National Park Service
U.S. Department of the Interior

ROCK CREEK PARK
WASHINGTON, DC

Wireless Telecommunications Analysis
Rock Creek Park

August 15, 2007

Printed on recycled paper

Prepared for the National Park Service, U.S. Department of the Interior

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PREFACE

Purpose of the Analysis

The analysis in this report will provide the National Park Service (NPS) with the technical data needed to assist in developing a range of alternatives for the consideration of applications for telecommunications facilities within the boundaries of Rock Creek Park (the park).

The analysis will show:

- The existing service from all licensed service providers individually within the park,
- A composite representation of all service providers combined together, and
- Some technical options the park may use when considering applications for wireless telecommunications facilities.

The following section will describe how the three network deployment methods are designed and planned. For the purpose of this analysis, Enhanced Specialized Mobile Radio (ESMR) operates in the same frequency band as cellular so it will be considered the same as cellular services, and both will be referred to as cellular since the radio frequency (RF) properties are very similar in that band.

Methodology

In developing the methodology for this analysis, the ***"Rock Creek Park, Telecommunications Facilities Environmental Assessment"*** dated April 2, 2003 and information from National Park Services staff were considered, as well as information gathered during meetings with representatives of all the wireless service providers.

The purpose of this analysis is to provide technical information regarding gaps in wireless telecommunications coverage in and around Rock Creek Park to assist the NPS in developing a reasonable range of alternatives for the National Environmental Policy Act (NEPA) process.

This report will provide the park with background information regarding how the wireless system works and how the service providers develop their networks. Background information will also include the developmental stages of wireless system deployment, the three basic types of wireless services, and the limitations of the systems.

In order to determine where service coverage gaps exist, the metholdogy included developing a reasonable representation of each of the provider's current service in and around the park. This information was used to produce a composite overlay map of all the current service areas for all providers for the "pedestrian" or "on street" service level. The wireless industry has three defined levels to identify the quality of service. The highest is the in-building services, which translates to a signal power intensity that should allow for consistent and uninterrupted service. Next is the in-car service level, which is a mid-level signal resulting in consistent communications ability. Last, is the pedestrian or street level service representing a level of wireless service the industry finds representative of meeting its minimum service requirement.

To calculate minimal service requirements, what has to be considered is the various levels of infrastructure deployment and knowledge of particular facilities that can reach an over-capacity situation, resulting in that site being non-dependable. These events would indicate the need for additional support structures and base stations for each carrier. The following assumptions are standard and include:

- The carrier with the most complete service area has the same limitations as the carrier with the lesser service area. Therefore, the carrier that currently has the best service in the area likely has more infrastructures presently in place than the carrier with lesser services in the area.

- The carrier that has the least service in the area has reasonable access to the same or similar sites as the carrier with the best service in the area.

- The limitation to the carriers with lesser service is the availability of necessary antenna elevation, yet that can be substantial.

- Facilities outside the park or that border the park have already been substantially developed. These sites were reviewed to determine if any technical changes would provide better service into the park. Furthermore these existing locations were examined and, primarily due to height restrictions in conjunction with the terrain, it was concluded that any improvements to these sites would not offer any reasonable improvement of service in the park. Many of these existing sites are not utilized by all the carriers simultaneously. In some situations there is only a single carrier at some locations. There may be many reasons, for instance, safety concerns or excessive cost, but carrier access to facilities outside the park is at the sole discretion of the carriers, and not within the scope of the telecommunication facilities plan/Environmental Assessment (EA).

As part of the methodology, all of the carriers providing service around the park were interviewed regarding the level of coverage they currently provide around the park. During these discussions, the carriers expressed interest in further development of wireless telecommunications facilities that would provide services within the park.

Carriers were also asked about their targeted areas of development, with responses indicating that all carriers had similar target areas. Existing service contours, also known as propagation maps, were provided by some of the carriers and were used, as a point of comparison with other existing propagation maps to ensure accuracy. This comparison showed that the two data sources were similar and the data sets showing level of coverage were accurate so that the information obtained from this analysis are well within acceptable standards of engineering practice.

Network carriers typically will desire to locate new facilities, also known as network deployment, once the system recognizes the maximized use of local handset (i.e., there are more cell phones in a given area), if there is a high degree of customer complaints, or if the carrier’s internal metering methods show system over-capacity. Once it is determined that a new facility is needed, the carrier’s RF engineers target potential new locations that efficiently blend into the existing system infrastructure. In looking at the carrier coverage data for Rock Creek Park, it appears that there are substantial areas that have signal strength below acceptable levels to allow for continuous communications with handsets within the park, specifically the area along Beach Drive. The remaining administrative units of Rock Creek Park appear to have sufficient existing service, and the coverage maps developed, as well as the interviews with the carriers indicated no concerns for future siting by these providers.

