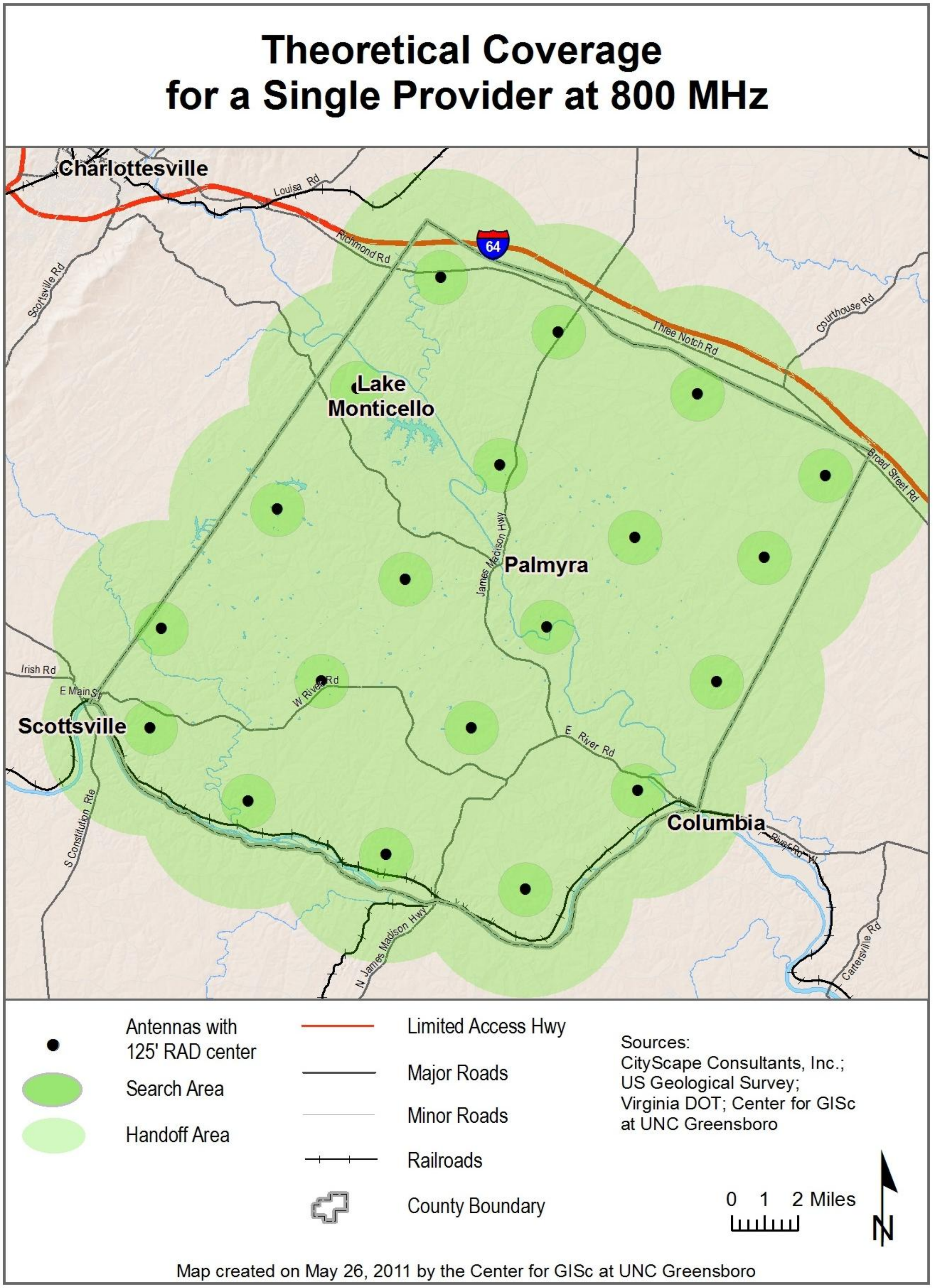


Figure 6: RMS 800 MHz Handoff and Search Areas at 125' Antenna Mounting Elevations

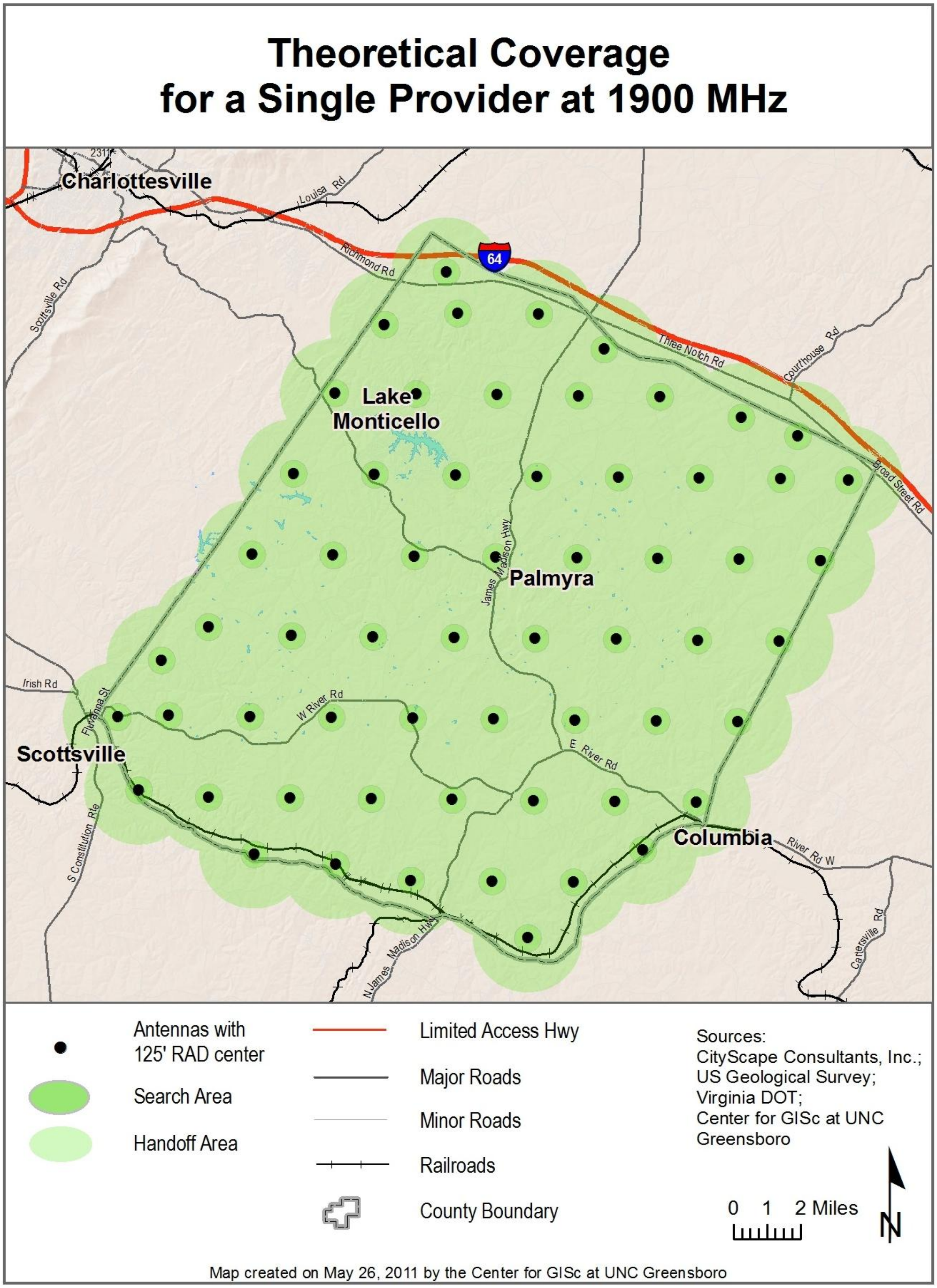


Figure 7: RMS 1900 MHz Handoff and Search Areas at 125' Antenna Mounting Elevations

Topographic variable on theoretical coverage

In flat terrain and sparsely populated areas base station prediction is an easier art. The impact terrain has on a service area can be the most dramatic. Radio frequency propagation is line-of-sight technology. Line of sight works best with an unobstructed path between the base station and the handset. There are some variations of this principle. The analogy of a light bulb works well to explain how a wireless signal gets from point A to point B.

In this manner communication signals perform very similar to light. The areas closest to the light are illuminated the brightest. Adding a lampshade over the light bulb dims the light. Walls, closed doors, and other opaque objects obscure the light. Similarly for best results in wireless communications there should be nothing in the transmission line of sight path between antenna point A and antenna point B, but that is usually impossible. Reflected or refracted signal will fill in some geographic areas but at a reduced power level.

Therefore, on flat terrain service areas with minimal vegetation, the coverage network from each antenna propagates in an even circular pattern. In areas with varying terrain conditions, the line of-sight coverage will be altered by higher and lower ground elevations. The County has considerable topographical variations which creates gaps in coverage in the RMS theoretical maps.

Using the same random grid locations identified in Figure 6 (RMS 800 MHz Handoff and Search Areas at 125’ Antenna Elevations) and Figure 7 (RMS 1900 MHz Handoff and Search Areas at 125’ Antenna Elevations); Figures 8 and 9 illustrate how wireless service coverage is affected when the topographic variable is added to the propagation formula. Areas in gray identify geographic areas with reduced or no coverage due to variations in terrain (ridgelines and valleys).

Figure 8: 800 MHz Handoff at 125' Antenna Mounting Elevations with Terrain

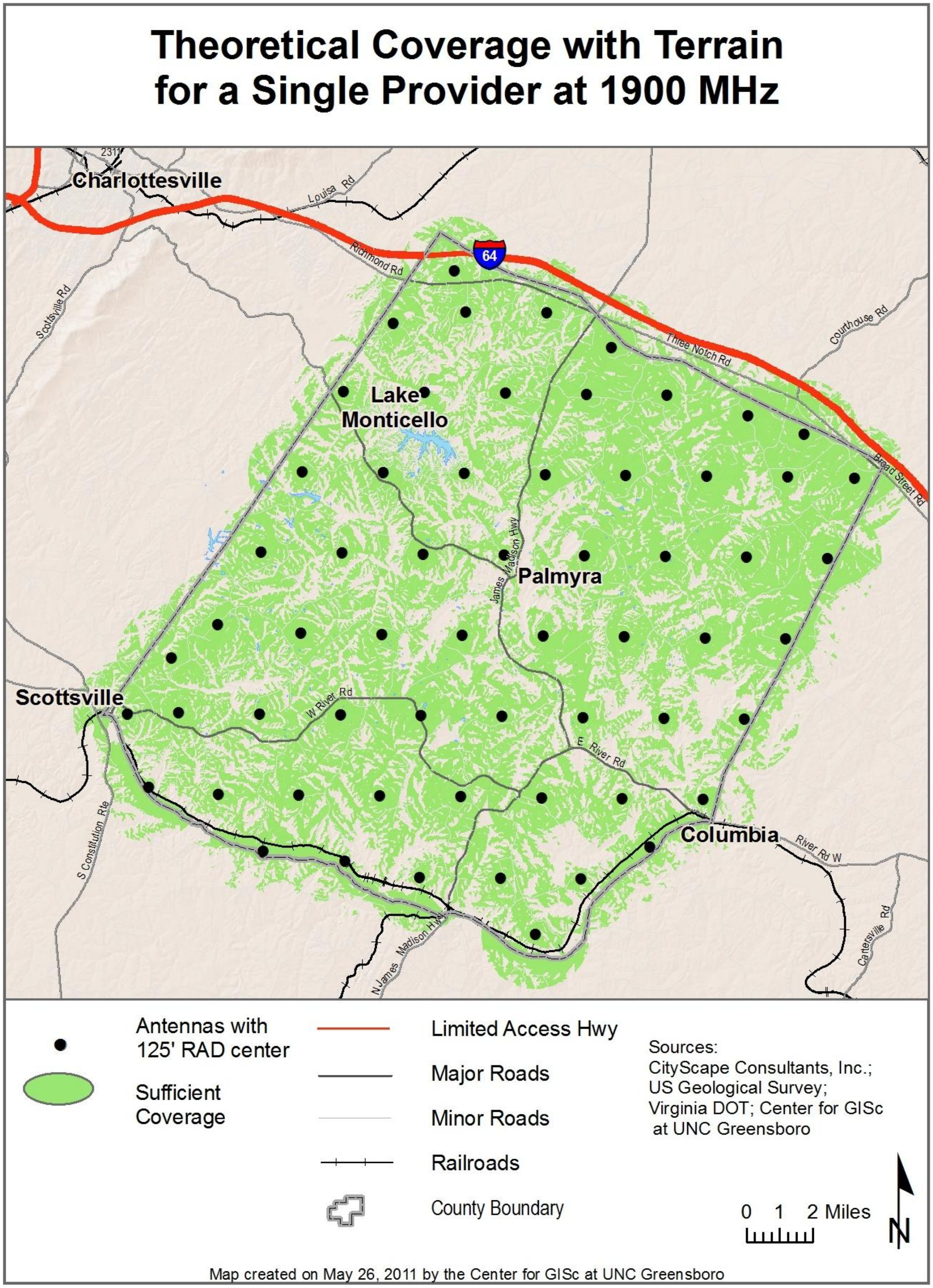


Figure 9: 1900 MHz Handoff with 125' Antenna Mounting Elevations with Terrain

Signal strength on theoretical coverage

Signal strength

The RMS theoretical maps to this point in the master plan illustrate general coverage area from identified sites. Propagation mapping is a process that illustrates the level of coverage from an individual antenna site. Signal strength, in this application, is a term used to describe the level of operability of a handheld portable phone. The stronger the signal between the elevated antenna and the handheld wireless phone, the more likely the phone and all the built-in features will work. A reduced signal decreases the opportunity for satisfactory service caused by dropped calls or failed calls on the wireless device. Distance between the wireless handset and the elevated antennas, in addition to existing obstructions such as topography, buildings, and the physical location of the person using the handset (indoors or outdoors) are variables that affect signal strength.

The level of propagation signal strength is shown through the gradation of colors from yellow to blue. The geographic areas in yellow identify superior signal strength; green equates to areas with average signal strength; shades of blue symbolize acceptable signal strength; and gray shades show marginal or no signal strength. Generally, the closer the proximity of the wireless devise to the antenna equates to better quality wireless service and this is shown in shades of yellow. An increase in geographic distance between the handset and the antenna affects the quality of wireless service. Shades of green, blue, and gray shades indicate geographic service areas with good, marginal, sporadic, or no signal strength, respectively. Table 3 below provides further explanation of the color coding relative to propagation signals.

Signal Strength Color	Signal Strength Title	Signal Strength Description
Yellow	Superior	Signal strength strong enough to receive signal in many buildings
Green	Average	Signal strength strong enough to receive signal in a car, but not inside most buildings
Blue	Acceptable	Signal strength strong enough to receive signal outside for many handsets, but no expectation of receiving a signal in a car or building

Table 3: Signal Strength

Seasonal variables

Radio frequency propagation is also affected by vegetative cover. For example, pine needles absorb radio frequency emissions which distort the propagation from the antenna. Leaf foliage has a similar effect on propagation. Geographic land areas predominately covered by deciduous vegetation will have improved network coverage in the winter when the leaves are off the trees.

Using the same random antenna locations identified in Figure 6 (RMS 800 MHz Handoff and Search Areas at 125' Antenna Elevations) and Figure 7 (RMS 1900 MHz Handoff and Search Areas at 125' Antenna Elevations); Figures 10 and 11 illustrate the various levels of signal coverage from the theoretical antenna locations including the foliage (clutter) variable. The areas in yellow identify geographic areas with superior signal strength; green equates to areas with average signal strength; shades of blue symbolize acceptable signal strength; and gray shades show marginal or no signal strength.

While the industry standards identify green and blue shades as "average" and "acceptable" coverage; customers tend to indicate otherwise. Most early twenty-first century wireless subscribers are demanding superior signal strength (yellow) in their residences, schools, offices, and places frequented for shopping and entertainment. As consumers continue the trend of terminating traditional land line phone services and using the wireless handset as the primary mode of communication, having signal strength inside buildings is paramount to meeting these expectations. The industries "average" and "acceptable" coverage variables do not meet customer demands and expectations. Figure 10 shows almost complete yellow/superior signal strength indicating very little need for additional infrastructure. Figure 11 also illustrates good signal coverage from the sixty-one theoretical 1900 MHz telecommunication facilities with the exception of the ridgelines and valleys. The geographic areas in gray have minimal or no network coverage.

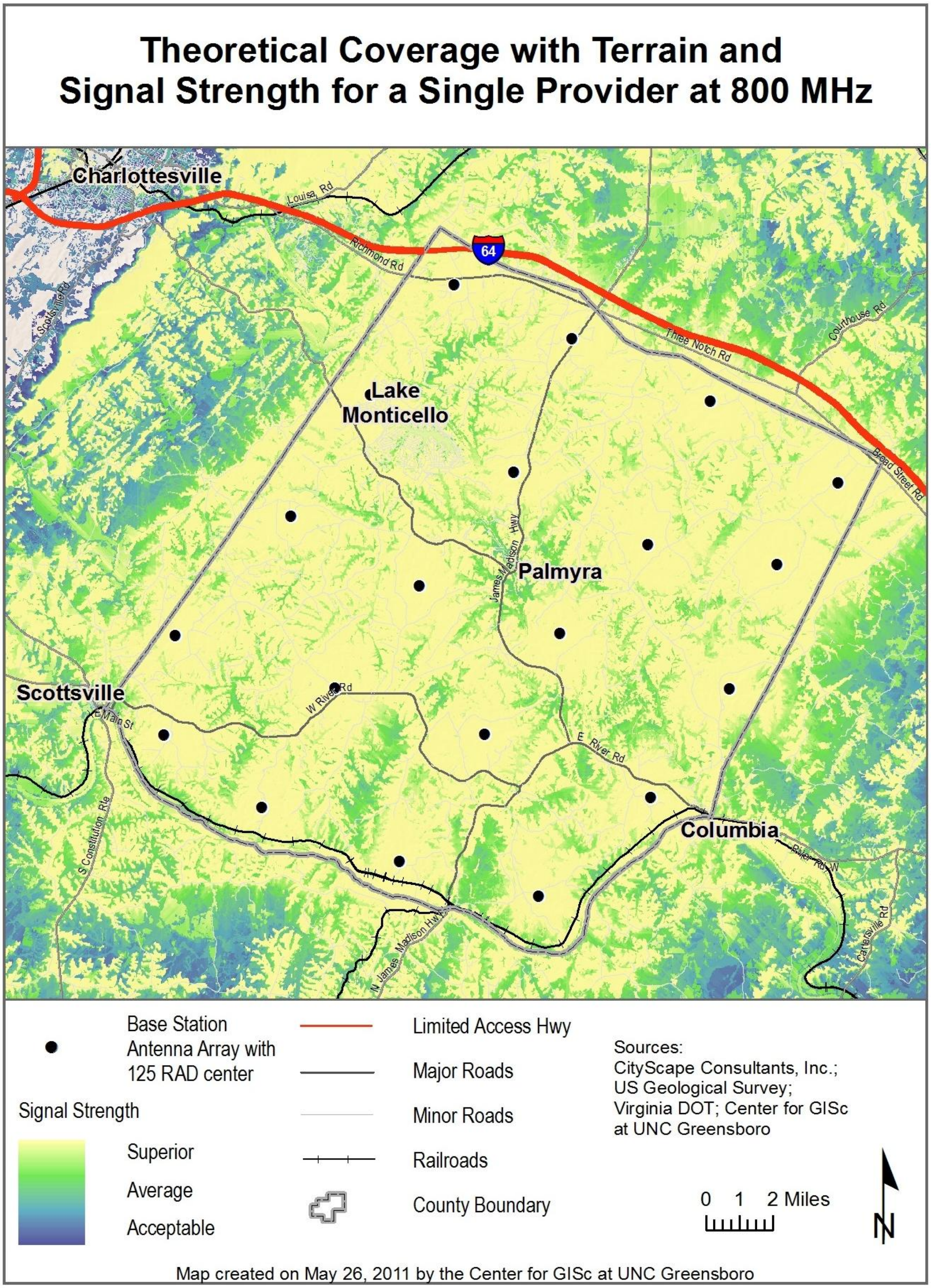


Figure 10: RMS Coverage and Signal Strength for a Single Theoretical 800 MHz Wireless Provider

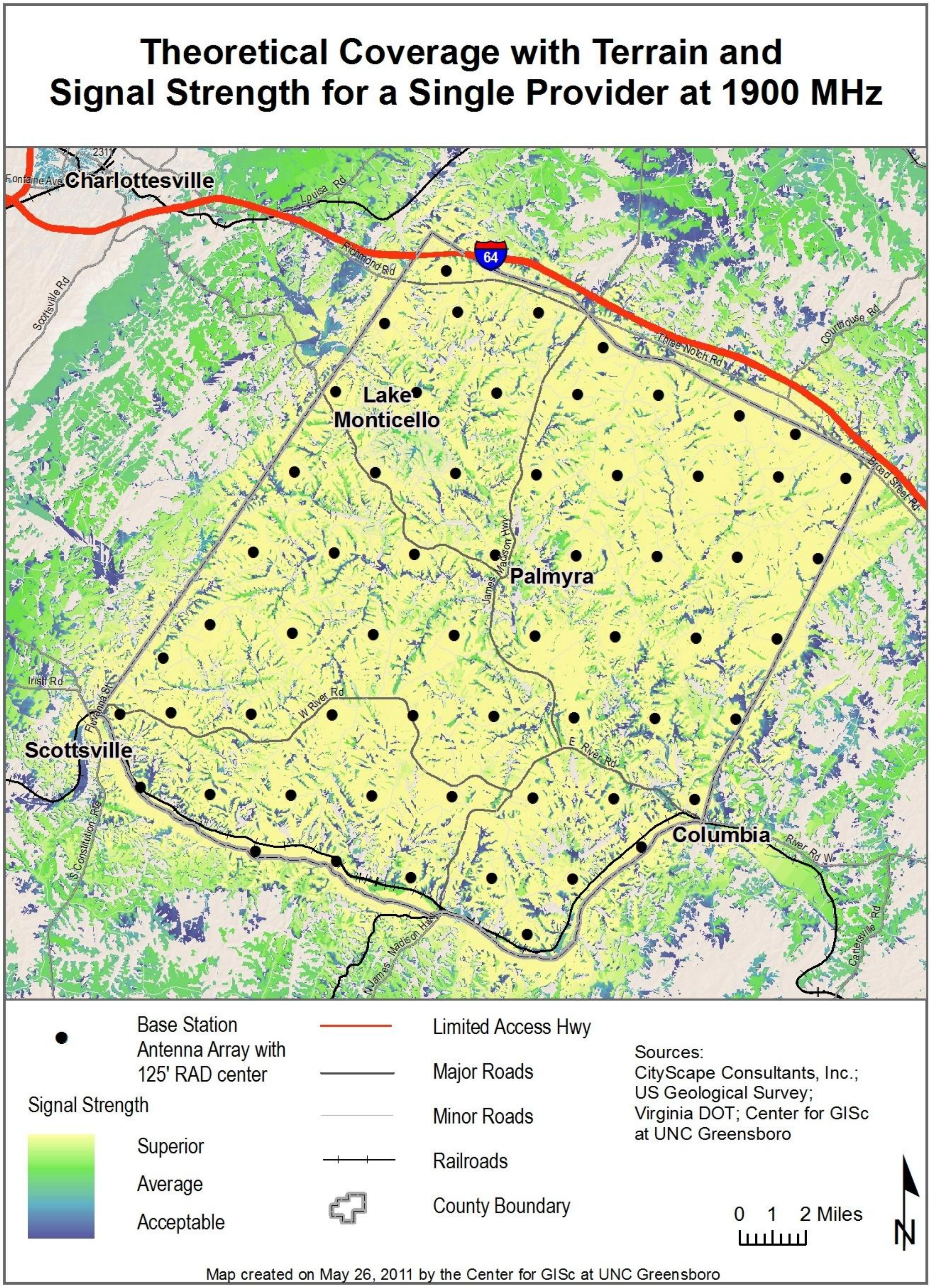


Figure 11: RMS Coverage and Signal Strength for a Single Theoretical 1900 MHz Wireless Provider

Wireless industry stakeholders and infrastructure

Prior to the granting of the cellular licenses in 1980 for the first phase of deployment, the United States was divided into 51 regions by Rand McNally and Company. These regions are described as Metropolitan Trading Areas (MTA). The spectrum auction conducted by the Federal Government for the 1900 MHz bands for 2G (PCS), further divided the United States into 493 geographic areas called Basic Trading Areas (BTA). The County is located in the "Washington-Baltimore" MTA (a.k.a. MTA 10) and the "Charlottesville" BTA (a.k.a. BTA 75). The Metropolitan Trading Areas map and the Basic Trading Areas map are shown in Figures 12 and 13, respectively.