This analysis of coverage gaps utilized software common to the wireless industry that computes propagation maps showing signal strength. There is no individual software that is common to all carriers, and each has chosen platforms they feel will best address specific areas and will reflect accurately what may best duplicate actual real-world operating systems. All software has numerous data input requirements that are determined by each particular carrier to generate a predicted service area that will best represent a predicted contour, which best fits their own design standards once the system is in service. Predicted contours can be reasonably confirmed by drive tests. Drive test is a scientifically advanced method used to measure the signal strength and document the system's operation in specific locations by using sophisticated electronic equipment and calibrated antennas. Many times drive tests are conducted where complications require special solutions. Propagation programs are only good if the input data is accurate and is correctly entered. Special attention was afforded to the human aspect of the process, as that is where such inaccuracies would most likely occur. Gathering data is paramount to producing a model that would be within real field test representations. For best accuracy, we used the same input data as provided by the individual carriers when available, as the results should be reflective of each carriers own computation. Confidentiality agreements were entered into with all but one of the carriers. Three of the carriers provided complete data, and in addition, two of the carriers supplied propagation maps. One carrier provided partial information that was unusable and therefore the specific information was later obtained from other public documents. Comparison of propagation maps from public sources and those that were provided by the carriers, confirmed that the data used for the analysis were accurate, with a high level of confidence in the results.

The analysis combines land-use planning strategies with industry-accepted RF engineering standards to provide technical data to the park during the NEPA process.

CityScape Consultants, Inc.

This analysis was prepared by CityScape Consultants, Inc. (CityScape). CityScape is a land-use planning, legal and radio frequency engineering consulting firm located in Boca Raton, Florida. 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 the Telecommunications Act of 1996 and other controlling laws and guidelines.

I. THE TELECOMMUNICATIONS INDUSTRY

A. Introduction

Telecommunications is the transmission, emission or reception of radio signals, 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.

One-way communication for radio and television utilizes a combination of antennas and receivers to transmit signals from the broadcast station to an antenna or group of antennas located on a broadcast tower, which then transmits the radio signal 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 increases these capabilities by delivering not only traditional telephone, but also high-speed Internet and cable television and is capable of substantially more. The new technology involves an extensive network of fiber optic lines sited in above and below ground locations.

Wireless telephony, also known as wireless communications, includes mobile phones, pagers, and two-way enhanced radio systems. These systems rely on the combination of land lines, cable and an extensive network of elevated antennas, typically found on communication towers, interconnected to the ground level electronics, or base stations to transmit voice and data information. This technology is known as the first and second generation (1G and 2G) of wireless deployment.

Third, fourth and fifth generations (3G, 4G and 5G) of wireless communications includes the ability to provide instant access to e-mail, the Internet, radio, video, TV, mobile commerce, and Global Positioning Satellite (GPS), in one hand-held, 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, all supplied with the electronic frequency and data information from a base station. The recent evolution of telecommunications began in the 1800's and continues to evolve at a very fast pace. Figure 1 identifies some of the most significant telecommunication benchmarks over the past 160 years.

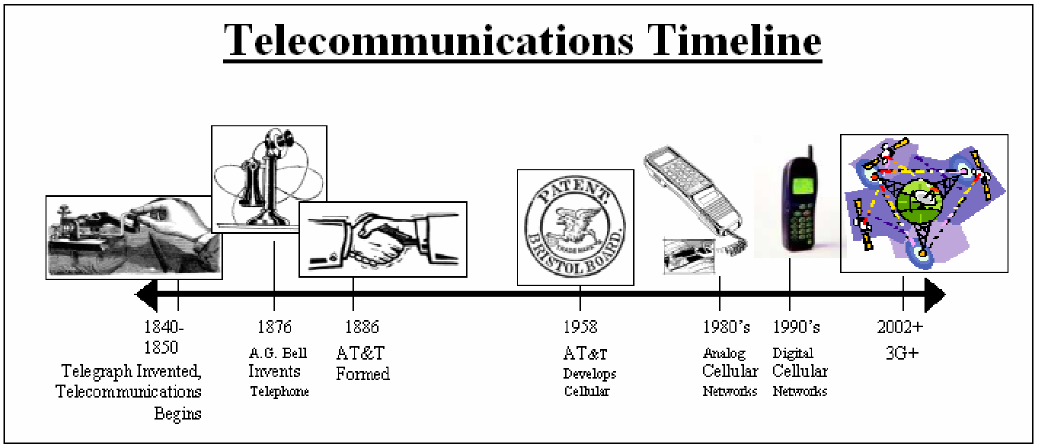


Figure 1: Telecommunication Timeline

B. Wired and Wireless 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. Figure 2 illustrates the wired, landline network system.

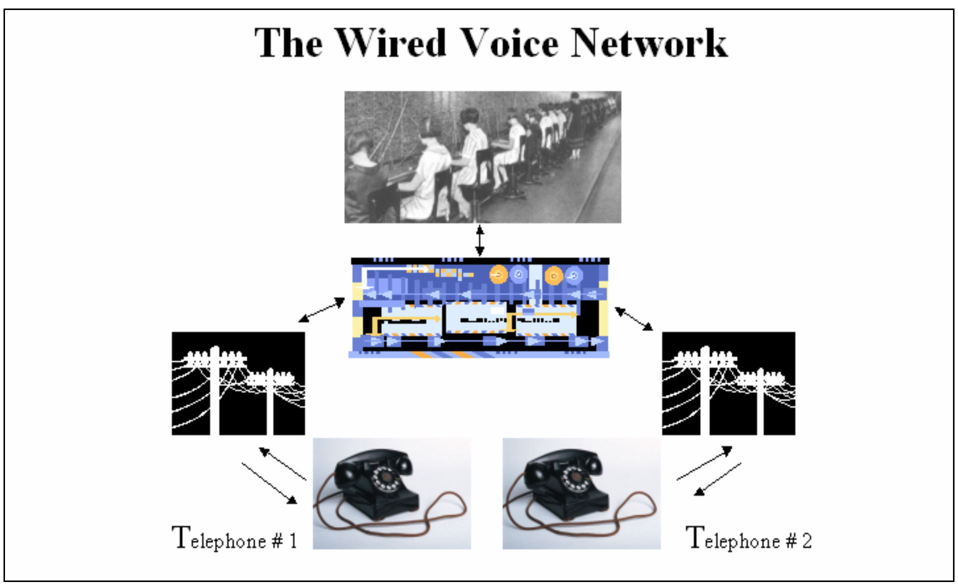


Figure 2: Wired Voice Network Systems

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 facility coverage area, or the area that a proposed facility would serve. 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 up to nine different grid systems in each community.

During the 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 are still 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 similar to the sound of a weak AM or FM radio station was heard through the handset. Recent technological advancements now allow 800 MHz systems to also support digital customers, which allowed the networks 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 has a higher rate of disconnects or dropped calls, yet it does allow for more services such as paging devices, and the ability to send text messaging through the handset. Deployment of 2G also targeted larger more populated areas which resulted in much of rural or less populated area having 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 or 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.

The 800, 900 and 1900 MHz bands all utilize a system of elevated antennas attached to a base station and either the preferred fiber optics links or the traditional land lines to send and receive the voice and data signals between customers. Wireless systems must have a continuous trail of antennas to successfully send and receive the signals without interruptions, interference, or dropped calls. The antennas must be elevated to a height where a reasonably clear line of site is attained to avoid interference from obstruction caused by vegetation and buildings. The elevated base stations of choice have been telecommunication towers but rooftops, water tanks and tall signage are also utilized as mounting platforms for wireless infrastructure. Rooftops are especially effective in downtown areas where buildings cause interference issues and ground space for new towers is usually unavailable. Figure 3 illustrates the wireless telephone network.