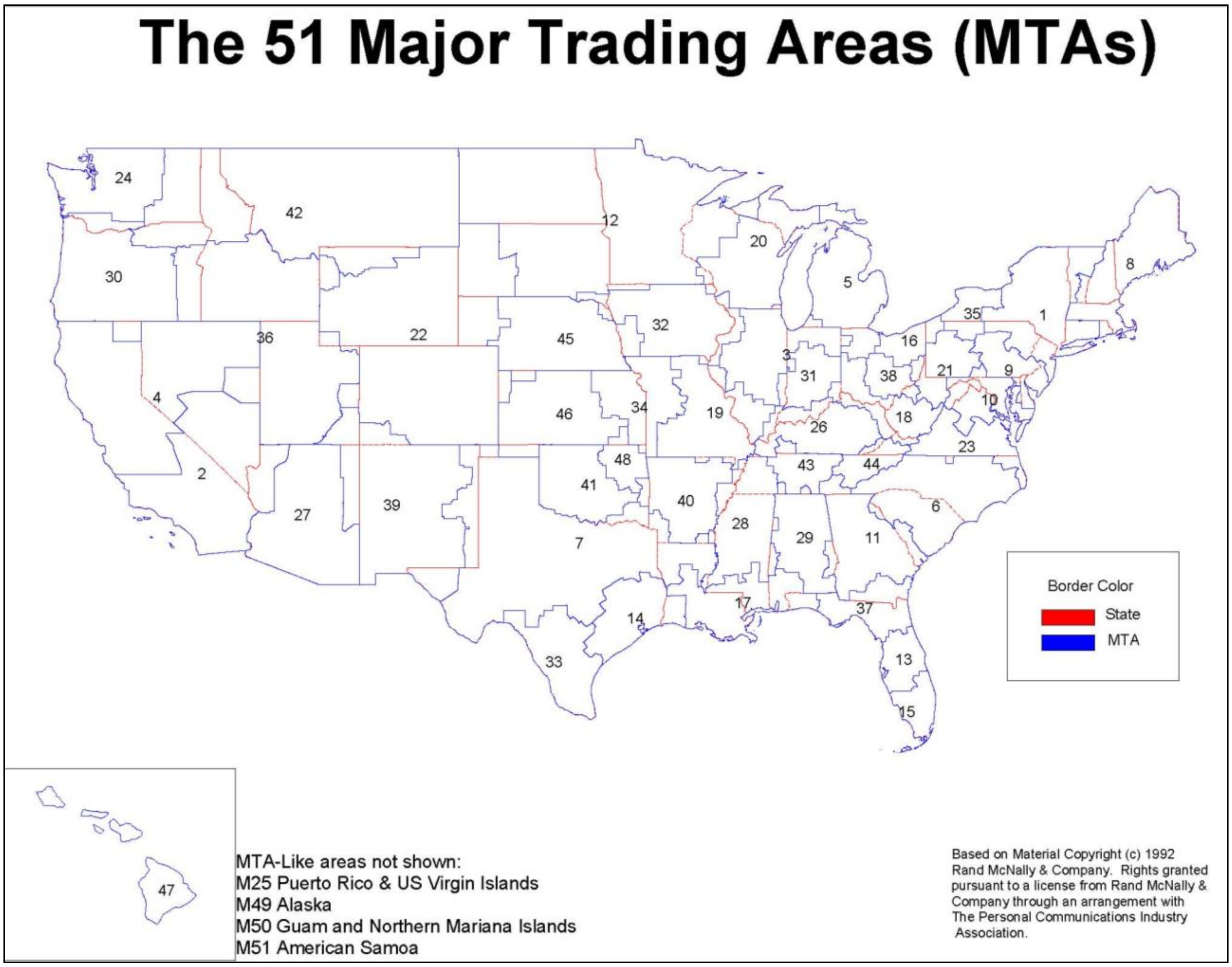


Figure 12: Metropolitan Trading Areas

URL: http://wireless.fcc.gov/auctions/data/maps/mta.pdf

Figure 13: Basic Trading Areas

http://wireless.fcc.gov/auctions/data/maps/bta.pdf

Presently throughout the County there are two providers licensed to operate in the blocks of cellular services allocated in the 800 MHz band: Alltel (recently purchased by Verizon), and US Cellular. There are six Personal Communications Services (PCS) licensed to operate in the 1900 MHz band: AT&T Wireless, Sprint Nextel, Ntelos (for Verizon), T-Mobile, Triton PCS, and Verizon Wireless. Per Section 704 of the Telecommunications Act of 1996, all seven service providers (Verizon, US Cellular, AT&T Wireless, Sprint Nextel, T-Mobile and Triton PCS) will require uninterrupted and continuous handoff service throughout the County. Additionally wireless broadband service providers Century Link and ClearCom have a few sites in the 2300 MHz frequency.

The recent transition to digital broadcasting (DTV) from the 700 MHz frequency has enabled the FCC to reassign the 700 MHz band for public safety radio communications and licensed wireless service providers. Public safety entities including police, fire, ambulance, rescue, and other emergency responders will use the spectrum to improve public safety networks. Licensed service providers and local and regional providers of wireless voice or data services will use 700 MHz to improve in-building network coverage. Qualcomm, Verizon Wireless, Echostar, Continuum 700, Pegasus Guard Band, LLC, US Cellular, AT&T, and Verizon Wireless are 700 MHz license owners in the Fluvanna trading areas.

Existing antenna locations

The previous RMS and propagation maps have been based on theoretical antenna locations. Identifying the actual existing antenna locations creates the base map from which current wireless deployment trends and projected future deployments for the County are derived. The geographic study area includes the County's jurisdictional boundary and a one-mile perimeter around the county limits. The initial database is developed from the County Department of Planning and Community Development, the FCC database, industry stakeholder's databases, and field work. Currently there are forty-seven existing, proposed, or potential telecommunication facilities within the geographic study area. Table 4 provides a summary of the total number of sites assessed within the described study area and a detailed tally of infrastructure type, height, and ownership.

13 Total Sites Within 1- Mile Perimeter of County	**47 Total Number of Existing/Proposed or Possible Antenna Locations Identified within Study Area**	**34 Total Sites Within County**
0	Fire Tower	1
3	Guy Towers	3
3	Monopoles	21
5	Lattice	0
2	Water Tanks	3
unknown	Approved and Not Built	4
unknown	Pending Approval	2
13	**Total**	**34**
Within 1- Mile Perimeter of County	**Heights of Existing/Proposed or Possible Antenna Locations Identified within Study Area**	**Within County**
0	> 100' < 115'	5
1	> = 120' < = 130'	16
2	> = 130' < 150'	4
5	> = 190' < 199'	4
2	> = 200' < 350+'	1
2	unknown	5
12	**Total**	**35**
Within 1- Mile Perimeter of County	**Ownership of Existing/Proposed or Possible Antenna Locations Identified within Study Area**	**Within County**
0	Alltel (service provider)	3
2	American Tower Corporation (tower owner)	2
6	Crown Castle International (tower owner)	4
0	Fluvanna County (public)	6
0	Fluvanna County School Board (public)	5
0	SBA Towers II LLC (tower owner)	2
1	US Cellular (service provider)	3
0	Verizon (service provider)	3
2	Other (1 tower owner)	5
1	Unknown	2
12	**Total**	**35**

Table 4: Summary of Identified Antenna Locations

The forty-seven location are mapped and identified in Figure 14. Antennas mounted on towers are symbolized with a black dot. The blue dots indicate water tanks available for attached antennas. The white dot represents the locations where new towers have been approved for new construction, and orange dots indicate locations where towers are proposed but not yet approved. Dots with red circles represent antenna used for emergency services.

Typically, wireless infrastructure deployment patterns (antenna and tower locations) parallel major thoroughfares, and this is characteristic of the deployment pattern to date in Fluvanna County.

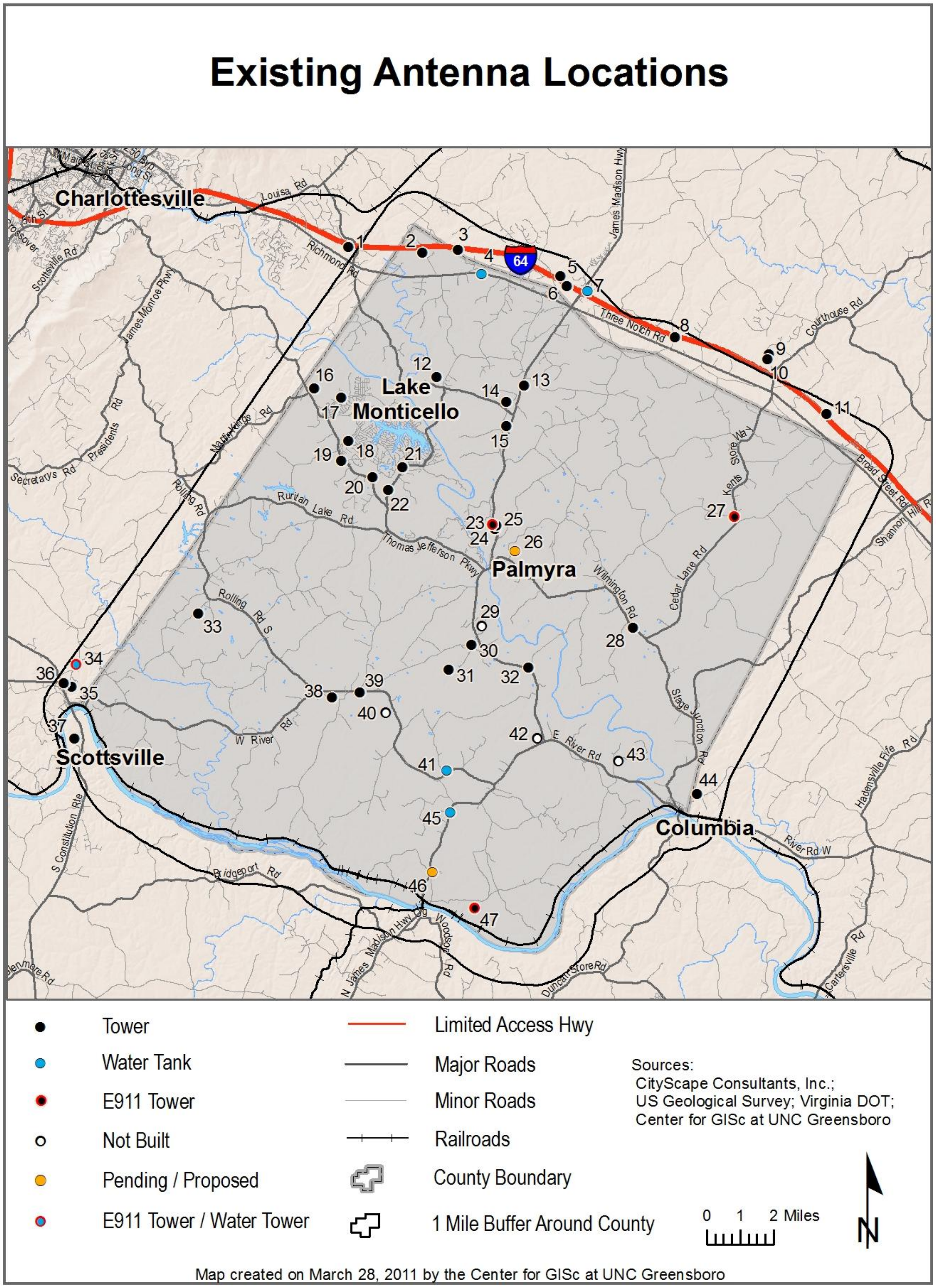


Figure 14: Existing Antenna Locations

Theoretical coverage from existing antenna locations

The next step in the evaluation process is to examine the coverage from all known existing antenna locations to determine if any area of the County has unsatisfactory or no service at all. CityScape theorizes how existing antenna locations might be used by the wireless industry.

For example, CityScape asks the following questions. First, "Would network coverage gaps be visible if a single Cellular (800 MHz) and PCS (1900 MHz) provider utilized all identified antenna locations?" And second, "Does the County have adequate existing infrastructure suitable for providers to meet complete network coverage objectives?"

Figures 15 and 16 demonstrate the theoretical propagation coverage for a single 800 and 1900 MHz service provider, respectively. For purposes of this mapping exercise CityScape has created two sets of height variables based on the tower data in Table 4. Existing antenna support facilities up to 150'; and existing antenna support facilities over 199'. Facilities up to 150' are shown to have a theoretical antenna mounting elevation at 100' and the taller facilities are based on a theoretical antenna mounting elevation at 150'. These maps include the terrain, summer foliage, and rural density variables. The following sites are not included in any of the propagation analysis due to the unlikelihood of colocation on these particular structures: 4, 25, 36, and 39.

Figure 15 illustrates nearly complete County-wide coverage if indeed one 800 MHz provider was located at each of these sites. Figure 16 illustrates an incomplete network coverage scenario with many geographic areas with minimal or no coverage.

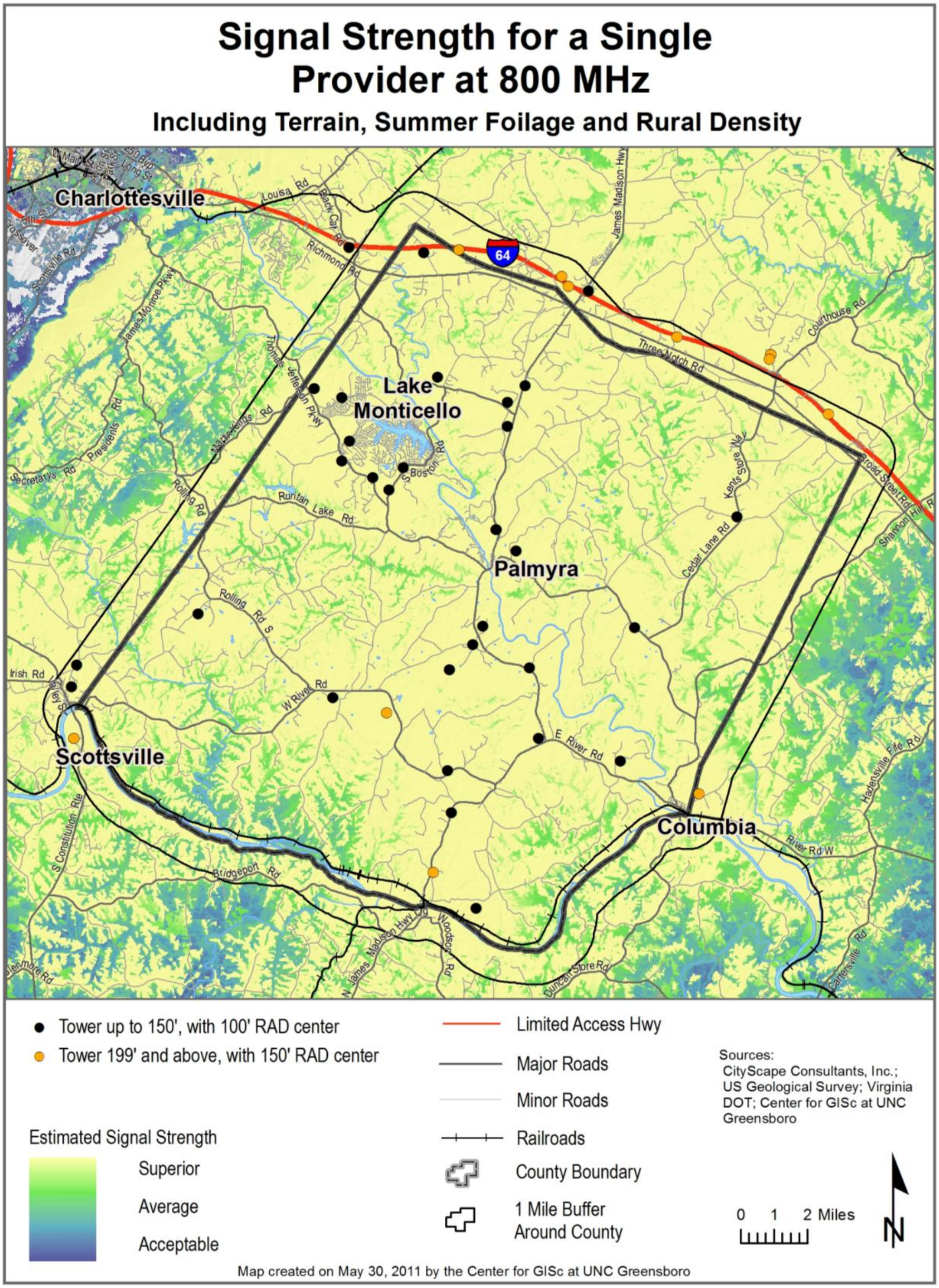


Figure 15: RMS Coverage for a Single Theoretical 800 MHz Wireless Provider from All Existing Antenna Locations and with Terrain

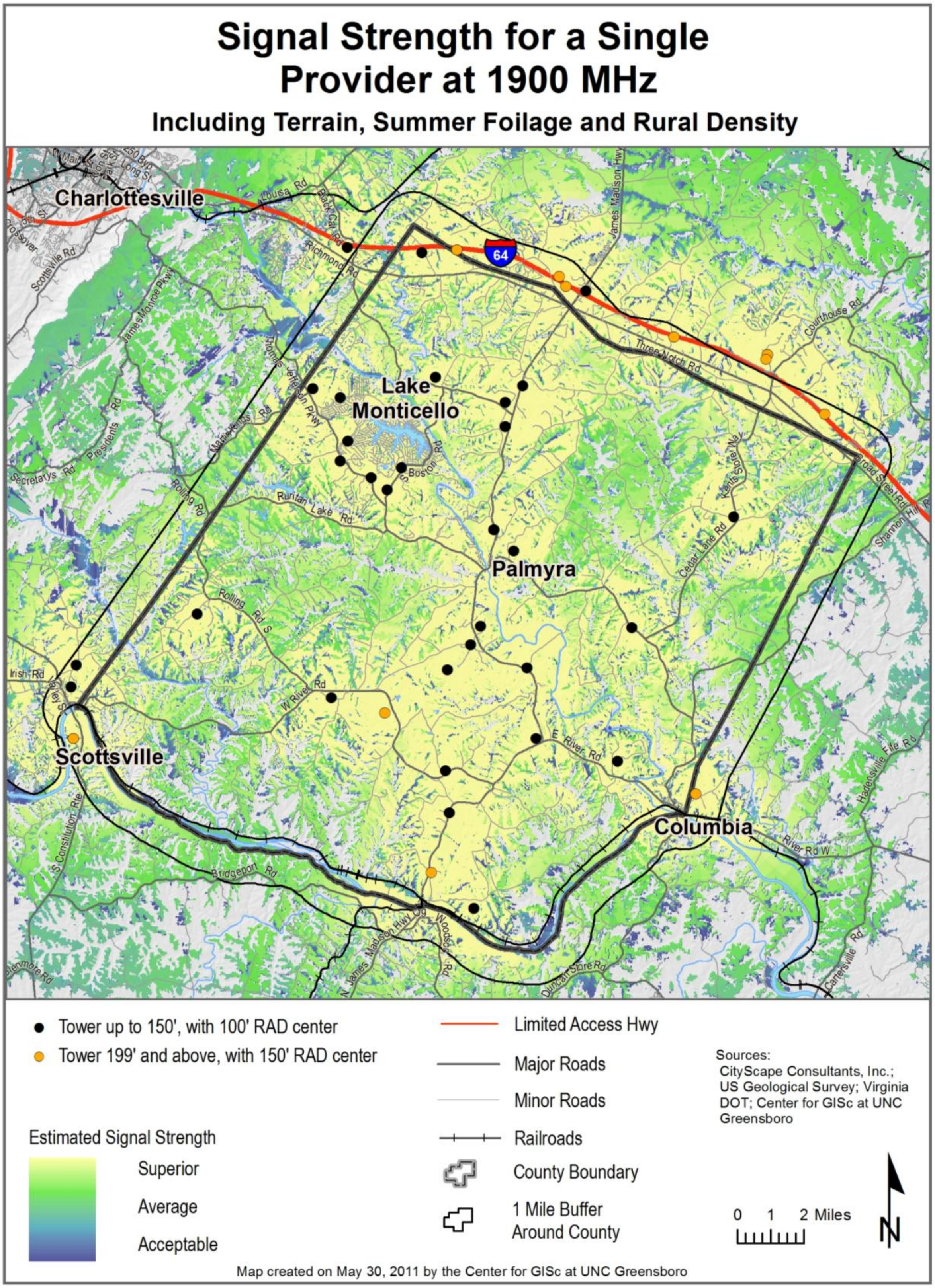


Figure 16: RMS Coverage for a Single Theoretical 1900 MHz Wireless Provider from All Existing Antenna Locations and with Terrain

Actual 800 MHz and 1900MHz Propagation Analysis

In reality, there is not a single 800 MHz or 1900 MHz service provider at each of these antenna support facility locations. But the information ascertained from Figures 15 and 16 is useful in validating present network deployment strategies. The objectives to saturate the geographic areas along the major thoroughfares and the more densely populated residential areas is evidenced by the infrastructure that parallels the highways and around Lake Monticello.

To evaluate the existing network deployment more thoroughly CityScape collected existing and proposed antenna location data during the site assessment field work. This collection of data enables CityScape to create propagation maps for existing 800 MHz and 1900 MHz service providers. *CityScape stresses the fact that this data is based largely on CityScape's experience, field work, and the data collected from the County. No specific data has been collected from the individual wireless providers thus these maps serve as close approximations*. For exact network coverage maps Cityscape would need the specific antenna mounting elevations, operating frequency, and for some facilities the antenna power output from each wireless provider. Even though the propagation maps are approximations the maps help identify geographic areas where future infrastructure will be needed for improved network coverage.

Maintaining confidentiality between the different wireless providers must be honored. For this reason all references to the actual service provider are omitted intentionally. The providers are only identified numerically.

Figures 17 through 19 are the approximate coverage maps for the 800 MHz providers; Figures 20 through 25 are the approximate coverage maps for the identified 1900 MHz service providers; and Figures 26 and 27 illustrate the approximate coverage maps for 2300 MHz wireless broadband providers.

After studying the maps CityScape provides the following observations:

- 800 MHz service providers have a more comprehensive network. In large part due to the fact that 800 MHz service providers started deploying their networks first so their networks are more mature. Also the 800 MHz frequency allows the network signal to propagate a greater radius from the antenna so larger geographic areas are services with fewer facilities.
- 800 MHz service providers seem to have nearly complete coverage parallel to Interstate 64 and have expanded southward into Fluvanna with their network deployments.
- 1900 MHz networks have less coverage. The initial coverage for most networks is parallel to Interstate 64. These networks are expanding southward into Fluvanna County parallel to the highways and around Lake Monticello.
- The 125' tower heights limit antenna mounting elevations to the 80' to 125' range. Consequently the propagation radius is limited to approximately 3.2 to 3.88 miles in the geographic areas of 1900 MHz frequency providers.
- The southern half of the county has minimal 1900 MHz coverage presently.
- Wireless broadband is concentrated around the business node of Interstate 64 and Zion Crossroads.