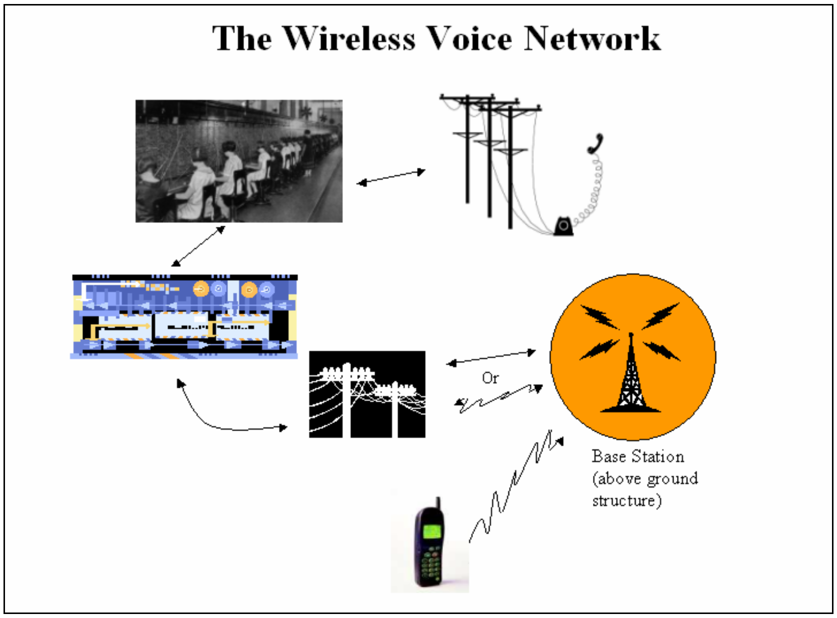


Figure 3: Wireless Voice Network

C. Wireless Providers

In 1983, the Federal Communications Commission (FCC) granted licenses to two competing wireless providers to provide cellular coverage nationwide. The early stages primarily were served by the local telephone companies and on a national level by companies like Cellular One. There were many initial problems and growth was slow. Most wireless providers preferred tall towers in the range of 300 to 500 feet to service large areas. There was also a preference for analog services to reach farther, without much concern for static. Due to the difficulty of constructing new facilities, the expansion was costly and challenging.

In 1995 and 1996, the FCC auctioned four additional licenses in regional areas to competing wireless providers for purposes of building a nationwide digital wireless communication system. This auction raised over twenty-three billion dollars for the United States Treasury, which helped the federal government pay off the annual deficit by 1998.

D. Wireless Coverage

Wireless system providers attain service coverage via antennas located on elevated base stations. The height and location of the towers is critical to meeting the objectives of RF engineering. The systems need continuous coverage with minimal overlap to provide continuous service that the wireless subscribers desire.

In wireless system evolution, a wireless provider initially built fewer base stations with relatively tall antenna-supporting structures to maximize the network coverage footprint. These initial 1G 800 and 900 MHz systems sought to broadcast coverage to large geographic areas with minimal infrastructure. Typically, these tall towers were spaced four to eight miles apart.

By nature, the 1900 MHz frequency band is higher than the 800 MHz band and cannot transmit a signal an equal distance. For the same coverage, these base stations must be closer together, generally two to four miles apart. The mounting height of the antenna for 2G was not as critical as 1G, as these towers were shorter.

Figures 4 and 5 illustrate the ideal wireless network grid. In Figure 4, the yellow and blue hexagons represent 800 MHz and 1900 MHz coverage, respectively. As previously described, the yellow hexagons cover a larger geographic area because the 800 MHz frequencies can broadcast the cellular signal. The blue hexagons are closer together because the 1900 MHz frequency transmits a shorter range. Figure 5 illustrates the applied grid design to providing network coverage parallel to an interstate highway. The red triangles represent the base station and the circles represent the estimated wireless coverage to be operated from the base stations.

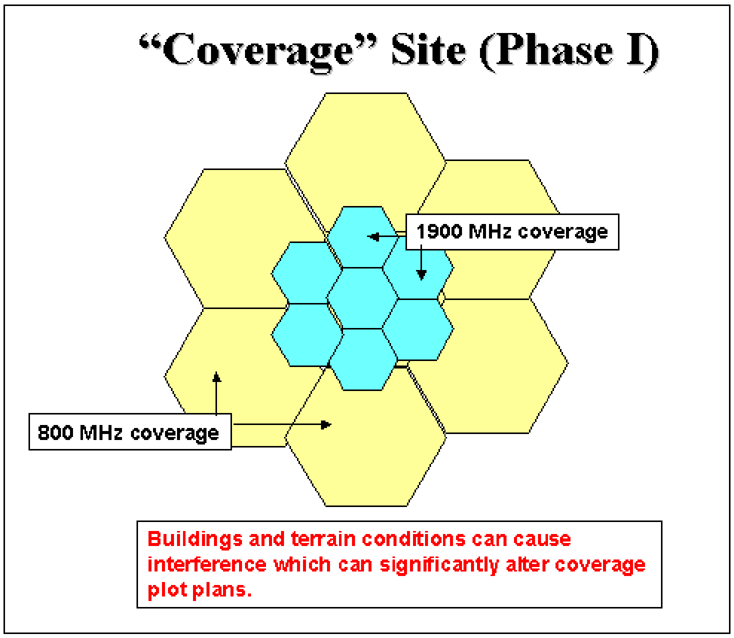


Figure 4: Coverage Grids

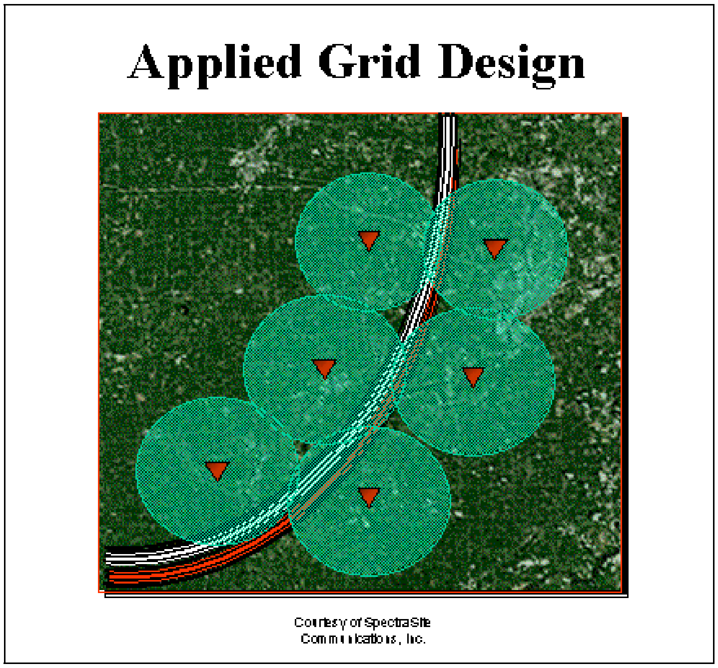


Figure 5: Applied Grid Design

E. 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 base station can process as many as 1,000 subscribers per minute as subscriber's transverse through particular cell sites, yet at any time a single cell site can handle simultaneously no more than 200 calls (different providers prefer different numbers, 1,000 is an average). This process is referred to as network capacity. As population and 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, get a message indicating all circuits are busy, or commonly be asked to leave a message without hearing the phone ring on the receiving end of the call.

As the wireless network reaches design network capacity, it causes the coverage area to shrink, further complicating coverage objectives. Network capacity can be increased several ways. The service provider can readjust the antennas to better serve the needed area, 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 as its primary objective. An assumption behind the capacity base station concept is that an area already has sufficient 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 over-capacity or busy messages, leading to no service indications for subscribers when they press the call send button on the wireless handset.

Figures 6 and 7 illustrate the complications and resolutions of network capacity issues. In Figure 6, the 1G networks covered specific areas. As more customers purchased wireless communication services, the coverage areas shrunk, creating gaps in the original coverage area. Figure 7 demonstrates the combination of options available for solving coverage gaps as networks reach maximum capacity.