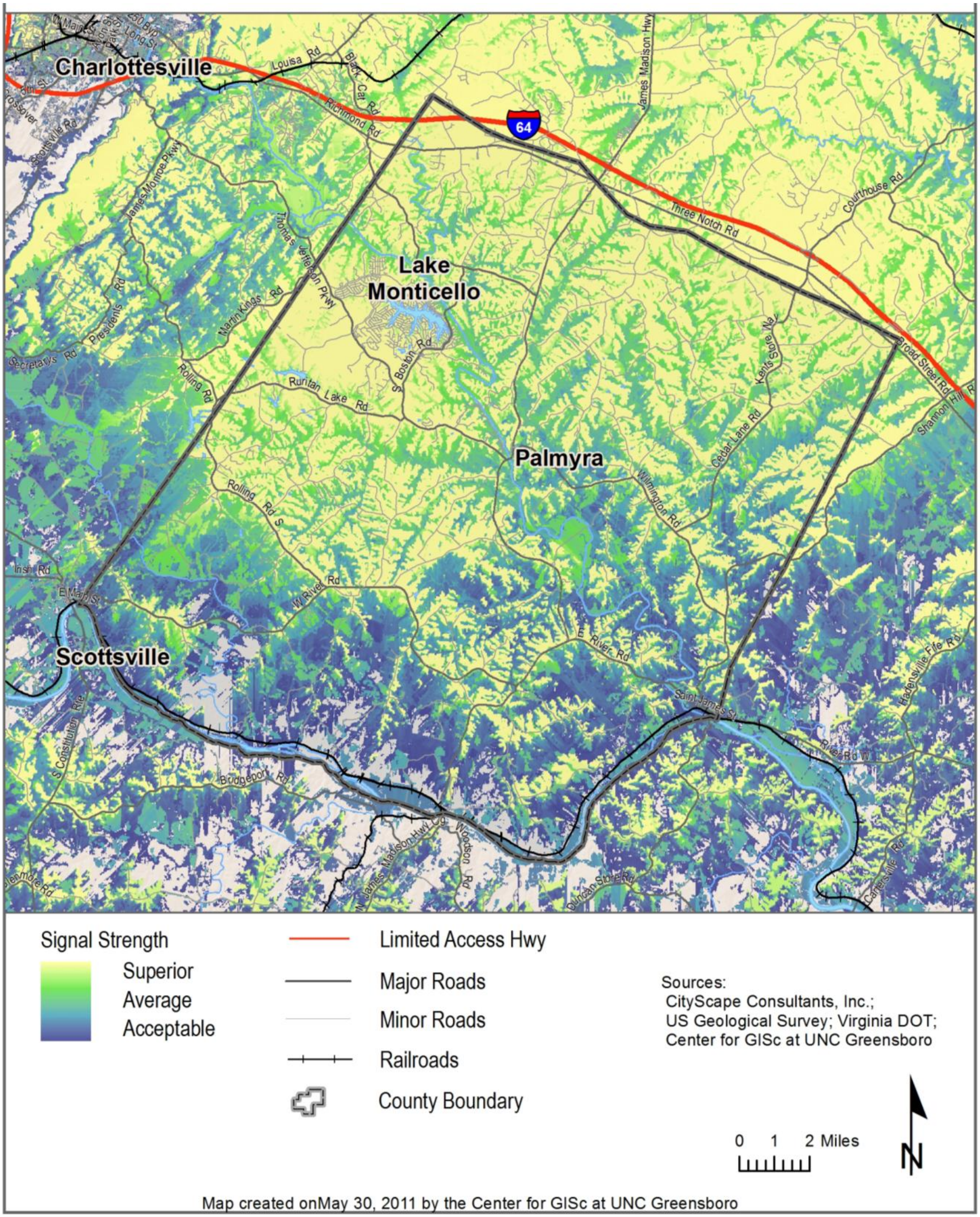


Figure 17: Theoretical Coverage Provider A in the 800 MHz frequency

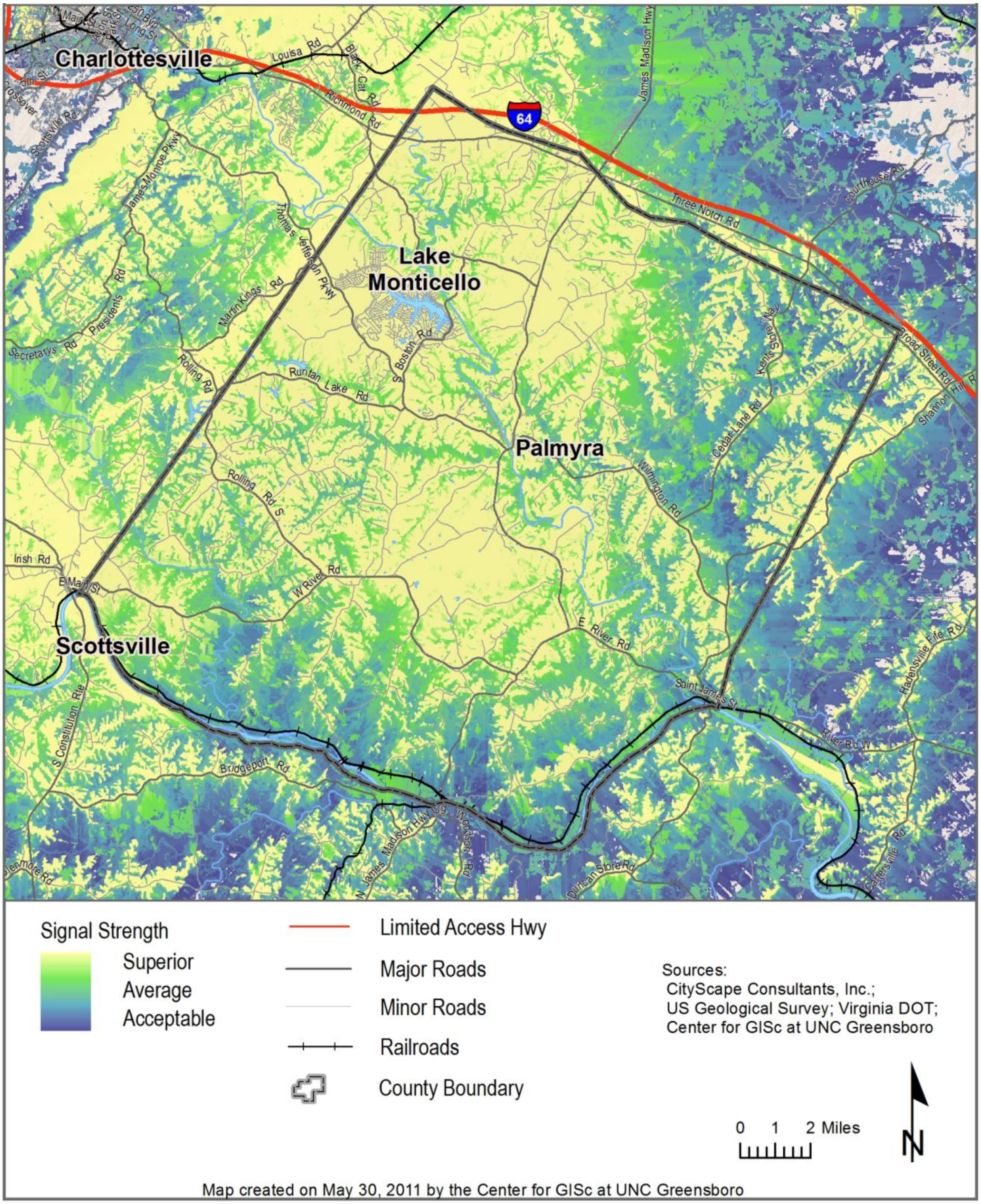


Figure 18: Theoretical Coverage Provider B in the 800 MHz frequency

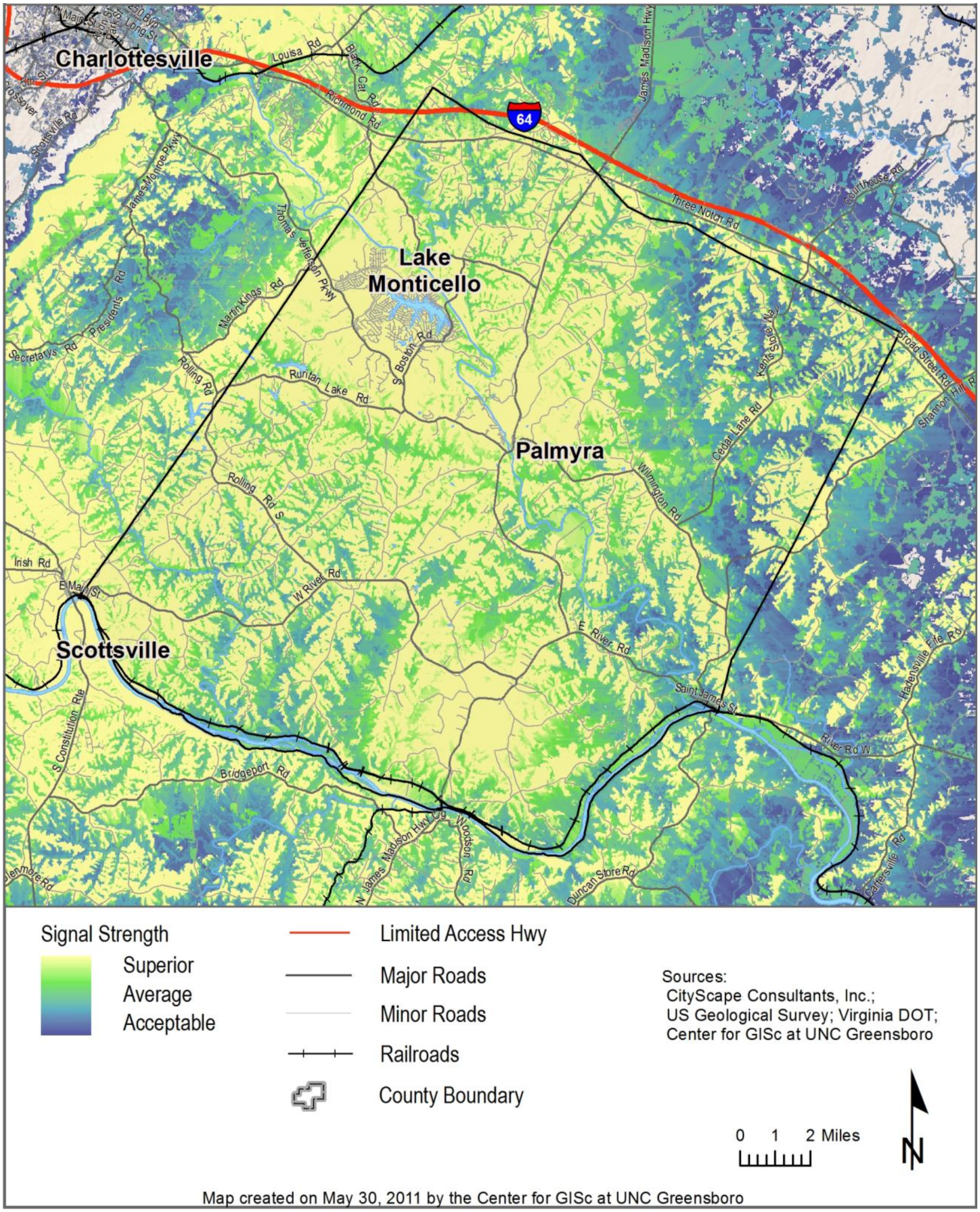


Figure 19: Theoretical Coverage Provider C in the 800 MHz frequency

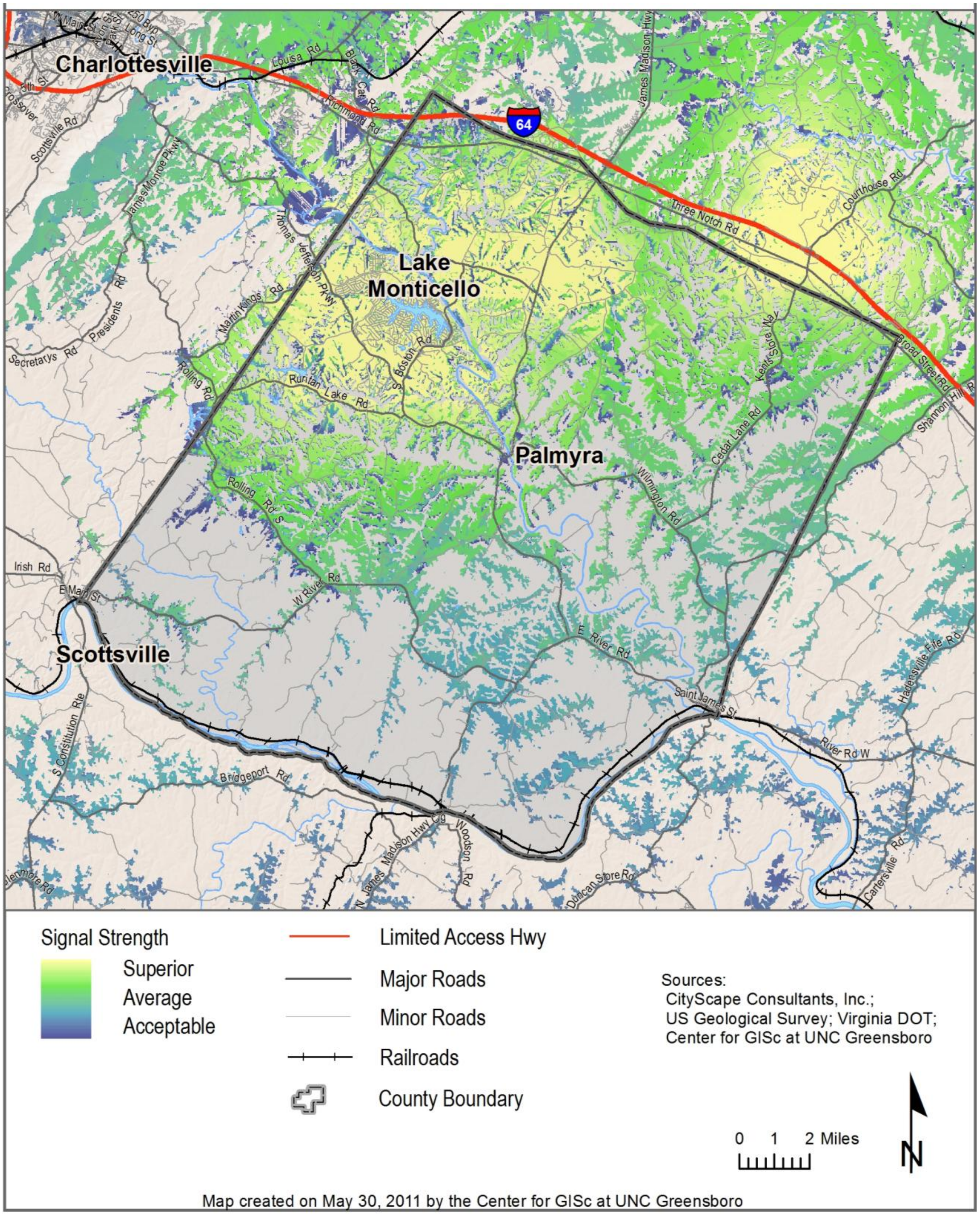


Figure 20: Theoretical Coverage Provider A in the 1900 MHz frequency

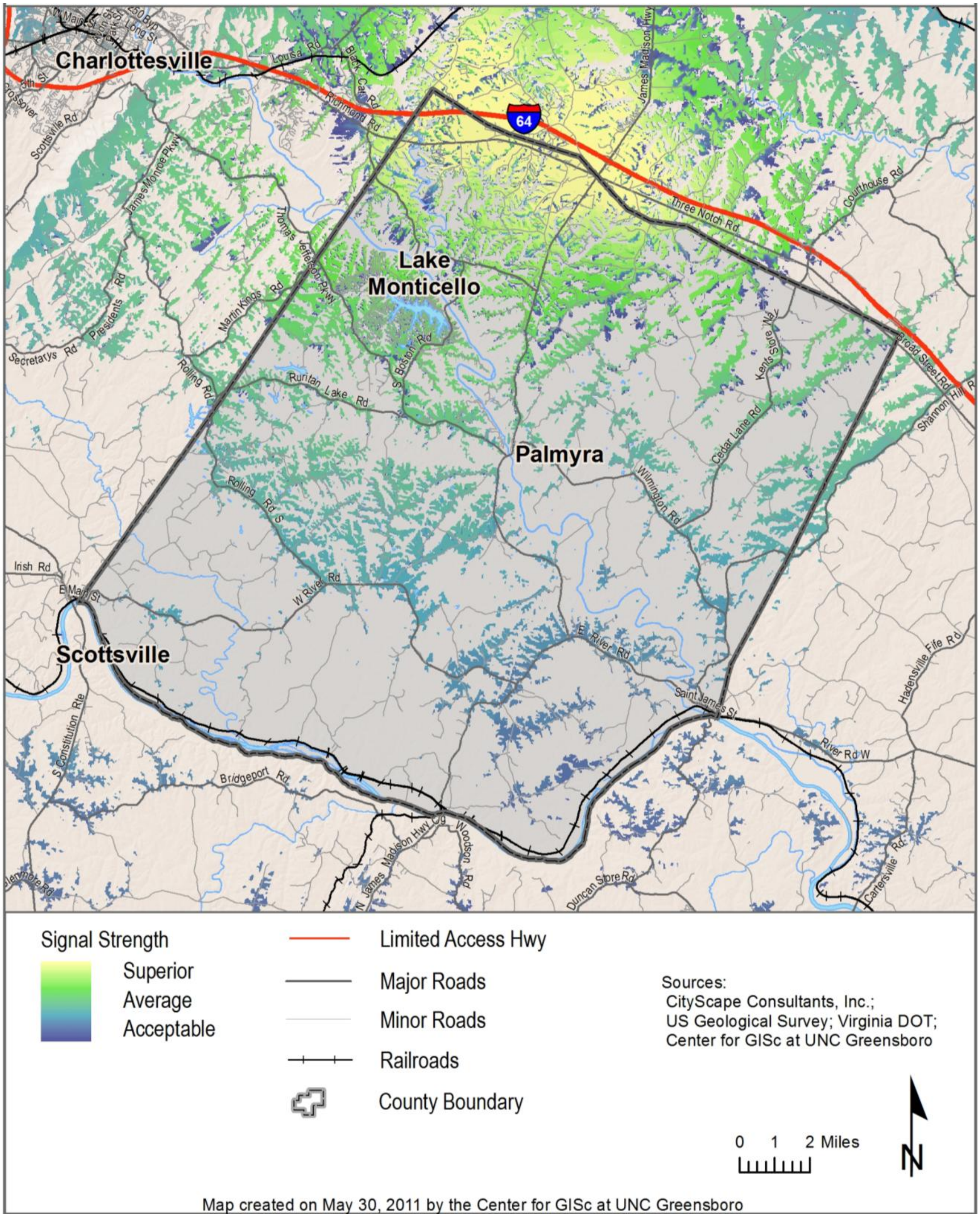


Figure 21: Theoretical Coverage Provider B in the 1900 MHz frequency

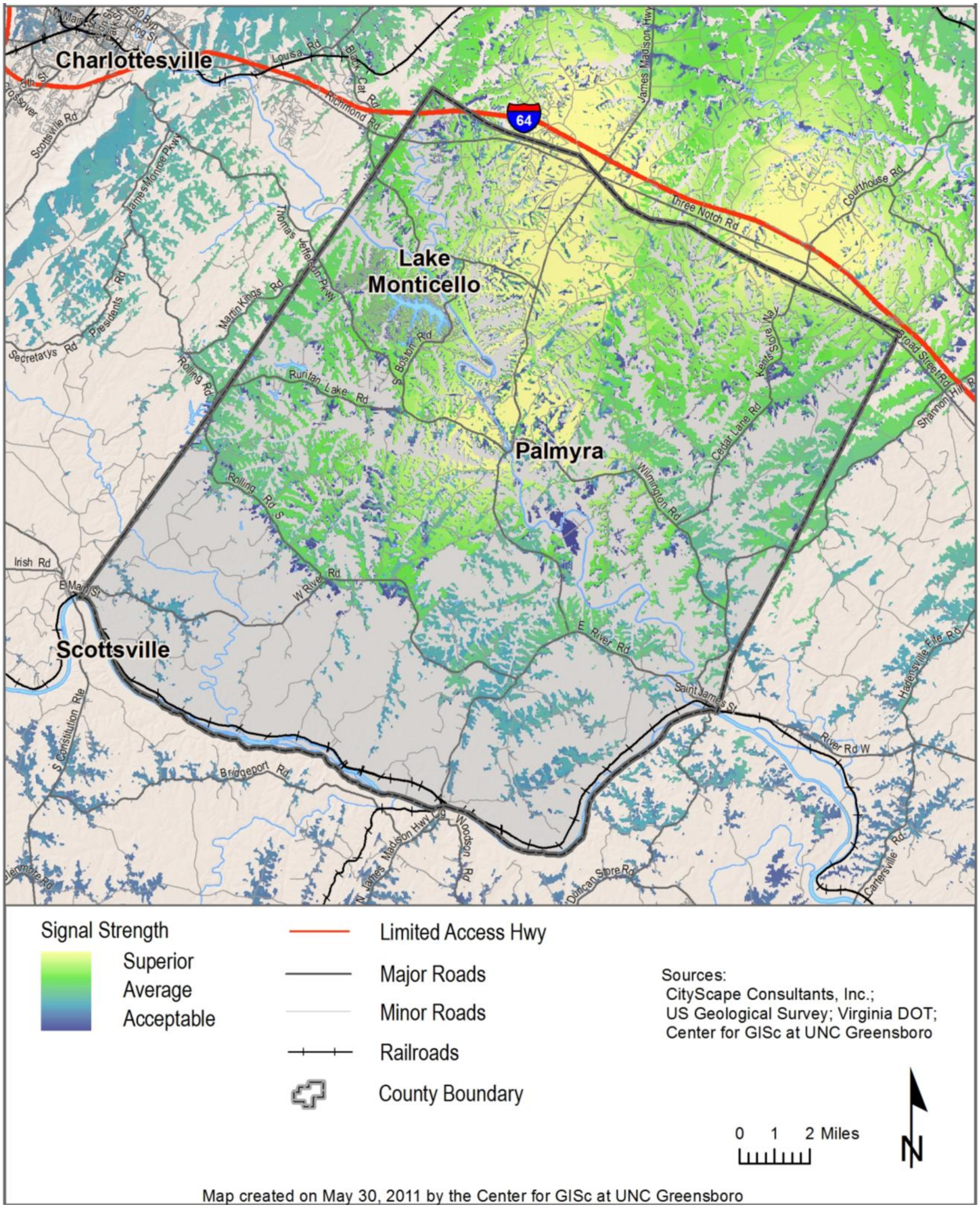


Figure 22: Theoretical Coverage Provider C in the 1900 MHz frequency

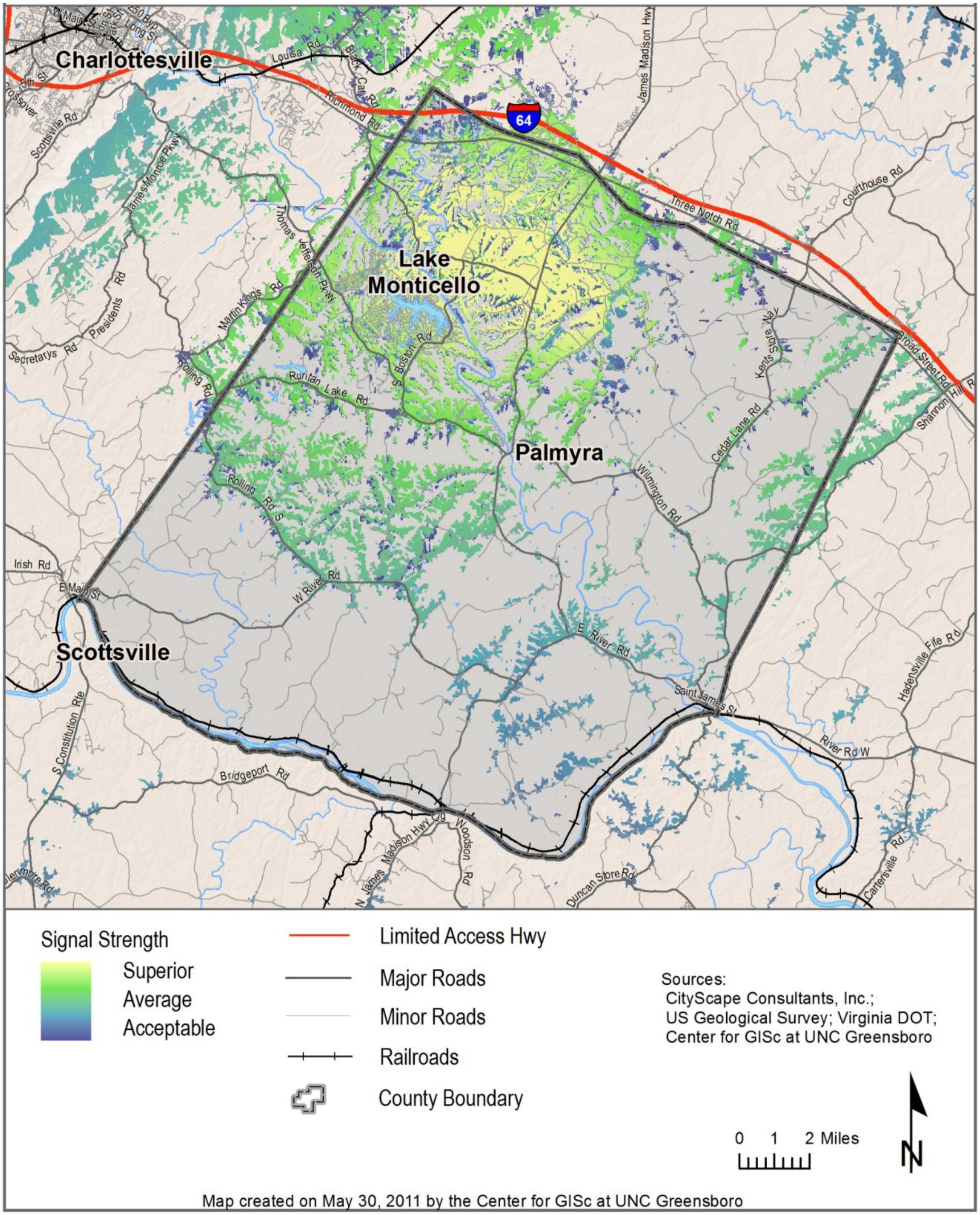


Figure 23: Theoretical Coverage Provider D in the 1900 MHz frequency

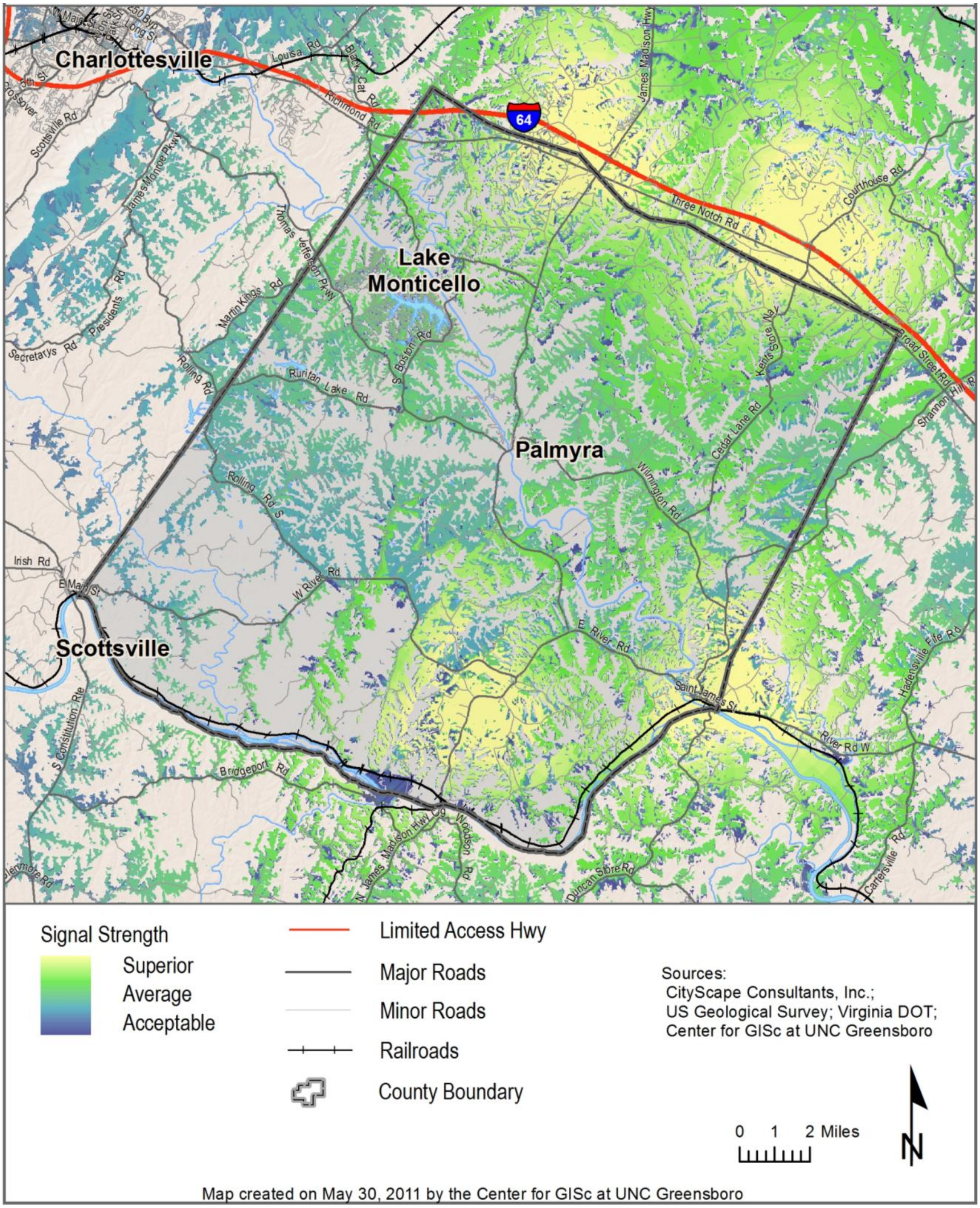


Figure 24: Theoretical Coverage Provider E in the 1900 MHz frequency

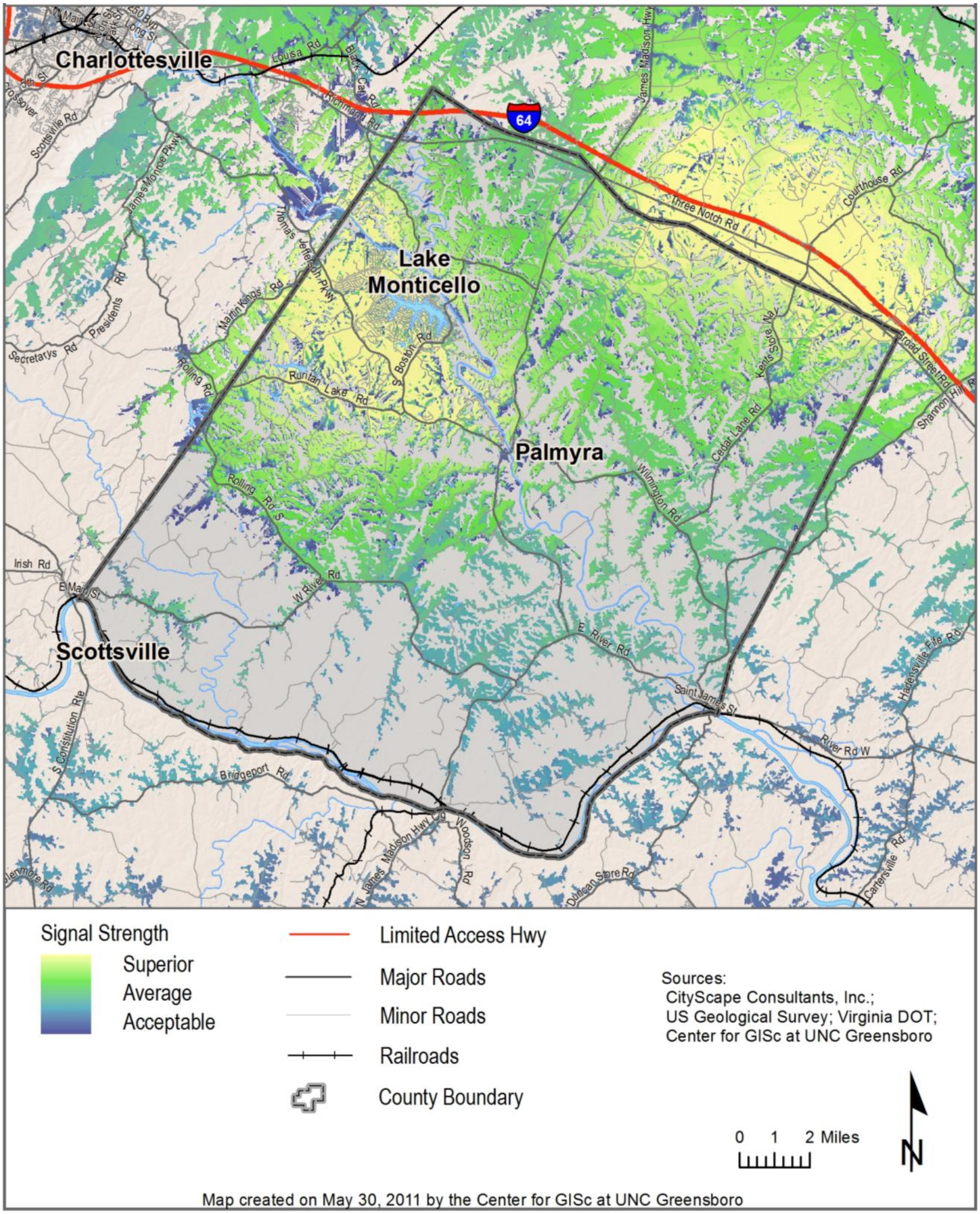


Figure 25: Theoretical Coverage Provider F in the 1900 MHz frequency

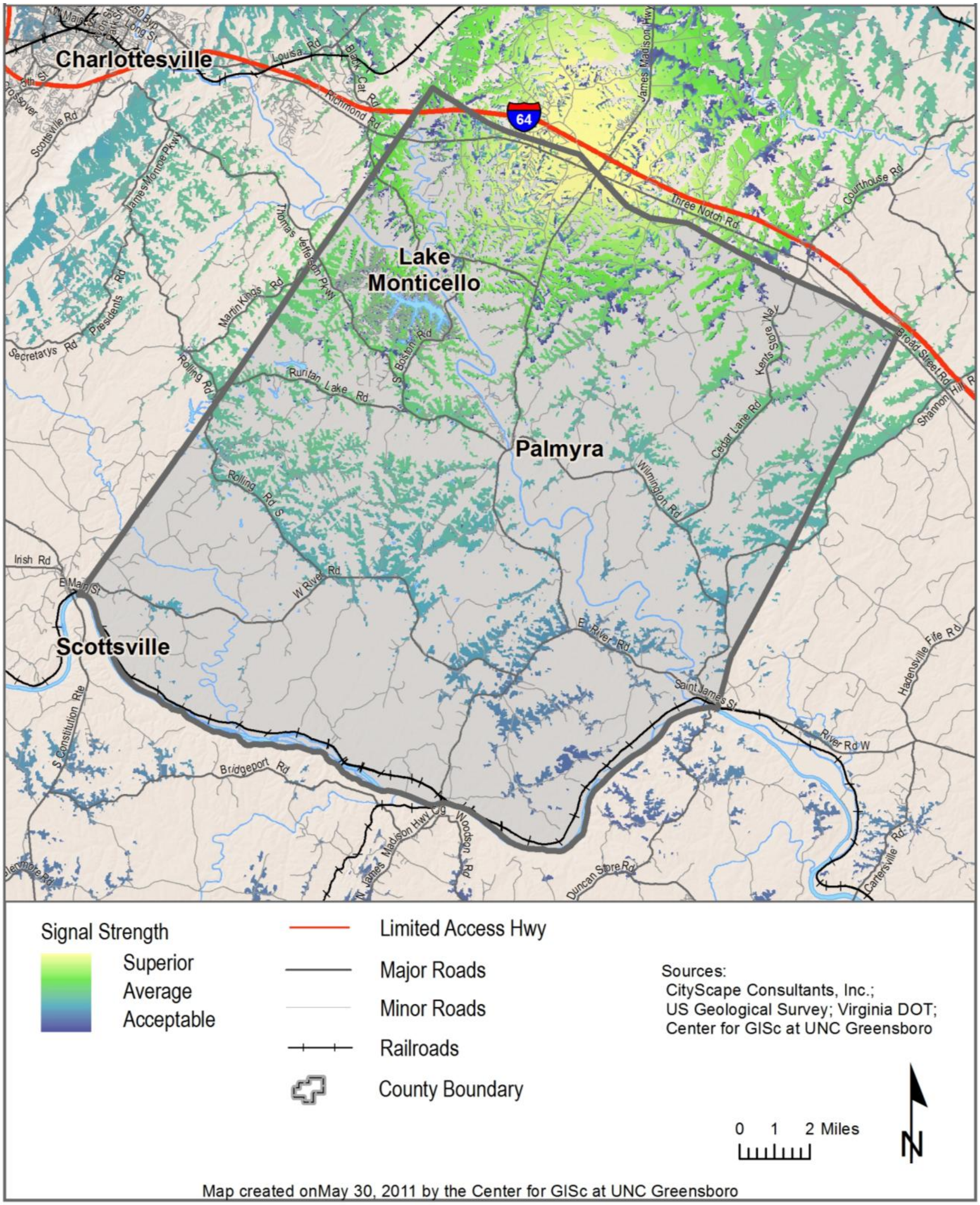


Figure 26: Theoretical Coverage Provider A in the 2300 MHz frequency

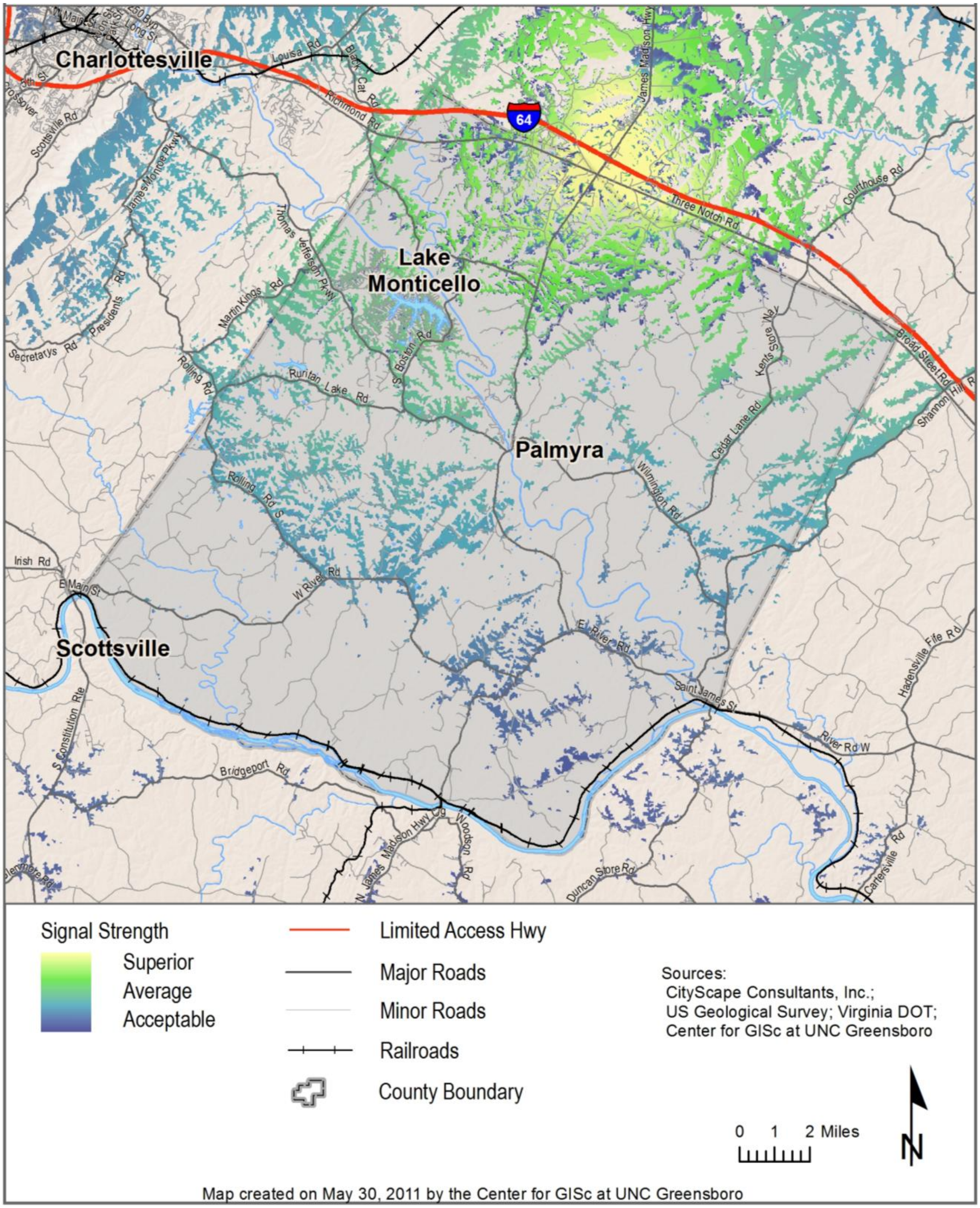


Figure 27: Theoretical Coverage Provider B in the 2300 MHz frequency

Chapter 4 Public Safety Proposed Tower Analysis

Background

On December 9, 2010 the County held the Kick-off and scoping meeting for the wireless telecommunications master planning process. At this meeting the citizenry learned about the Telecommunications Act of 1996 and public policy strategies to regulate new tower infrastructure. Additionally they participated in a survey pertaining to preferable types of future infrastructure, heights for future towers and geographic preferences for future facilities. Comments received from those completing the surveys indicated a great need for improved wireless network coverage county-wide with concern to tower heights and aesthetics.

A second public meeting was held on April 11, 2011 at the Fluvanna County Public Library. This meeting had significant greater attendance as compared to the December 9th meeting and included a summary of the presentation given at the previous meeting and an interactive participant activity to further ascertain community commentary on how to regulate future wireless network deployments. The public participation at this meeting was great and the overall consensus from the attendees was to consider taller and fewer tower structures in geographic areas that would provide the largest service coverage in lieu of numerous shorter towers county-wide.

Simultaneous to the wireless telecommunications master planning the County is also reviewing the future needs of the County's public safety communications network. The County hired RCC Consultants to review options for improving the County's emergency services coverage. RCC's report, "Comparative Analysis of Public Safety Radio Communication Options" dated February 9, 2011, identifies the use of nine tower locations countywide (existing and proposed) in their propagation modeling scenarios. CityScape was directed to study locations in the RCC report in combination with the existing tower infrastructure owned by the wireless industry as the basis of evaluating the "fewer and taller" tower possibilities. Table 5 lists the nine tower sites in the RCC report and the corresponding CityScape identification (ID) used by CityScape on CityScape's propagation maps.

CityScape's Site ID	RCC's Site Name	General Location	Proposed antenna mounting locations (feet)
A	Site #4 Fluvanna Correctional	NW County	150 & 199
B	Site #8 (New UHF N)	North Fluvanna	150 & 199
C	Site #7 (New UHF W)	Cunningham	150 & 199
D	Kents Store	NE County	150 & 199
E	Fluvanna County Dispatch	Central County	150 & 199
F	Fluvanna High School	Central County	150 & 199
G	Site #5 (Replacement)	SW County	150 & 199
H	Site #6 (New UHF E)	Columbia	150 & 199
I	Bremo Bluff	SE County	150 & 199 & 330

Table 5: Public Safety Tower Locations for Consideration

Propagation maps

Using the public safety antenna locations identified by RCC Consultants and listed in Table 5 CityScape developed a series of propagation maps to illustrate the coverage from these towers if they were also used by the wireless telecommunications service providers in the 800 and 1900 megahertz (MHz) frequencies. The proposed sites are identified by a red dot.

The first series of maps anticipates all nine emergency service towers built at 199 feet. This is the tallest tower allowed by the FCC without a continuous blinking warning light system. The scenario accounts for antenna mounting elevations (referenced as RAD centers) at the 199'; 190'; 180' 170' 160; and 150' locations on each tower. Antenna arrays mounted at the higher elevations will actually have a greater propagation radius than the lower mounted antenna. For this reason the lower antenna mounting elevations are necessary to show the propagation from the lowest mounting elevation antenna on the tower rather than the highest elevation illustrating the least possible coverage area. The propagation maps in Figures 28 and 29 shows the service coverage area from the lowest antenna mounted elevation at 150' by an 800 or 1900 MHz wireless service provider, respectively. All of the propagation maps include terrain, summer foliage and rural population density variables.

The areas in yellow identify geographic areas with superior signal strength; green equates to areas with average signal strength; shades of blue symbolize acceptable signal strength; and gray shades show marginal or no signal strength.

Figure 28 illustrates the coverage from the nine locations in the 800 MHz frequency with an antenna mounting elevation of 150 feet as generally complete with the exception of a geographic area approximately 2.5 miles east of site G and approximately 2.5 miles west of Site I.

Figures 29 illustrates the coverage from the nine locations in the 1900 MHz frequency does not transmit as great a distance as in the 800 MHz frequency and the coverage area is significantly reduced. Geographic areas in grey indicate little or no wireless coverage.

Figure 30 and 31 illustrates the 800 MHz and 1900 MHz frequency coverage, respectively, from the nine proposed locations by RCC Consultants and also includes the existing towers in and around Fluvanna County used for wireless telecommunications by the wireless industry. Existing towers up to one hundred and fifty feet in height assume an antenna mounting elevation of 100'; and existing towers in excess of one hundred and ninety-nine feet assume an antenna mounting elevation of 150'. Figure 30 illustrates almost one hundred percent coverage in the 800 MHz frequency county-wide. Figure 31 illustrates a much greater coverage area in the 1900 MHz with smaller geographic gaps.

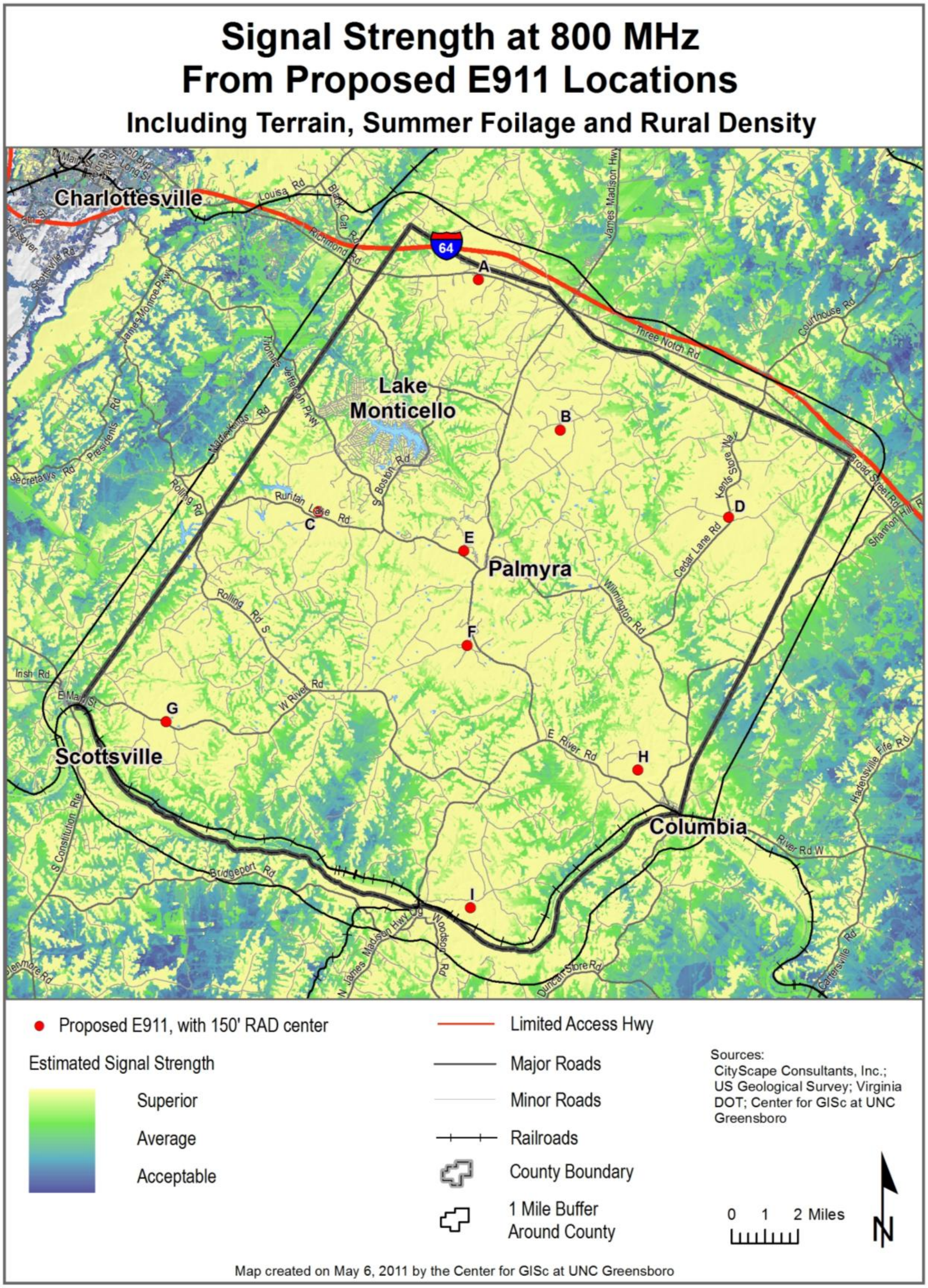


Figure 28: Propagation Map 800 MHz from proposed RCC sites

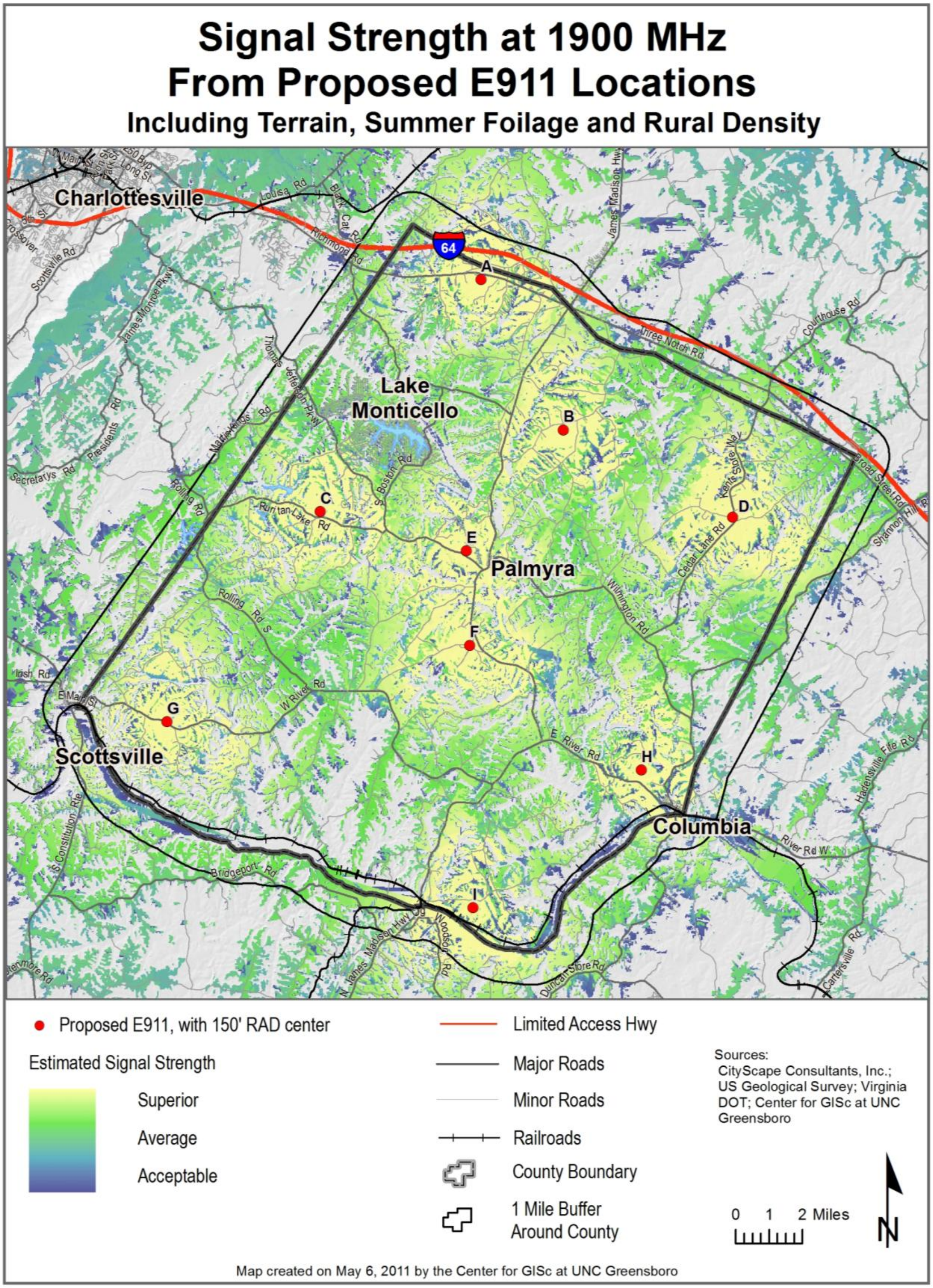


Figure 29: Propagation Map 1900 MHz from proposed RCC sites with 150 RAD centers

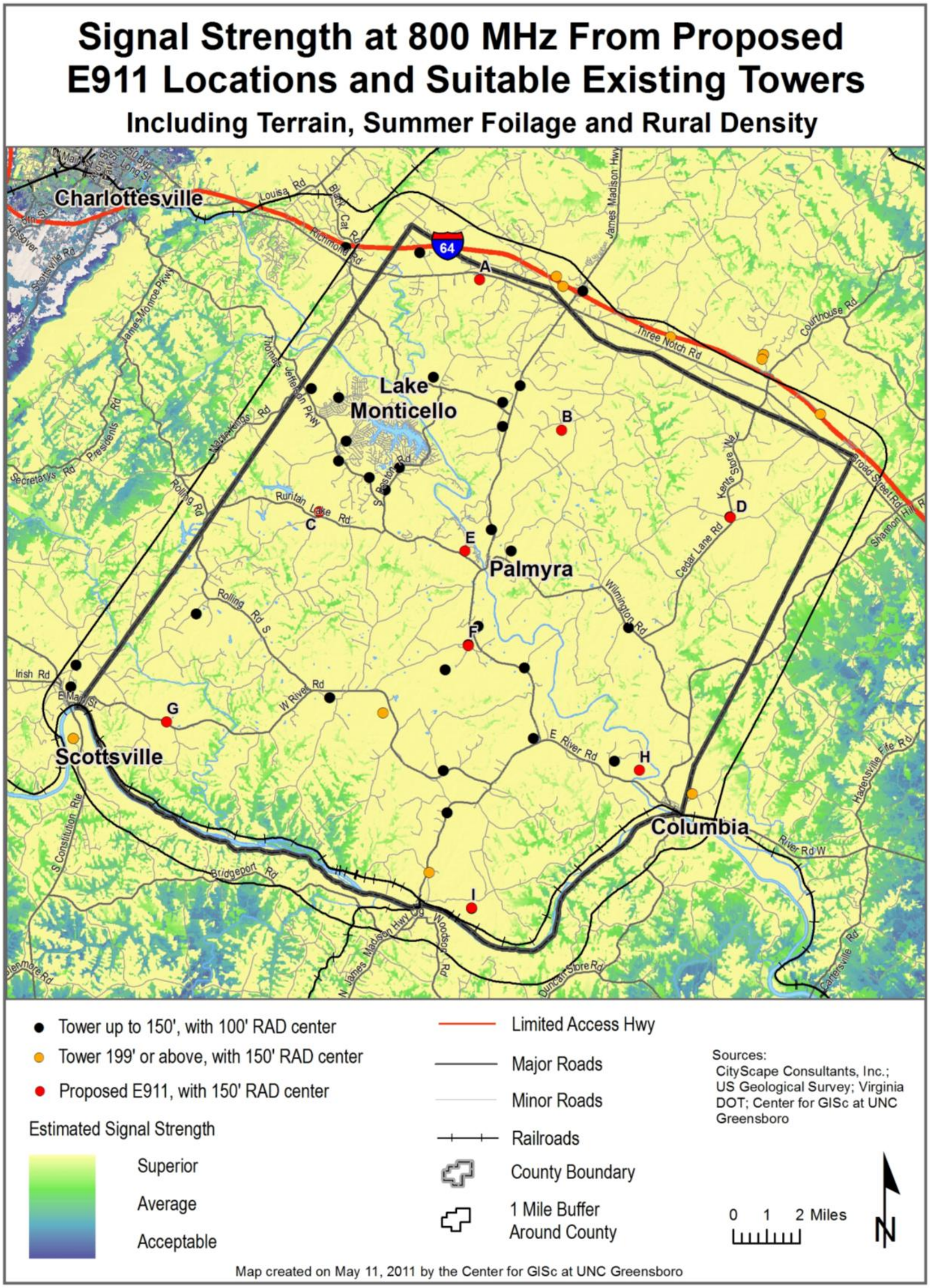


Figure 30: Propagation Map 800 MHz from proposed RCC sites and existing towers

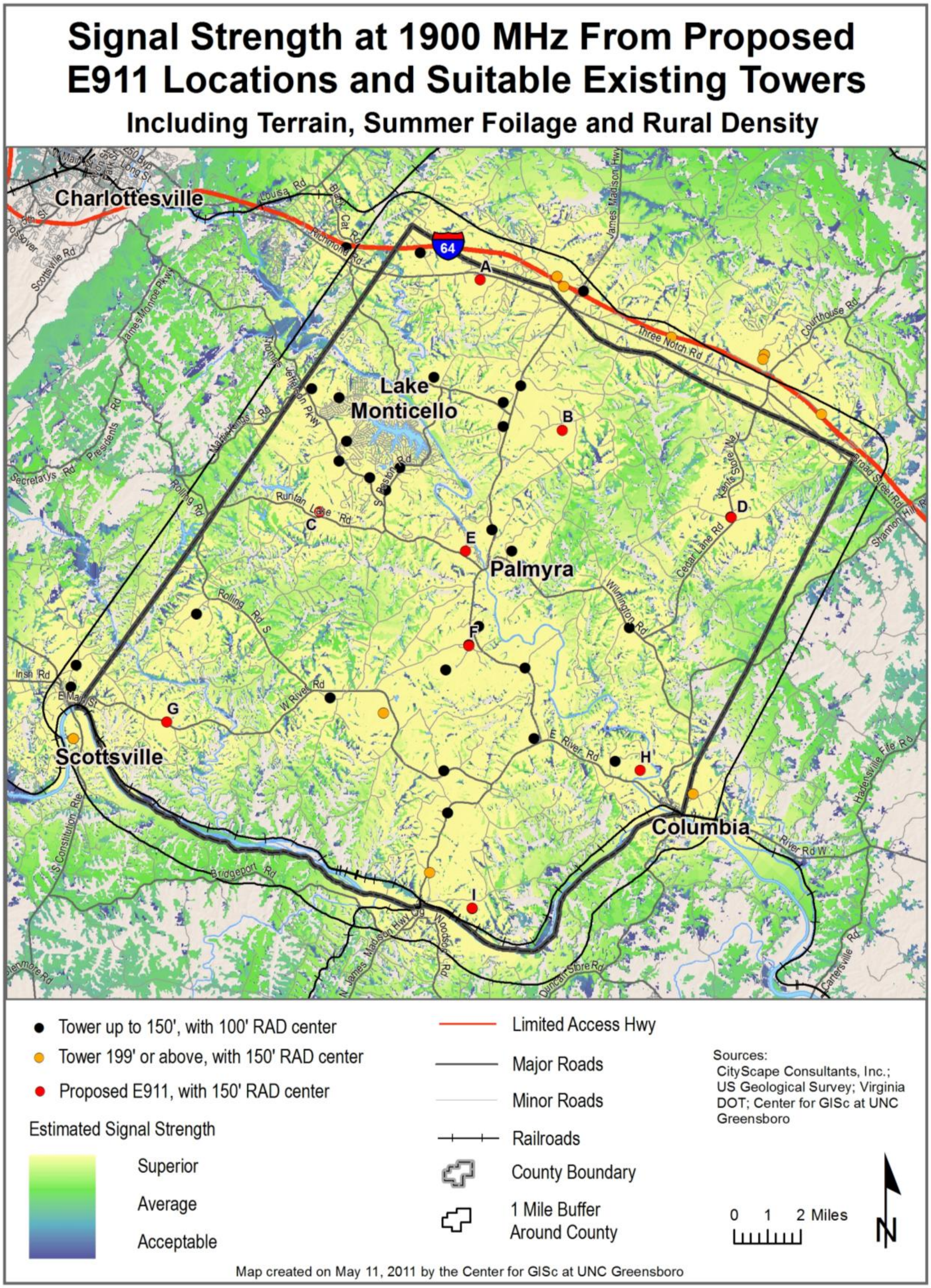


Figure 31: Propagation Map 1900 MHz from proposed RCC sites with 150 RAD centers and existing towers

County-owned properties

The County provided CityScape a list of eleven (11) County-owned properties as potential locations for new wireless telecommunications infrastructure. CityScape went to each property and reviewed the following site development criteria for each location: lot size; accessibility; existing and adjacent land uses; proximity to existing towers; and potential use of the land for new telecommunications infrastructure. All eleven (11) locations identified were found acceptable for potential future infrastructure. Providing lease space to the wireless telecommunications industry on these properties could gross the County millions of dollars over the next twenty years.

At the public meeting held on April 11, 2011 at the Fluvanna County Public Library the participants reviewed the public land sites and voted on the type of wireless infrastructure they would be willing to support on each property. Table 6 lists the public lands and the winning votes for the type of telecommunications facility the attendees thought best for each site.

Site ID	Location	Suggested Height	Suggested Type of Telecommunication Facility
A	Pleasant Grove Road	>200'	Light Stanchion
B	Palmyra Fire House	≤199'	Monopole
C	Kent Store Fire House	>200'	Monopole
D	Central Elementary School	>200'	Light Stanchion or no pole
E	Carysbrook Complex	≤199'	Light stanchion
F	Columbia Elementary School	≤199'	Light Stanchion
G	Fluvanna County Solid Waste Convenience Center	≤199'	Monopole
H	Omohundro Water Tank	≤199'	Attachment
I	Future Fork Union Fire House	≤199'	Monopole, Slick Stick, or Flag Pole
J	Weber City Water Tank	≤199'	Attachment
K	Weber City/Melton Property	≤199'	Monopole
L	Bremo Bluff Property	>200'	Faux Fire Tower
M	Bottom Road Property	>200'	Painted Monopole

Table 6: Public land listing

The County-owned properties are listed in Table 6 and shown in Figure 32.

In effort to improve 1900 MHz network coverage in Figure 31, CityScape added the use of identified publicly-owned lands to the study.

The scenario assumes a 199’ tower at each identified public property with an antenna mounting elevation at 150’. Figure 33 indicates certain geographic areas with improved network coverage from the addition of the publicly-owned lands. One reason the coverage improvements appear marginal is that most of the publicly-owned lands already have existing infrastructure on them in the form of an existing tower or water tank.

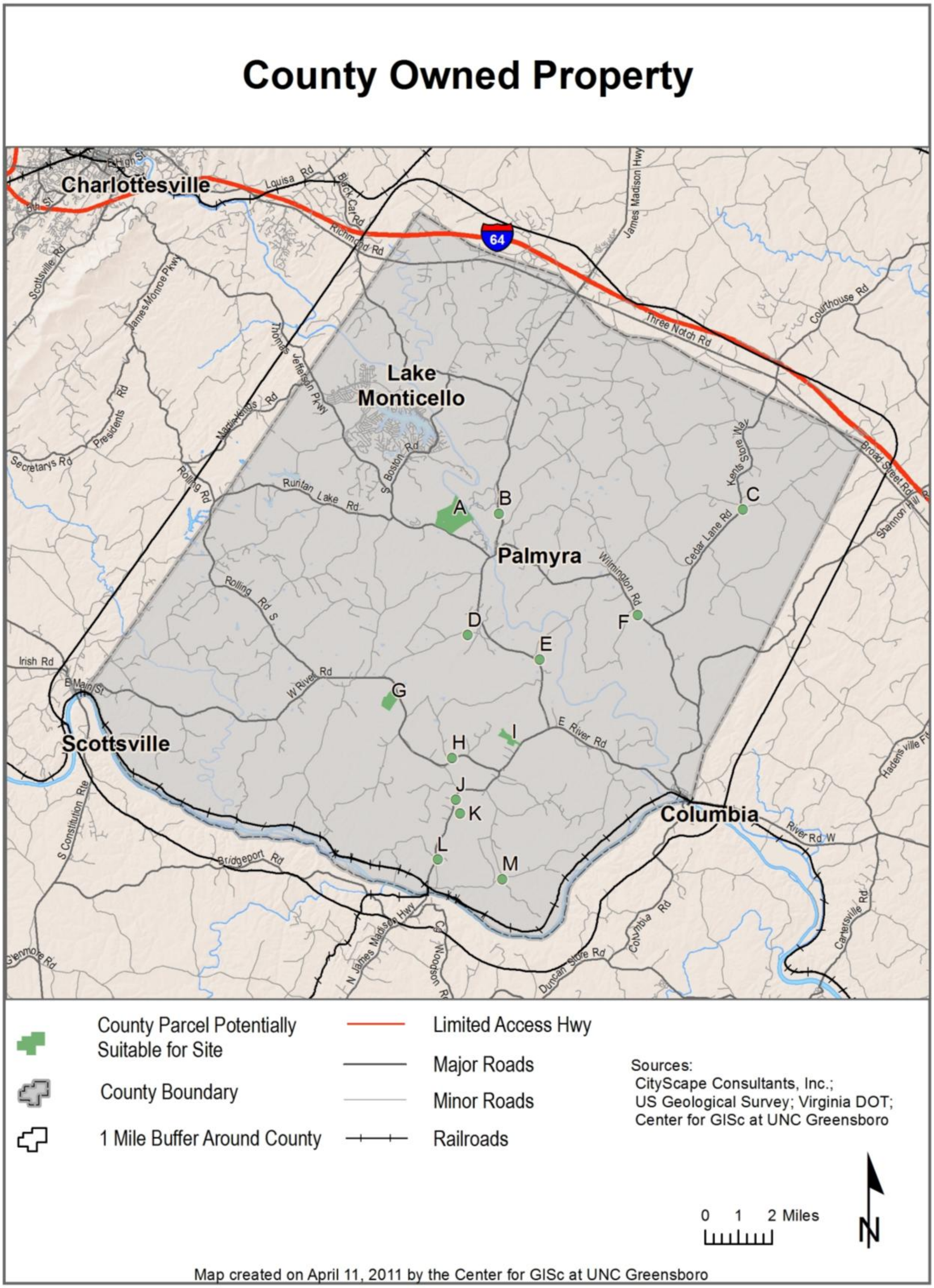


Figure 32: Public Properties

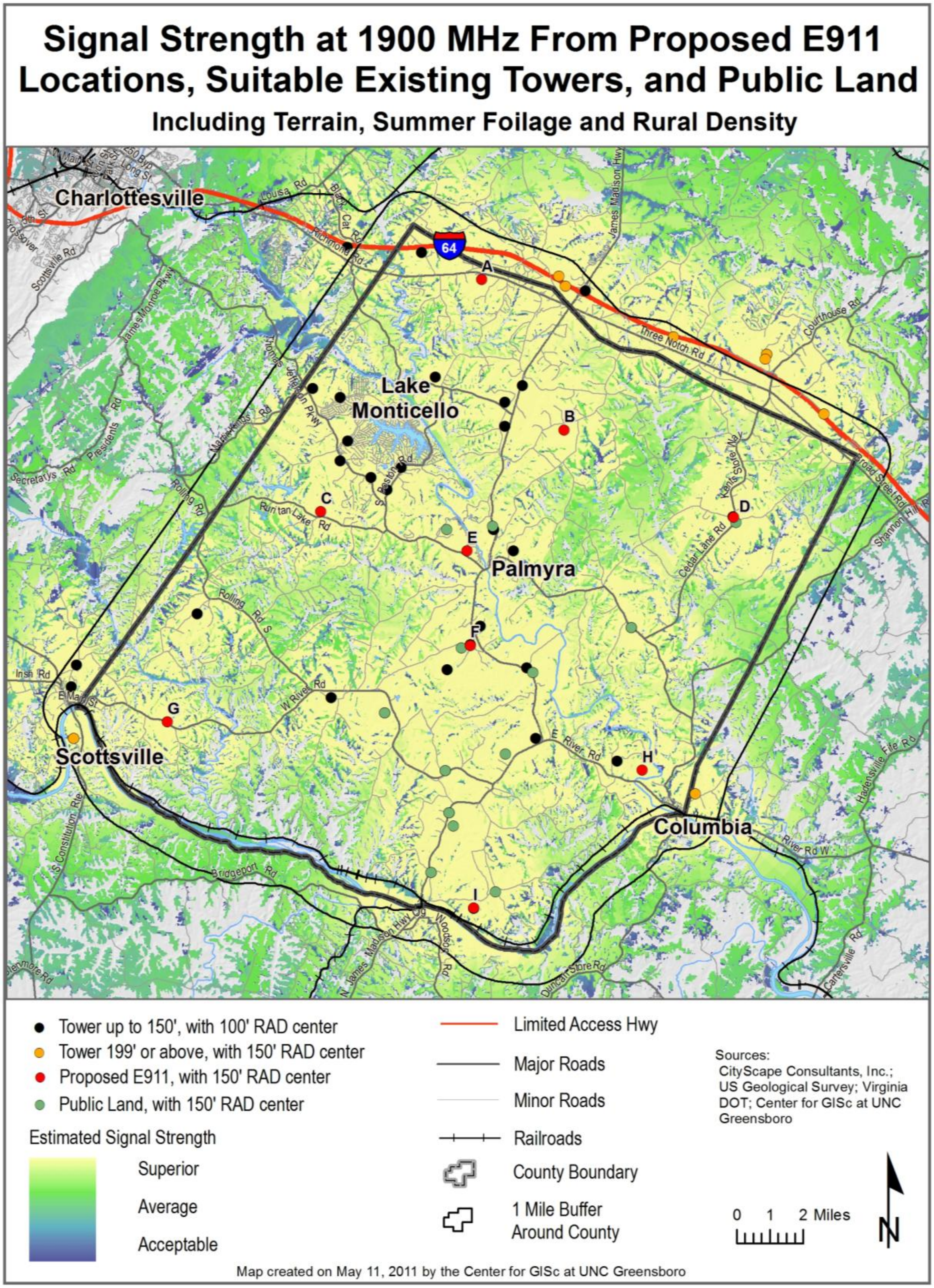


Figure 33: Propagation Map 1900 MHz from proposed RCC sites with 150 RAD centers and existing towers including publicly-owned land

Attempting to improve network coverage predictions for the 1900 megahertz frequencies CityScape changed the tower height and antenna mounting elevations for the nine emergency services towers to 250'. The scenario accounts for antenna mounting elevations (RAD centers) at the 250'; 240'; 230' 220' 210; and 190' locations on each emergency service tower. The propagation for these maps is based on the 190' antenna mounting elevation and shown in Figure 35.

Figure 34 includes the existing towers county-wide up to one hundred and fifty feet in height assuming antenna mounting elevation of 100'; and existing towers in excess of one hundred and ninety-nine feet with an antenna mounting elevation of 150'. Figure 35 also includes the publicly-owned lands with a 199' tower with an antenna mounting elevation at 150'.

Figures 34 and 35 show an improvement in coverage area with the increase in antenna mounting elevation height.

Figure 36 provides a side-by-side comparison of the network coverage maps with the 150' and 190' RAD center elevation variations in the 1900 MHz frequency. The comparison between the two propagation maps illustrates that network gaps are generally the same in both models but the quality of the signal strength is improved from average to superior in the geographic areas of the emergency service towers.

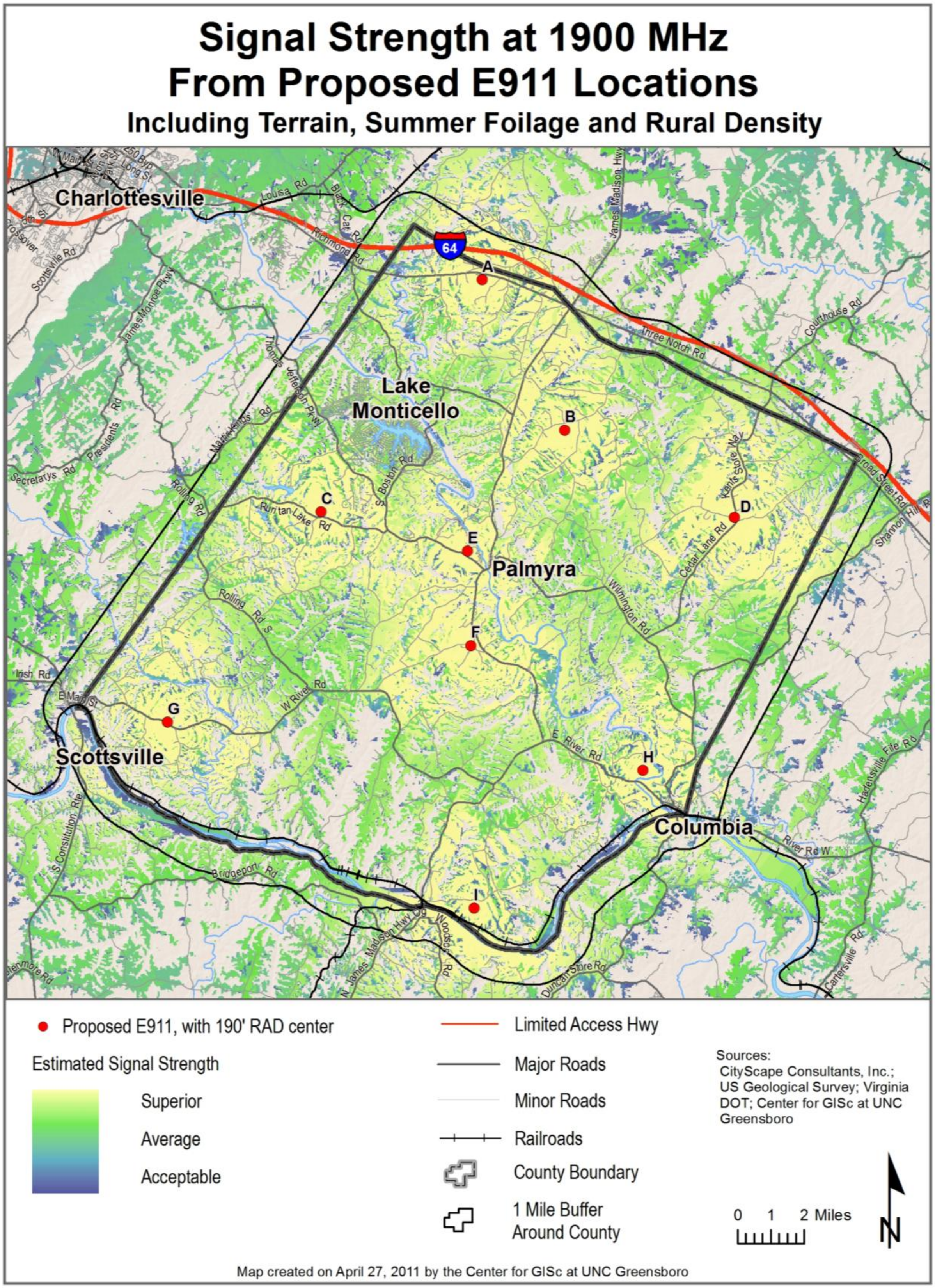


Figure 34: Propagation Map 1900 MHz from proposed RCC sites with 190 RAD centers

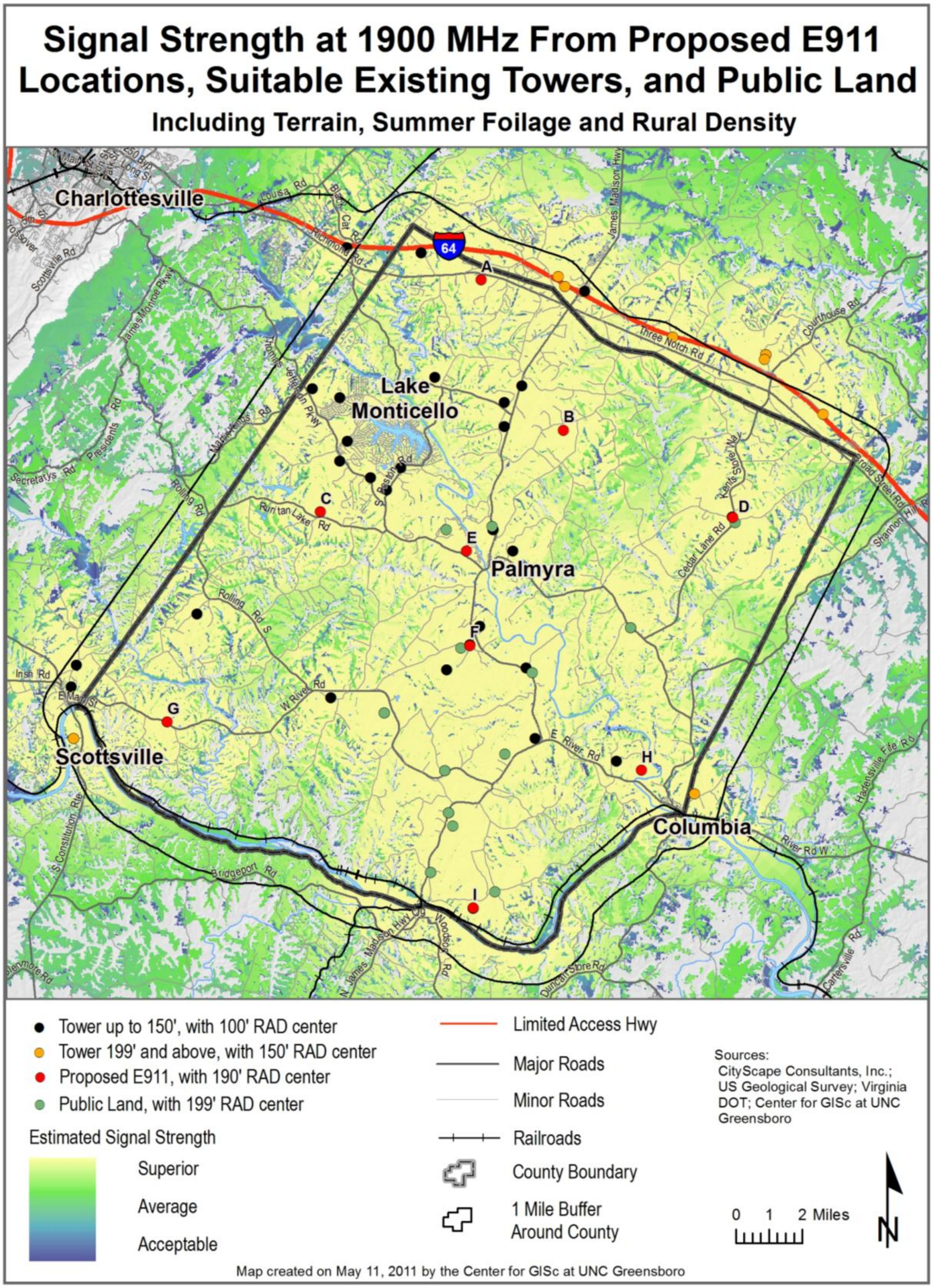


Figure 35: Propagation Map 1900 MHz from proposed RCC sites with 190 RAD centers and existing towers including publicly-owned land

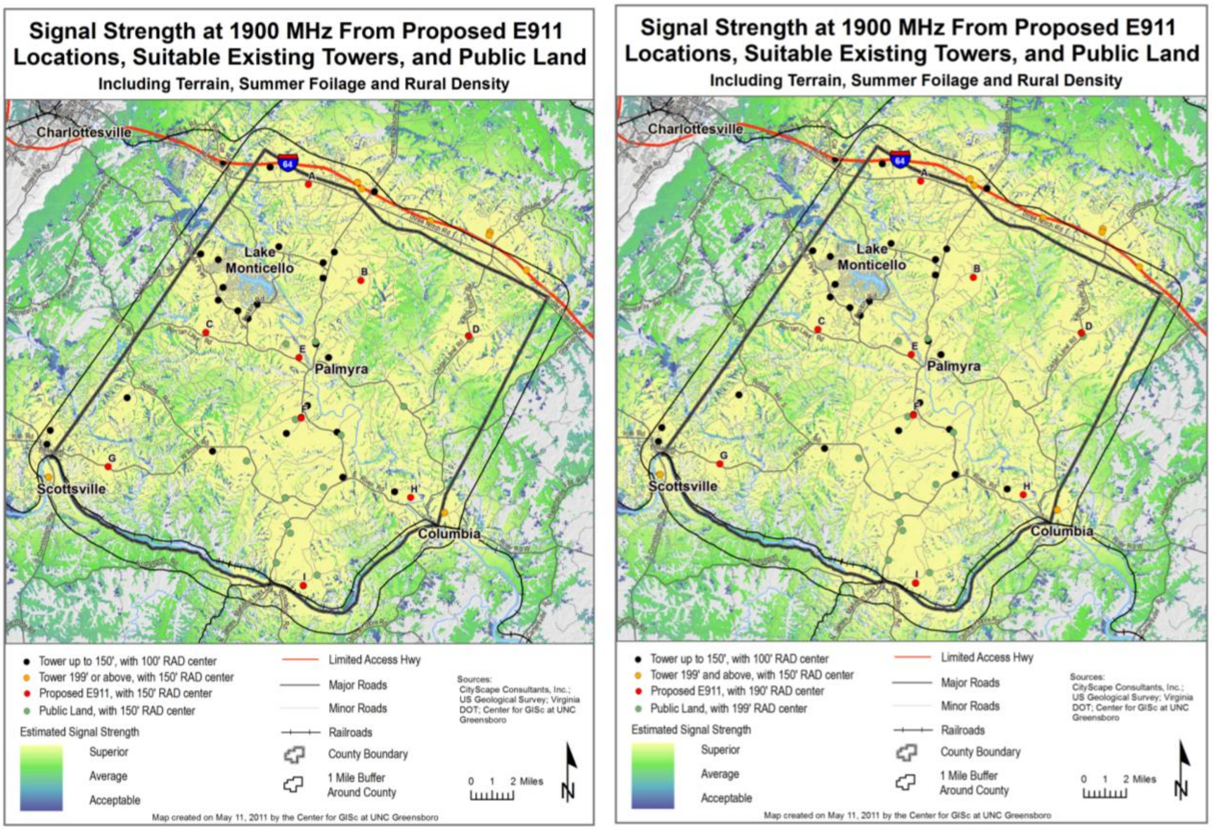


Figure 36: Side by side comparison of propagation maps at 1900 MHz frequency with 150' and 199' RAD centers with existing towers and publicly-owned land

Results of the propagation maps support the use of the existing and proposed emergency services tower locations as described in the RCC Consultants report. The emergency services tower locations are existing or proposed in areas where future wireless telecommunications service providers will also need access. For this reason it is highly probable that the County could benefit from either having certain towers built by the industry; or by having future colocation lease revenues on the emergency service towers - provided these towers are built and managed with this objective.

CityScape recommends the County consider the additional need for service in the geographic area circled on the map in Figure 37. The RCC Consultants maps show this area with marginal service; the 800 MHz frequency maps in this study show marginal service; and the 1900 MHz maps in this study show little and no service.

Figure 38 illustrates the effects of adding a facility in this geographic area (new site J). Also note in Figure 38 the increased tower elevation for RCC's proposed tower "I". In RCC's report this facility is actually proposed to be 330'. Figure 38 illustrates the propagation from that facility from an antenna mounting elevation of 280'.

Zoning observation

Another objective of the propagation analysis pertained to future heights for new wireless telecommunications towers. The increase in tower height from 125’ to 199’ will certainly reduce the overall number of towers needed county-wide by increasing the coverage area from each antenna array and allowing for multiple colocation opportunities on each facility. While the increase in height to 199’ will not require tower lighting, they will have a greater visual impact on the landscape in comparison to the existing towers at 125’. Increasing the tower heights to 250’ will require the towers to have twenty-four hour lighting systems and will help to improve the quality of the wireless network service area; but not necessarily improve gaps in coverage. Additional towers will still be needed in those specific geographic areas regardless of the tower being 199’ or 250’ in elevation.

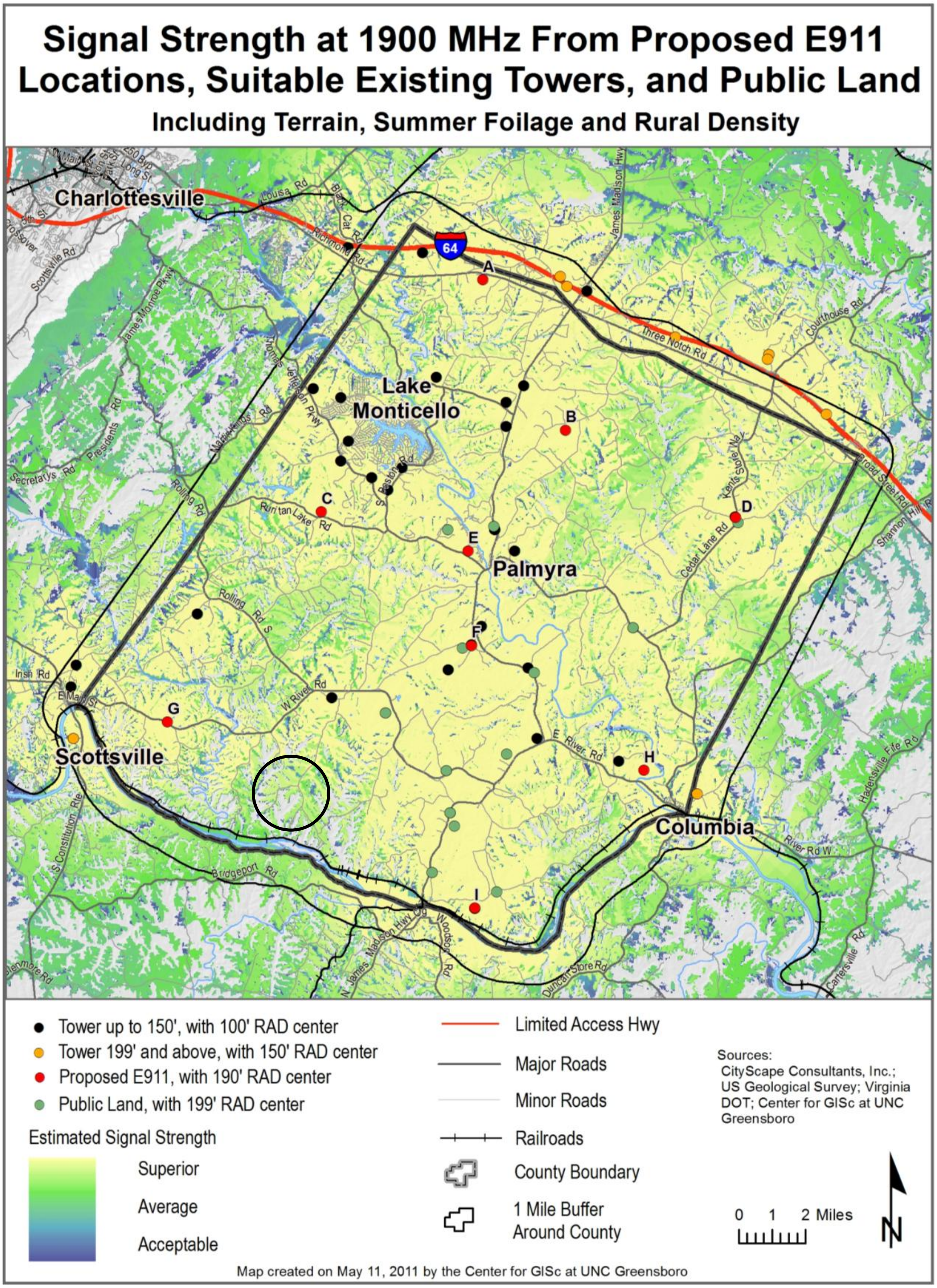


Figure 37: Identification of Geographic Area for Potential Additional Emergency Services Facility

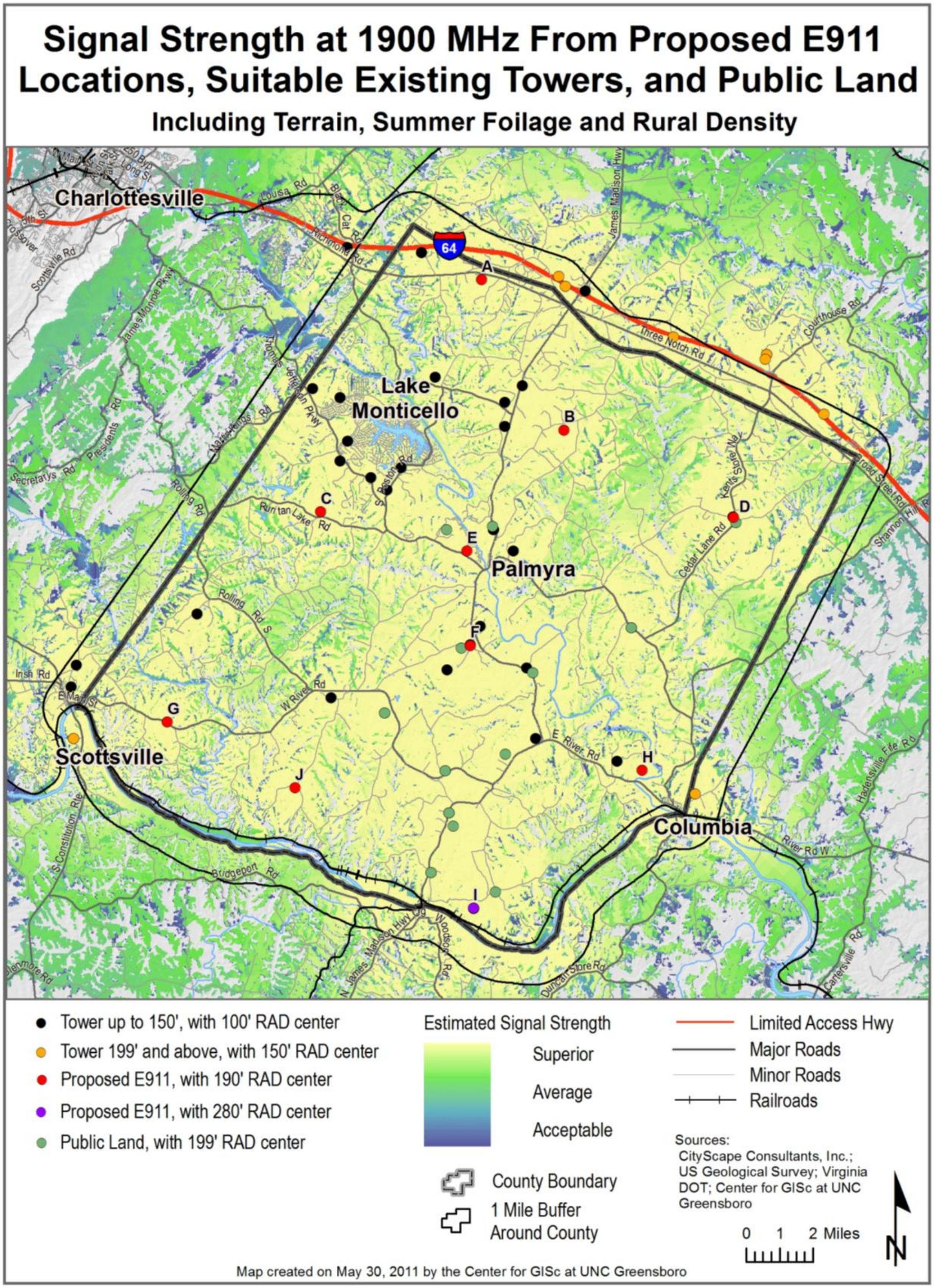


Figure 38: Propagation Map1900 MHz with proposed new site "J"

Chapter 5 Future Infrastructure

Population analysis

Fluvanna County is located in north central Virginia south of Interstate 64, east of Charlottesville, and west of Richmond. According to the United States Census (the Census) the physical size of the County is approximately 287.37 square miles. The Census further estimates the 2009 population for the County at 25,732. This equates to an average of around 70 persons per square mile. The largest population center is Lake Monticello. Figure 39 illustrates the population density by census block group.

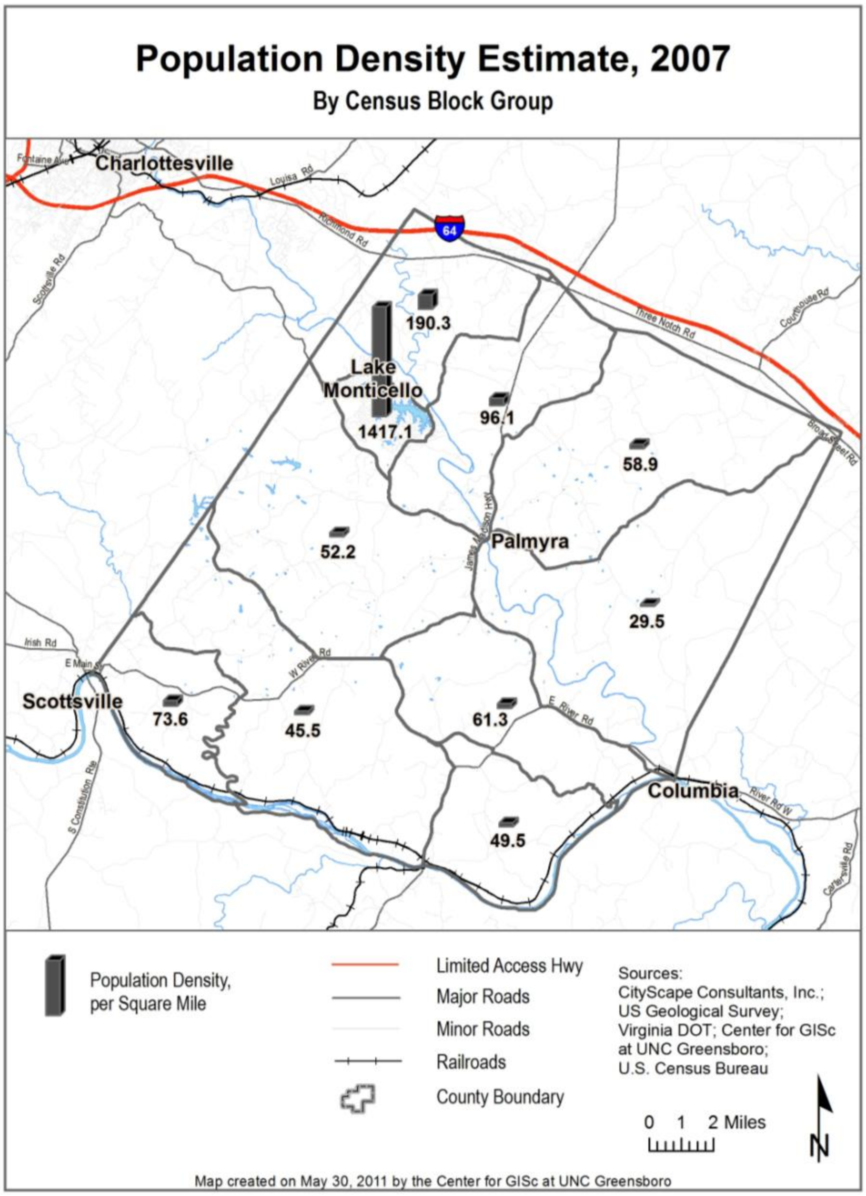


Figure 39: Fluvanna County Population by Census Block Group (2009)

According to the Fluvanna County Comprehensive Plan the population for Fluvanna County increased about 43 percent from 2000 to 2010. A 30 percent increase is projected between 2010 to 2020 equating to an estimated population of 37,433 in 2020 and up to 47,010 by 2030 (34, Comprehensive Plan).

The propagation patterns for 800 MHz are almost complete assuming the same 800 MHz provider utilizes all the existing and proposed emergency services towers for their wireless network. However, the 1900 MHz maps illustrate significant deficiencies in network coverage. The correlation between the more densely populated area with coverage and low population areas with unacceptable or no coverage is well illustrated in propagation maps. This pattern of network coverage relative to population density illustrates common wireless deployment practices. The larger centers of population offer more potential for wireless subscribers. The larger the subscriber base the more quickly the industry can recover the return on their investments. Wireless network to rural areas will improve over time especially with changes in land use and population growth.

Subscribers and wireless network planning

Up to this point the Master Plan has focused on existing wireless base station coverage, however current network coverage is only one aspect of wireless service. The primary objective of the first phase of network development is to create coverage over a large service area. When network coverage is achieved wireless service providers begin to monitor the number of calls. Once the number of simultaneous calls consistently reach “x” (a predetermined maximum number), and the facility cannot support the subscriber base, the wireless network exceeds the capacity design of the system. Exceeding network capacity equates to overloading the network which results in lost service, dropped calls, rapid busy signals, and the inability to make calls. To overcome problems caused by over-capacity challenges, additional antenna and base stations are required.

Carriers use varying methods for maintaining a sufficient level of service for their network design such as base population estimates. Usually it is derived from a projected number of people within reach of a base station. As network penetration levels increase and the duration of calls grows longer, carriers will reduce the projected number of people within reach of a base station, therefore shrinking size of the subject cell which creates the need for additional "drop-in" facilities.

According to 2009 data the federal penetration rates of subscribers with wireless telephone service for the United States indicate a level of around 77 percent. Cell phone service was projected to increase to about 80 percent by the end of 2010, and may exceed that with the success of “smartphones.”

Carriers use base population estimates for their network design. Population density is what controls the separation distance between base stations. The existing network design, based on local wireless penetration rates and usage, has each site facilitating the use of between 1750 and 2500 separate devices. As wireless devices increase in number *and* usage (particularly more intensive bandwidth usage like email, facebook, and mobile tv), each site will need to *decrease* its geographic area and serve a smaller number of subscribers in order to avoid overloading its systems. In other words, a projection of 1750 to 2500 users per site will shrink significantly over the next 10 years, with estimates ranging from 500 to 1200 devices per site, depending on the particular carrier, services offered, and number of overall subscribers. Concurrent with the shrinkage of number of users per site will be an increase in the total number of sites needed in order to provide service to subscribers.

Wireless broadband

Wireless broadband is analogous to the communications of voice via wireless phones but for the transmission of high speed wireless data. Wireless broadband is the transfer of data (wireless internet) via radio waves between computers, hand held wireless phones and other wireless devices. First generation (1G) wireless deployments launched the analog hand held phones operating in the 800 MHz frequency. Second generation (2G) wireless deployments launched the digital wireless voice network in the 800 and 1900 MHz frequencies. Third and fourth generation (3G and 4G) wireless deployments add the capability of wireless data networks generally in the 700 and 2400 MHz frequencies, although many carriers are using their designated voice channels for broadband.

Traditional service providers such as AT&T, Verizon, and Sprint/Nextel have added wireless broadband to their platforms. Newer wireless handsets (phones) can communicate both voice (phone) and access the internet (broadband). Additionally there are service providers like Clear Wire, Cricket, Next Generation, Frontier, and other smaller regional services whose business plan is to provide wireless internet (broadband) to its subscriber base as an alternative to Roadrunner or other local cable and dial up internet providers.

The infrastructure for wireless broadband is similar to that in use for wireless phones; i.e. elevated antenna with a base station for each service provider. The base station foot print for wireless broadband is smaller in comparison due to the limited spectrum and operating frequency available from the Federal government for the wireless broadband industry. For example to cover a geographic area of approximately five square miles the following would be required:

- 1G – Analogue - 1 cell site
- 2G – Cell phone - Digital TDM – 6 cell sites
- 3G – Smart phone - Digital CDMA – 14 sites
- 4G – Universal personal communicator devise - Digital CFDM or LTE - 36 sites

Complete fourth generation broadband network deployment is anticipated to begin in 2013 beginning in the urban markets.

Future tower site projections through 2010

Each wireless phone and/or broadband network has unique deployment needs, and might need antennas at varying heights. Just because one provider locates on a building, does not mean that building height will work for the next provider. Additionally, the rapid change in how people are using technology will continue to impact the existing network infrastructure. More and more devices on the market can transfer data via cell signals (Kindles, iPads, Nintendo DS, etc.) The addition of wireless objects such as these coupled with the ongoing popularity of text messaging will require new antenna locations not due to increased wireless network traffic, but the evolvement of high speed wireless broadband devices, even with a stagnant population.

As a result of the present growth models and the current wireless market penetration rate, along with the rate of wireless network evolution from 3G to 5G, CityScape's prediction for future antenna deployment is based on network growth from the existing antenna locations. Each year in the future the number of new colocations, antenna attachments, and tower facilities will vary. Subscriber demand on the network will control future deployments.

To effectively and efficiently provide network coverage County-wide over the next ten years, CityScape anticipates it will require about 22 to 25 new antenna support facilities to provide a comprehensive network to fill in the service coverage and capacity gaps. Table 7 generally describes the breakdown of proposed facilities.

Approximate new facility projection	**General description of anticipated locations**
9	Proposed RCC Consultants emergency service locations
1	Proposed additional emergency service by CityScape Consultants
5	Publicly-owned lands presently void of an existing antenna support structure
4	Proposed telecommunication facilities in residential areas at approximately 150' in height.
14	Proposed telecommunication facilities in rural areas at approximately 199' in height.
22	**Total**

Table 7: Explanation of proposed in-fill telecommunication facilities

Yearly population increases cannot be anticipated to be evenly divided as customer demand on the network will control future deployments. As a rule of thumb the County could anticipate an average (of any combination) of approximately two new tower sites and/or two to four colocations and/or antenna attachments per year over the next ten years. This estimation is based on the mathematics of the population density; subscriber base and usage; transient movement through the County, and how many calls a base station can simultaneously serve at any given time.

This projection model is based on various new tower heights keeping in mind aesthetic concerns while allowing for maximum colocation opportunities and the reduction of multiple towers within the same geographic search areas. The geographic areas of where these new facilities are projected are shown in Figure 40.

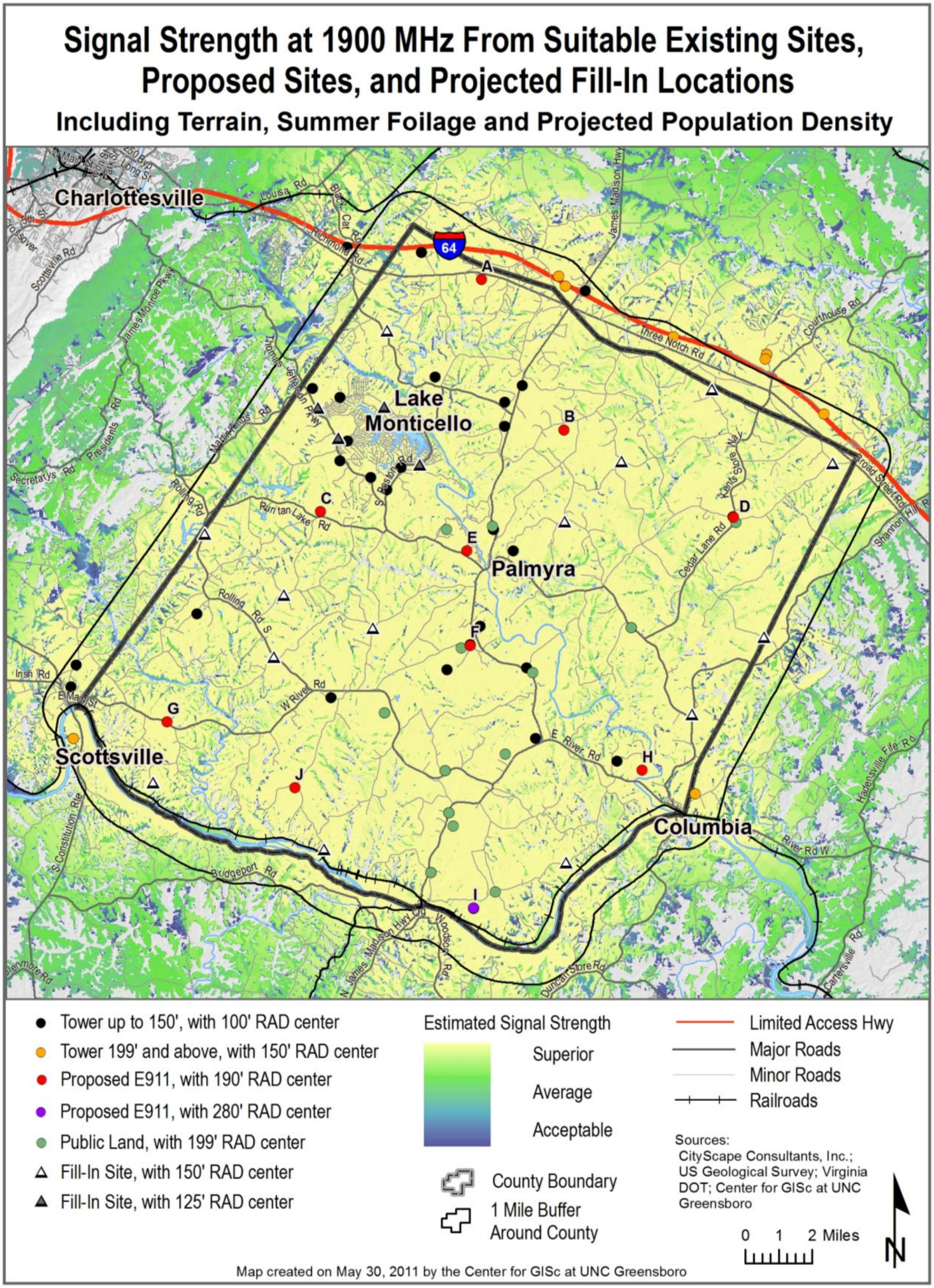


Figure 40: **Projected new infrastructure infill sites**

Chapter 6 Zoning

Zoning Analysis

CityScape has reviewed Article 17. entitled, General Provisions Sec. 22-17-14 and 14.1 relative to how the County currently regulates communication towers and offers the following comments.

Height: The current policy sets a 125 foot height maximum for new towers. This elevation limits network service coverage areas and limits the number of colocation opportunities on the tower. It is likely the industry will choose to develop facilities in other localities where they can get a return on investment. The current policy allows for taller towers to facilitate colocation but the vast majority of the towers in the County are less than 130 feet in height which sends a warning to the industry that taller towers may not be approved. Tower heights should be increased to allow for improved network coverage and increased opportunity for colocations.

Broadcast facilities: The existing Ordinance does not separate radio broadcasting towers and antennas from wireless telecommunications facilities. Yet the two land uses are different. There are specific regulatory requirements through the 1996 Federal Telecommunications Act that apply only to wireless telecommunications and broadcast facilities and not vice versa. Land use development standards for broadcast facilities should to be addressed separate from wireless telecommunications.

Land Use Development Standards: CityScape has attended two public meetings and met with County staff and citizenry to discuss wireless telecommunication deployment practices, goals and objectives. Based on the feedback from those meetings CityScape can affirm the following:

- Monopole tower structures are the highly preferable non-concealed tower type option; and
- Monopoles painted dark brown, deep green or black, flag poles (with and without the flag) and light stanchions are the concealed highly preferable favorites; and
- Use of utility distribution poles and utility right-of-way for new towers and colocations is highly preferable; and
- Locating new non-concealed telecommunications facilities in commercial and office districts and on public property is highly preferable over allowing new towers in residential districts; and
- Allowing concealed facilities Countywide is more highly preferable to non-concealed towers; and
- Improving infrastructure for emergency services ranked very important; and
- Protecting the visual impacts and appearances of the towers is also very important; and
- Prioritizing locations for new towers is ranked very important; and
- Minimizing site disturbances and keeping existing vegetation is very important.

Sec. 22-17-14 does not sufficiently address these land use development standards for new wireless telecommunications infrastructure. The existing policy is vague and uses terminology like "single poles" and "substantial detriment" which are non-industry terms and arbitrary in nature, respectively. CityScape suggests that detailed development standards addressing the bulleted items be added to the zoning ordinance. Pictures of the types of preferred facilities are pictured below.

Monopole

Flag Pole

Light Stanchion

Slick Stick

Painted Monopole

Hierarchy recommendation A Siting Hierarchy is a zoning tool to encourage the use of existing antenna support structures, and the use of publicly owned property for future telecommunications infrastructure. Providing a Siting Alternative Hierarchy is one way to encourage the use of existing facilities and county-owned properties as locations for new wireless telecommunications infrastructure. Adding the hierarchy of preferable infrastructure options also addresses the visual and locational preferences of future network installations. The siting hierarchy below is based on the feedback received from the attendees at the public meetings.

Siting hierarchy. Siting of a new antenna array or new TASF shall be in accordance with the preferred siting hierarchy in the order outlined below. All siting options are preferred to be located on publicly-owned property, as identified in the County's Telecommunications Master Plan, as a first option. The location of antenna array or other facilities on non publicly-owned property is acceptable as a secondary option within each category.

(1) Concealed attached antenna

(2) Colocation; antenna modification; combined antenna(s) on existing TASF

(3) Colocation or new TASF in utility right-of-way

(4) Non-concealed attached antenna

(5) Replacement of existing TASF

(6) Mitigation of existing TASF

(7) Concealed freestanding TASF

(8) Non-concealed freestanding TASF
- (a) Monopole
- (b) Lattice
- (c) Guyed

The order of ranking preference, highest to lowest, shall be from 1 to 8c. Where a lower ranked alternative is proposed, the applicant must file relevant information as indicated in the development standards in this Article including, but not limited to, an affidavit by a radio frequency engineer demonstrating that despite diligent efforts to adhere to the established hierarchy within the geographic search area, higher ranked options are not technically feasible, practical or justified given the location of the proposed TASF.

The order of ranking preference, highest to lowest, shall be from 1a to 8b(iii). Where a lower ranked alternative is proposed, the applicant must file relevant information as indicated in the development standards in this Article including, but not limited to, an affidavit by a radio frequency engineer demonstrating that despite diligent efforts to adhere to the established hierarchy within the geographic search area, higher ranked options are not technically feasible, practical or justified given the location of the proposed telecommunications facility.

Telecommunications Facility Permitted Use Table: A permitted use table that organizes the type of infrastructure permitted within the different zoning districts and the process by which the request would be submitted for review is helpful to all stakeholders. The permitted use table below is based on information received from the public meeting attendees.

Siting Preference Table							
Zoning Districts	**Permitted Telecommunications Facilities & Level of Development Standards**						
	Amateur Radio Facility & Comparable Antenna Element Replacement	Concealed Attached; Antenna Colocation, Antenna Modification; Noncomparable Antenna Element Replacement, Combining; and Non-concealed Attached Antenna	Replacement Antenna Support Facility	Mitigation of Existing Antenna Support Facility	Concealed Freestanding Antenna Support Facility	Non-Concealed Freestanding Antenna Support Facility	Broadcast Facility
A-1	B	B	B	S	B	S	S
R-1	B	B	B	S	B	S	Not allowed
R-2	B	B	B	S	S*	Not allowed	Not allowed
R-3	B	B	B	S	S*	Not allowed	Not allowed
R-4	B	B	B	S	S*	Not allowed	Not allowed
B-1	B	B	B	S	B	S	Not allowed
B-C	B	B	B	S	B	S	Not allowed
I-1	B	B	B	S	B	S	S
I-2	B	B	B	S	B	S	S
MHP	B	B	B	S	B	Not allowed	Not allowed
PUD	B	B	B	S	B	S	S

B: By Right – Administrative
S: Special Use Permit – Public Hearing Process
S* Any mitigation of an existing SUP requires an amendment through the SUP process

County-owned properties recommendation: The County intends to lease county-owned land, towers and water tanks for future wireless telecommunications infrastructure. The practice of installing infrastructure on publically-owned sites is common throughout the United States and is rooted in the enabling text of the federal legislation that revolutionized the wireless communications industry, the Telecommunications Act of 1996 (the Act).

Legal Opinion

The opinions provided herein relate solely to federal law and FCC decisions and regulations specifically and do not relate to any applicable state or local regulation. Anthony T. Lepore, Esq., CityScape's Vice President, devotes his practice exclusively to telecommunications issues, is a member of the Florida and Massachusetts Bars and is qualified to practice before the Federal Communications Commission.

The Act requires local governments to treat wireless telecommunications providers (who provide functionally equivalent services) equally and that those governments not enact regulations that hinder or prevent the development and provision of wireless services to consumers. Those provisions of Section 704 of the Act are well known, but lesser known sections provide that the federal government makes available property for wireless facilities stating in part:

> *"(c) AVAILABILITY OF PROPERTY- Within 180 days of the enactment of this Act, the President or his designee shall prescribe procedures by which Federal departments and agencies may make available on a fair, reasonable, and nondiscriminatory basis, property, rights-of-way, and easements under their control for the placement of new telecommunications services that are dependent, in whole or in part, upon the utilization of Federal spectrum rights for the transmission or reception of such services. These procedures may establish a presumption that requests for the use of property, rights-of-way, and easements by duly authorized providers should be granted absent unavoidable direct conflict with the department or agency's mission, or the current or planned use of the property, rights-of-way, and easements in question. Reasonable fees may be charged to providers of such telecommunications services for use of property, rights-of-way, and easements. The Commission shall provide technical support to States to encourage them to make property, rights-of-way, and easements under their jurisdiction available for such purposes" (emphasis added).*

Clearly, the congressional intent behind this language was to enable the utilization of Federal property for wireless services and to encourage state and local governments to make public property available for wireless purposes. The FCC interpreted the language in its *Wireless Siting Fact Sheet #1* (April 23, 1996)[1] to mean: "Federal agencies and departments will work directly with licensees to make federal property available for this purpose, and the FCC is directed to work with the states to find ways for states to accommodate licensees who wish to erect towers on state property, or use state easements and rights-of-way".

However, there is no federal telecommunications regulation prohibiting the extent to which a city, county or town desires to regulate the placement of wireless communications facilities to *favor* public property over private property. Indeed, based on the foregoing language, it would appear that Congress' intent is to encourage siting on public property. Of course, if the effect of such a provision were to prevent the implementation of wireless services (for example, by mandating that a provider had to construct on public property and there was no public property available in the geographic search ring for the proposed facility), then such regulation would have the effect of prohibiting wireless services and that could be a violation of the Act.

Leasing public lands for purposes of new wireless infrastructure can create new sources of public revenue. As new sites are developed on public land, the community generates lease revenue from that tower owner and tenant. Some communities are generating millions of dollars over the term of multiple contracts just from leasing public facilities to the wireless service providers. This revenue is created without bonds and without an increase in state and local taxes.

Ordinance revisions are intended to limit the visibility of new wireless telecommunications support structures on the landscape, reduce the number of new antenna support structures, and utilize publicly-owned lands for the purposes of wireless infrastructure deployment. Text amendments should also address concerns regarding tower proliferation, and include strategies to control future growth of the wireless telecommunications industry throughout the City.

[1] http://wireless.fcc.gov/siting/fact1.html

Leasing public-owned lands assures the community the preference of concealment materials and technologies presently available to the industry. As public sites are developed, the infrastructure installed becomes the precedent of how future sites should be developed on private land. For example, many “tree towers” and “flag pole” towers are available to the industry, as well as other creative ideas for concealment towers; some are more aesthetically pleasing and more practical than other types. As the local government utilizes these products, their applications become the standard for future tower sites on both public and private land. As public land sites are considered and utilized for these purposes, staff gains invaluable knowledge on how wireless sites are constructed, which will aid them in reviewing and processing future site plan designs and evaluations on both public and private properties. Leasing public lands for purposes of new wireless infrastructure can create new sources of public revenue. As new sites are developed on public land, the community generates lease revenue from that tower owner and tenant.

Ordinance revisions: Rather than amending the existing Article 17 CityScape recommends creating a new Article entitled, “Telecommunications Facilities” which would be a comprehensive zoning tool to manage the telecommunications industry and address the goals and objectives of the Master Plan. The new Article should include industry specific definitions, and land use development standards that support the goals and objectives discussed at the recent public meetings. The Article would likely be lengthy but necessary to promote organized future infrastructure deployments with an emphasis on having future towers built in strategic locations to meet emergency services, wireless phone and wireless broadband objectives.

Chapter 7 Inventory

Purpose of the inventory

Procedure

CityScape conducted an assessment of the existing antenna locations and potential County-owned properties throughout the County by driving to all locations. Data for the assessments was obtained from a number of sources including actual permits obtained from the County for wireless infrastructure, research of FCC registered site locations, direct information from existing wireless service providers and tower owners active in the County, the County GIS, and through actual site visits to each location. County account map references are provided for all antenna support structures and County-owned parcels whose exact location could be verified.

Inventory catalogue existing antenna(s) and towers

Pictures of existing antenna support structures, properties where towers have been approved but not yet built and proposed new infrastructure are included in the inventory catalogue. The site locations are identified numerically on Figure 41. Existing towers are identified by a black dot. White dots represent locations where towers have been approved but not yet built. Water tanks are symbolized by blue dots and orange dots identify sites under consideration.

Structural evaluation

Based on a visual inspection of antenna arrays already on existing antenna support structures, CityScape has made a judgment as to whether each support structure is likely to physically accommodate more antennas. The number of estimated colocations is referenced as future antenna colocation possibilities. The suggested colocation is based on visual observations only. In this consideration, adding antennas equates to adding another wireless antenna platform consisting of several antennas and associated heavy coaxial cable. Prior to mounting new antennas and related equipment, the structure must be examined and analyzed by a structural engineer for its ability to support the proposed addition.

Publicly-owned property

Figure 43 identifies the County-owned property and property owned by the Fluvanna County School Board that could be used for future telecommunications facilities is also included in the inventory. Proposed infrastructure type and height recommendations are provided per the data and information collected from the attendees at the two public wireless telecommunications workshops.

Site photographs

Photographs of both inventories are provided following the corresponding Figures 41 and 42.

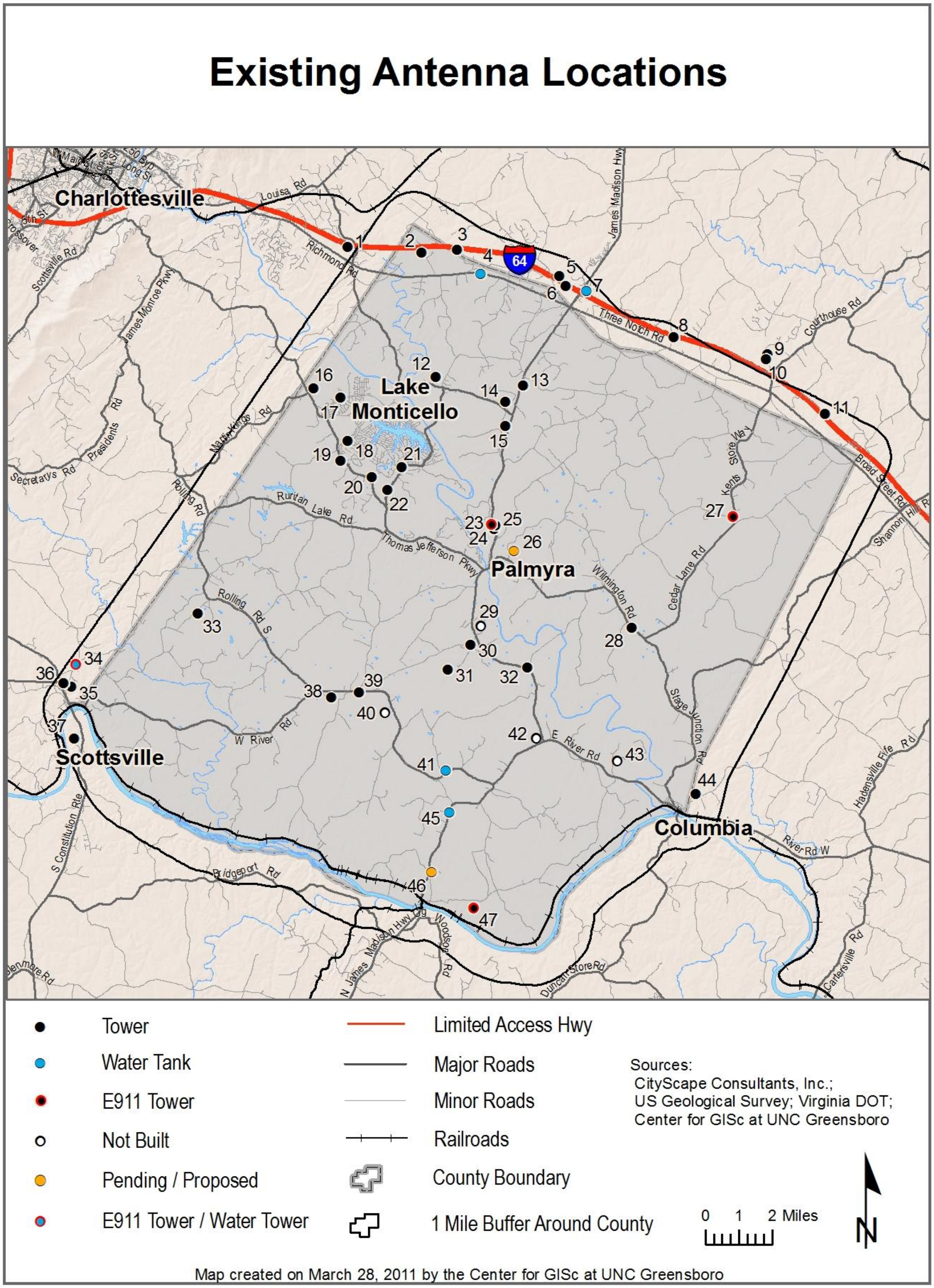


Figure 41: Existing Wireless Telecommunications Inventory

Inventory

SITE LOCATION 1
Crown Castle International
FCC #: N/A
CCI ID: 816316
Rt. 20 (Albemarle County)
Latitude: 37-59-48.98 N
Longitude: -78-20-30.8 W

Height: 149'
Type: Lattice
Future Capacity: 0-1

SITE LOCATION 2
American Tower Corporation
FCC #: 1004677
ATC ID: 99354
CO SUP: 96-05
2038 Beaver Dam Road
Latitude: 37-59-40.29 N
Longitude: -78-18-3.97 W

Height: 125'
Type: Monopole
Future Capacity: 2

SITE LOCATION 3
Crown Castle International
FCC #: N/A
CCI ID: 861959
532 Edd Ridge Lane (Louisa County)
Latitude: 37-59-44.72 N
Longitude: -78-16-54.25 W

Height: 190'
Type: Monopole
Future Capacity: 4

SITE LOCATION 4
Commonwealth of VA
Water Tank
FCC #: N/A
2130 Richmond Road

Latitude: 37-59-6.1 N
Longitude: -78-16-8.3 W

Height: Unknown
Type: Water Tank
Future Capacity: 0 –3

SITE LOCATION 5
Crown Castle International
FCC #: 1055136
CCI ID: 816425
1022 Zion Road (Louisa County)
Latitude: 37-59-3 N
Longitude: -78-13-32 W

Height: 193'
Type: Lattice
Future Capacity: 3

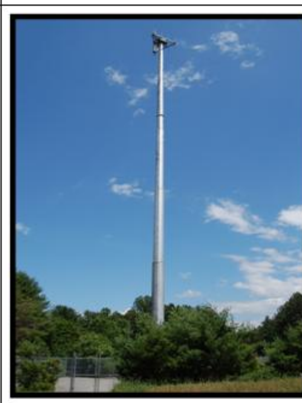
SITE LOCATION 6
Crown Castle International
FCC #: N/A
CCI ID: 849923
306 Zion Road (Louisa County)
Latitude: 37-58-46.99 N
Longitude: -78-13-18.89 W

Height: 190'
Type: Monopole
Future Capacity: 4

SITE LOCATION 7
Louisa County
FCC #: N/A
Zion Cross Road (Louisa County)

Latitude: 37-58-39.36 N
Longitude: -78-12-39.13 W

Height: 135'
Type: Water Tank
Future Capacity: Unsure



SITE LOCATION 8
Crown Castle International
FCC #: N/A
CCI ID: 849845
310 Rock Quarry Road (Louisa County)
Latitude: 37-57-26.92 N
Longitude: -78-9-46.12 W

Height: 190'
Type: Monopole
Future Capacity: 4-5

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

Inventory

SITE LOCATION 9
Crown Castle International
FCC #: 1023616
CCI ID: 814735
488 Land's End Road
(Louisa County)
Latitude: 37-56-59.21 N
Longitude: -78-6-41.46 W

Height: 286'
Type: Guy
Future Capacity: 4-5

SITE LOCATION 10
American Tower Corporation
FCC #: 1018675
ATC ID: 272631
465 Land's End Road
(Louisa County)
Latitude: 37-56-51.72 N
Longitude: -78-6-44.43 W

Height: 200'
Type: Lattice
Future Capacity: 4

SITE LOCATION 11
Crown Castle International
FCC #: N/A
CCI ID: 849853
892 Hasher Road (Louisa County)
Latitude: 37-55-25.51 N
Longitude: -78-4-48.3 W

Height: 194'
Type: Monopole
Future Capacity: 4

SITE LOCATION 12
SBA Towers II LLC
FCC #: 1260692
SBA ID: VA11283
SUP: 07-011
569 North Boston Road
Latitude: 37-56-25.37 N
Longitude: -78-17-36.89 W

Height: 127'
Type: Monopole
Future Capacity: 1-2

SITE LOCATION 13
SBA Towers II LLC
FCC #: 1256578
SBA ID: VA11336-A
SUP: 06-002
18956 James Madison Highway
Latitude: 37-56-11.3 N
Longitude: -78-14-44.7 W

Height: 129'
Type: Monopole
Future Capacity: 1-2

SITE LOCATION 14
Crown Castle International
FCC #: N/A
CCI ID: 804890
SUP: 08-001
215 Poorhouse Lane
Latitude: 37-55-45.83 N
Longitude: -78-15-19.38 W

Height: 124'
Type: Monopole
Future Capacity: 2

SITE LOCATION 15
Alltel
FCC #: N/A
SUP: 95-003
332 Wildwood

Latitude: 37-55-7.88 N
Longitude: -78-15-19.14 W

Height: 105'
Type: Monopole
Future Capacity: 1

SITE LOCATION 16
Alltel
FCC #: 1246776
SUP: 04-005
8200 block of Thomas Jefferson Parkway
Latitude: 37-56-7.8 N
Longitude: -78-21-39 W

Height: 125'
Type: Monopole
Future Capacity: 2

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

Inventory

SITE LOCATION 17
US Cellular Corporation
FCC #: N/A
SUP: 97-012
21 Burns Plaza

Latitude: 37-55-53.63 N
Longitude: -78-20-45.06 W

Height: 120'
Type: Monopole
Future Capacity: 0-1

SITE LOCATION 18
Alltel
FCC #: 1017511
CO SUP: 94-007
397 Jefferson Drive West

Latitude: 37-54-45.3 N
Longitude: -78-20-30.7 W

Height: 125'
Type: Monopole
Future Capacity: 2

SITE LOCATION 19
Crown Castle International
FCC #: N/A
CCI ID: 801477
SUP: 00-0010
6021 Thomas Jefferson Parkway
Latitude: 37-54-14.28 N
Longitude: -78-20-45.51 W

Height: 134'
Type: Monopole
Future Capacity: 1

SITE LOCATION 20
US Cellular Corporation
FCC #: 1246097
SUP: 03-008
4878 Thomas Jefferson Parkway
Latitude: 37-53-48.4 N
Longitude: -78-19-44.3 W

Height: 125'
Type: Monopole
Future Capacity: 2

SITE LOCATION 21
Roundtop Ltd Partners
FCC #: N/A
SUP: 03-010
21 Centre Court

Latitude: 37-54-3.7 N
Longitude: -78-18-44.3 W

Height: 125'
Type: Monopole
Future Capacity: 2

SITE LOCATION 22
Crown Castle International
FCC #: N/A
CCI ID: 801478
SUP: 00-006
509 Boston Road
Latitude: 37-53-28.92 N
Longitude: -78-19-12.54 W

Height: 122'
Type: Monopole
Future Capacity: 2

SITE LOCATION 23
Fluvanna County
FCC #: N/A
SUP: 92-011
14455 James Madison Highway
Latitude: 37-52-26.52 N
Longitude: -78-15-42.08 W

Height: 195'
Type: Monopole
Future Capacity: 2-3

SITE LOCATION 24
Fluvanna County School Board
FCC #: N/A
14455 James Madison Highway
Latitude: 37-52-26.5 N
Longitude: -78-15-42.09 W

Height: 145 '
Type: Monopole
Future Capacity: 0

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

Inventory

SITE LOCATION 25
ComCast
FCC #: N/A
14500 James Madison Highway

Latitude: 37-52-29 N
Longitude: -78-15-36.4 W

Height: Not available
Type: Guy
Future Capacity: 0

SITE LOCATION 26
Verizon
FCC #: 1004677
CO CUP: 11-001 Pending
94 Georges Mill Road

Latitude: 37-51-52.89 N
Longitude: -78-15-03.27 W

Height: 125' Proposed
Type: Monopole Proposed
Future Capacity: 3

SITE LOCATION 27
Fluvanna County
FCC #: N/A
SUP: 03-007
0-100 Kents Store Way

Latitude: 37-52-45.05 N
Longitude: -78-7-48.94 W

Height: 125'
Type: Monopole
Future Capacity: 3

SITE LOCATION 28
Fluvanna County School Board
FCC #: N/A

Latitude: 37-49-51.94 N
Longitude: -78-11-10.99 W

Height: Not available
Type: Monopole
Future Capacity: 0

SITE LOCATION 29
Lum, Robert L Trust ET AL
FCC #: N/A
SUP: 03-009
300 block Terre Haute Lane

Latitude: 37-49-54.85 N
Longitude: -78-16-8.9 W

Height: 125' (not built)
Type: Monopole
Future Capacity: 3

SITE LOCATION 30
Fluvanna County School Board
FCC #: N/A
3717 Central Plains Road

Latitude: 37-49-26.18 N
Longitude: -78-16-28.81 W

Height: 140'
Type: Monopole
Future Capacity: 0

SITE LOCATION 31
American Tower Corporation
FCC #: 1017471
ATC ID: 99317
SUP: 94-008
2226 Central Plain Road
Latitude: 37-48-47 N
Longitude: -78-17-14.6 W

Height: 110'
Type: Monopole
Future Capacity: 1

SITE LOCATION 32
Fluvanna County School Board
FCC #: N/A
9172 James Madison Highway
Latitude: 37-48-49.91 N
Longitude: -78-14-37.4 W

Height: 110'
Type: Monopole
Future Capacity: 0

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

Inventory

SITE LOCATION 33
Transco
FCC #: N/A
1300 block Transco Road

Latitude: 37-50-15 N
Longitude: -78-25-28 W

Height: Unknown
Type: Guy
Future Capacity: 0

SITE LOCATION 34
FCC #: N/A

(Albemarle County)
Latitude: 37-48-55 N
Longitude: -78-29-27 W

Height: Unknown
Type: Water Tank
Future Capacity: 1-3

SITE LOCATION 35
Ownership Unknown
FCC #: N/A
AM transmitter
253 Hardware Street
(Albemarle)
Latitude: 37-48-20 N
Longitude: -78-29-37 W

Height: Unknown
Type: Guy
Future Capacity: 0

SITE LOCATION 36
American Tower Corporation
FCC #: 1017514
ATC ID: 99330
253 Hardware Street
(Albemarle County)
Latitude: 37-48-20.6 N
Longitude: -78-29-37 W

Height: 130'
Type: Lattice
Future Capacity: 2

SITE LOCATION 37
US Cellular Corporation
FCC #: 1023035
533 Hancock Mill Road
(Buckingham)

Latitude: 37-46-60 N
Longitude: -78-29-32 W

Height: 400'
Type: Guy
Future Capacity: 0

SITE LOCATION 38
Fluvanna County School Board
FCC #: N/A
479 Cunningham Road

Latitude: 37-48-3.42 N
Longitude: -78-21-3.66 W

Height: 110'
Type: Monopole
Future Capacity: 0

SITE LOCATION 39
Owner unknown
FCC #: N/A
West River Road

Latitude: 37-48-11.2 N
Longitude: -78-20-9.7 W

Height: Unknown
Type: Private Fire Tower
Future Capacity: 0

SITE LOCATION 40
Fluvanna County
FCC #: N/A
SUP: 08-003
11206 West River Road

Latitude: 37-547-39.5 N
Longitude: -78-19-17.93 W

Height: 195' not built yet
Type: Monopole
Future Capacity: 4

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

Inventory

SITE LOCATION 41
Fluvanna County
FCC #: N/A
2900 block Gold Mine Road

Latitude: 37-46-8.84 N
Longitude: -78-17-18.58 W

Height: 147'
Type: Water Tank
Future Capacity: 3

SITE LOCATION 42
Verizon
FCC #: N/a
County SUP: 07-015
7000 block James Madison Highway
Latitude: 37-46-58.84 N
Longitude: -78-14-20 W

Height: 125' not built yet
Type: Monopole
Future Capacity: 2-3

SITE LOCATION 43
Verizon
FCC #: N/A
County SUP: 07-013
200 Bryants Ford Road

Latitude: 37-46-23.26 N
Longitude: -78-11-39.57 W

Height: 125' Not built yet
Type: Monopole
Future Capacity: 2-3

SITE LOCATION 44
National Communication Towers
FCC #: 1264736
2706 Marie Road (Gooch)

Latitude: 37-45-31.3 N
Longitude: -78-9-6 W

Height: 199'
Type: Lattice
Future Capacity: 4

SITE LOCATION 45
Fluvanna County
FCC #: N/A
2900 James Madison Highway

Latitude: 37-45-3.2 N
Longitude: -78-17-11.5 W

Height: 114'
Type: Water Tank
Future Capacity: 3

SITE LOCATION 46
Fluvanna County
FCC #: N/A
County SUP: 08-02 Pending
200 Bremo Bluff Road

Latitude: 37-43-29.82 N
Longitude: -78-17-47.43 W

Height: 195' Proposed
Type: Monopole
Future Capacity: 4

SITE LOCATION 47
Virginia Electric & Power Company
FCC #: 1016964
County SUP: 78-001
2139 Bremo Road
Latitude: 37-42-33.12 N
Longitude: -78-16-23.88 W

Height: 327'
Type: Guy
Future Capacity: 0

■EXISTING OR APPROVED AND NOT BUILT ■WATER TANK ■PROPOSED ■PUBLIC SAFETY

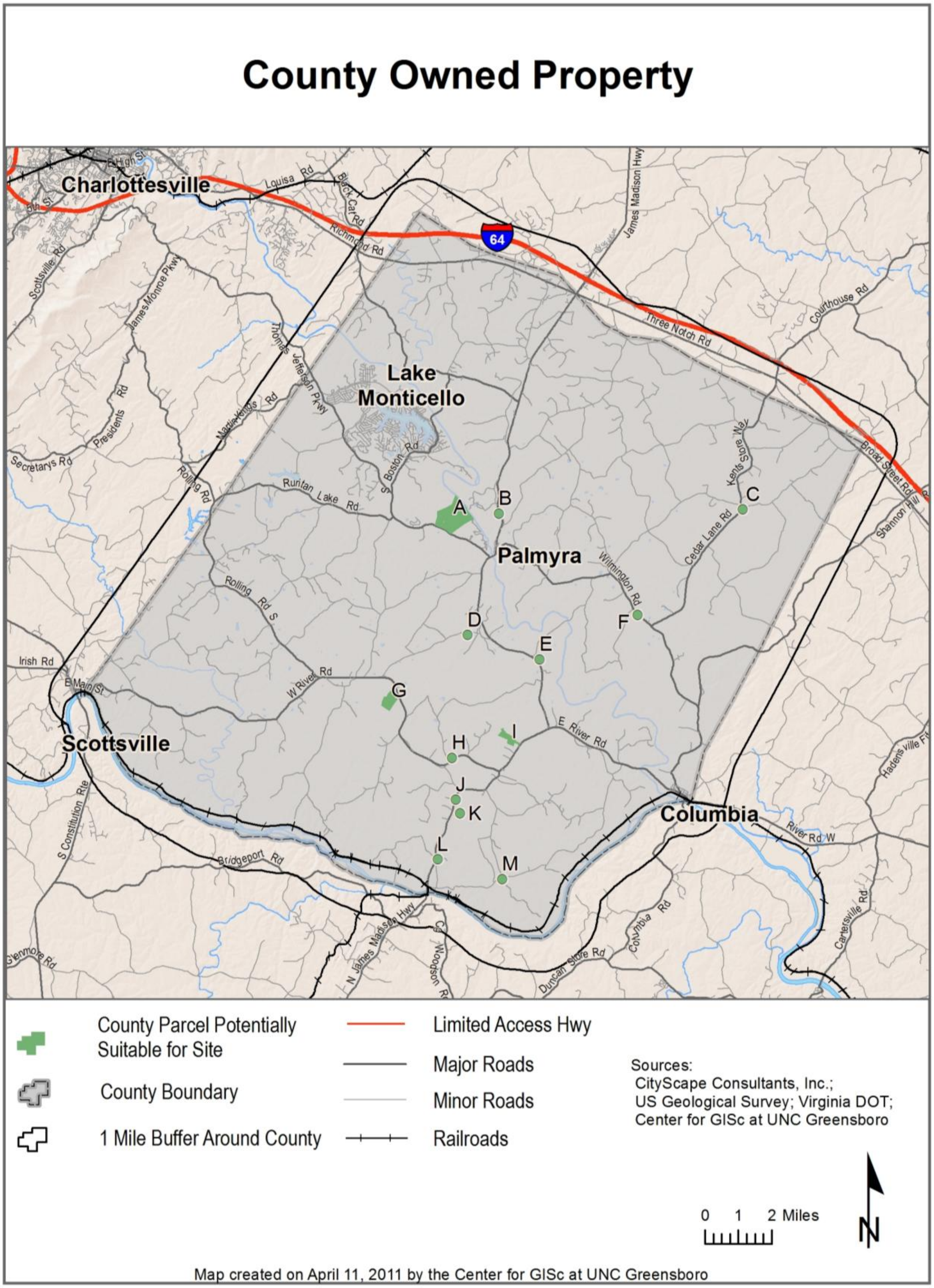


Figure 42: County-owned lands

Public Land Inventory

SITE LOCATION A
Fluvanna County
Address: Pleasant Grove Road
PIN: 30 A 1 & 30 A 3
Zoning: A-1
Planning: Community Planning Areas
Acreage: 508 & 196
Current Land Use: Pleasant Grove Park, Library, Sheriff's Office
Latitude: 37-52-26.65 N
Longitude: -78-17-14.9 W

Proposed Infrastructure Type: Light Stanchion
Proposed Height: >199'

SITE LOCATION B
Fluvanna County
Address: N. James Madison Highway
PIN: 19 A 39B
Planning: Community Planning Areas
Acreage: 3.058
Zoning: A-1
Current Land Use: Palmyra Fire Station
Latitude: 37-52-31.32 N
Longitude: -78-15-44.56 W

Proposed Infrastructure Type: Monopole
Proposed Height: ≤199'

SITE LOCATION C
Fluvanna County
Address: Kents Store Way
PIN: 22 A 62
Zoning: A-1
Planning: Rural Preservation
Acreage: 0.858
Current Land Use: Kent Store Fire Station
Latitude: 37-52-36.52 N
Longitude: -78-7-43.33 W

Proposed Infrastructure Type: Monopole
Proposed Height: >199'

SITE LOCATION D
Fluvanna County School Board
Address: Central Plains Road
PIN: 41 9 2B
Zoning: A-1
Planning: Rural Preservation
Acreage: 29.764
Current Land Use: Central Elementary School
Latitude: 37-49-21.15 N
Longitude: -78-16-46.97 W

Proposed Infrastructure Type: Light Stanchion or no pole
Proposed Height: >199'

■ PUBLICLY-OWNED PROPERTY

Public Land Inventory

SITE LOCATION E
Fluvanna County
Address: N. James Madison Highway
PIN: 42 1 4A
Zoning: A-1
Planning: Rural Preservation
Acreage: 9.100
Current Land Use: Carysbrook Complex
Latitude: 37-48-42.47 N
Longitude: -78-14-25.45 W

Proposed Infrastructure Type: Light Stanchion
Proposed Height: ≤199'

SITE LOCATION F
Fluvanna County School Board
Address: Wilmington Road
PIN: 43 A 22
Zoning: A-1
Planning: Rural Preservation
Acreage: 7.60
Current Land Use: Columbia Elementary School
Latitude: 37-49-51.94 N
Longitude: -78-11-10.99 W

Proposed Infrastructure Type: Light Stanchion
Proposed Height: ≤199'

SITE LOCATION G
Fluvanna County
Address: West River Road
PIN: 40 A 16
Zoning: I-1
Planning: Rural Preservation
Acreage: 100.288
Current Land Use: Convenience Center
Latitude: 37-47-39.5 N
Longitude: -78-19-17.93 W

Proposed Infrastructure Type: Monopole
Proposed Height: ≤199'

SITE LOCATION H
Fluvanna County
Address: Route 6
PIN: 51 A 6
Zoning: A-1
Planning: Rural Preservation
Acreage: 0.519
Current Land Use: Omohundro Water Tank
Latitude: 37-46-8.84 N
Longitude: -78-17-18.58 W

Proposed Infrastructure Type: Attachments
Proposed Height: ≤199'

■ PUBLICLY-OWNED PROPERTY

Public Land Inventory

SITE LOCATION I
Fluvanna County
Address: N. James Highway
PIN: 51 A 129A
Zoning: I-1
Planning: Community Planning Areas
Acreage: 84.528
Current Land Use: Future Fork Union Fire Station Site
Latitude: 37-46-34.45 N
Longitude: -78-15-20.58 W

Proposed Infrastructure Type: Monopole, Slick stick, flag pole, no pole
Proposed Height: ≤199'

SITE LOCATION J
Fluvanna County
Address: Route 15
PIN: 51 A 78
Zoning: A-1
Planning: Community Planning Areas
Acreage: 0.50
Current Land Use: Weber City Water Tank
Latitude: 37-45-3.2 N
Longitude: -78-17-11.5 W

Proposed Infrastructure Type: Attachments
Proposed Height: ≤199'

SITE LOCATION K
Fluvanna County
Address: N. James Madison Highway
PIN: 59 4 2D
Zoning: A-1
Planning: Community Planning Areas
Acreage: 0.326
Current Land Use: Undeveloped
Latitude: 37-44-41.95 N
Longitude: -78-17-3.15 W

Proposed Infrastructure Type: Monopole
Proposed Height: ≤199'

SITE LOCATION L
Fluvanna County
Address: N. James Madison Highway
PIN: 58 A 8B
Zoning: A-1
Planning: Rural Residential
Acreage: 1.67
Current Land Use: Undeveloped
Latitude: 37-43-29.82 N
Longitude: -78-17-47.43 W

Proposed Infrastructure Type: Faux fire tower, Slick stick
Proposed Height: >199'

■ PUBLICLY-OWNED PROPERTY

Public Land Inventory

SITE LOCATION M
Fluvanna County
Address: Bottom Road
PIN: 59 A 68A
Zoning: A-1
Planning: Rural Preservation
Acreage: 0.358
Current Land Use: Undeveloped
Latitude: 37-42-58.81 N
Longitude: -78-15-40.1 W

Proposed Infrastructure Type: Painted monopole
Proposed Height: >199'

■ PUBLICLY-OWNED PROPERTY

Appendix A

"A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance"

Appendix B

"Electromagnetic fields and public health; Base Stations and wireless technologies."