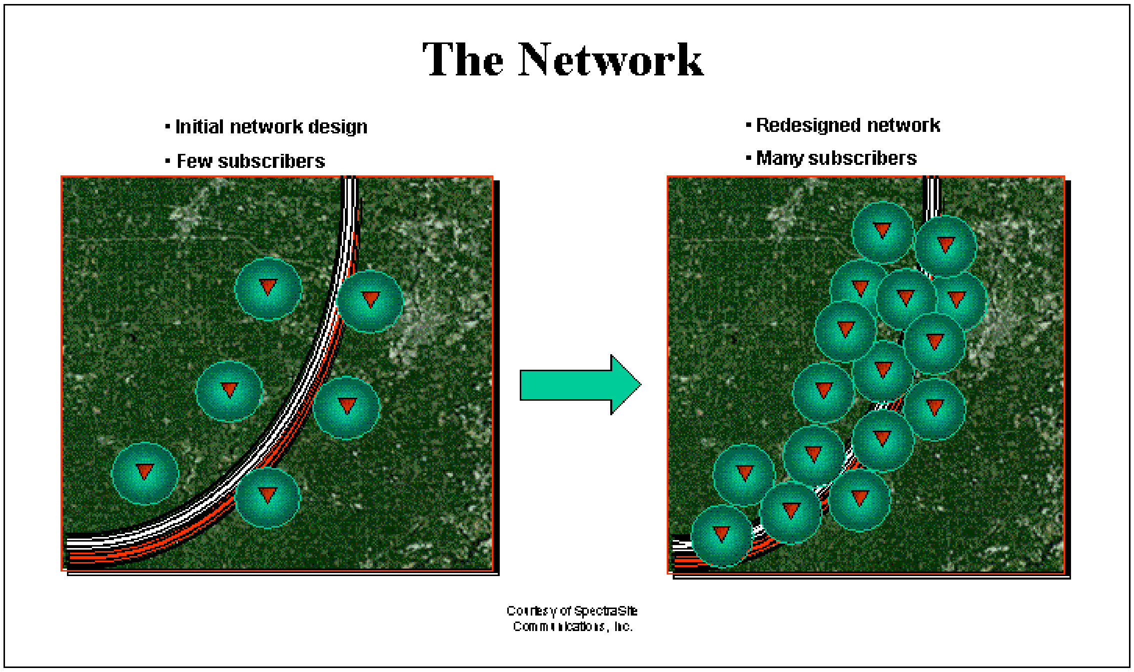


Figure 6: Network Capacity

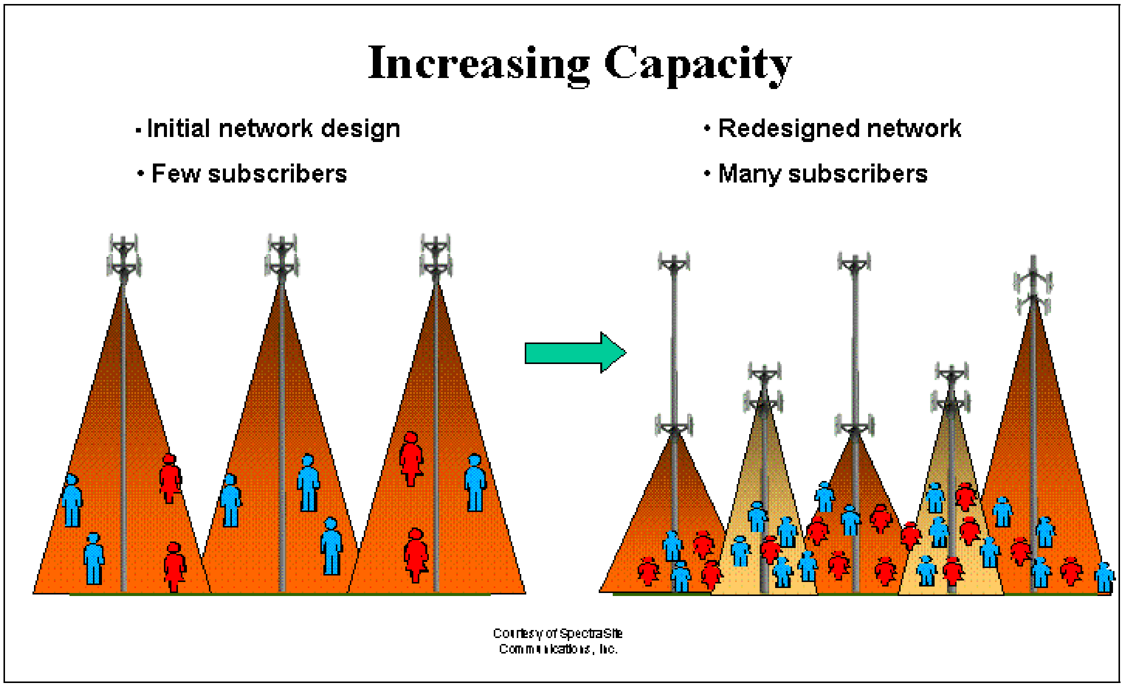


Figure 7: Increasing Network Capacities

F. Wireless Infrastructure and Zoning

Wireless base stations are facilities for mounting antenna arrays, for the purpose of meeting wireless telecommunication network deployment plans. A variety of structures can be used as base stations, such as towers, buildings, water tanks, existing emergency communications system tower facilities, tall signage, and light poles. Use of these structures is dependent on: 1) the structure being structurally capable of supporting the antenna and the inter-connecting coaxial cables and, 2) sufficient ground space to accommodate the accessory equipment cabinets used in running the network. Base stations can also be camouflaged in some circumstances to visually blend in with the surrounding area.

Figure 8 shows examples of some typical base stations. The monopole is a freestanding pole similar to an oversized utility pole. The lattice tower is also a freestanding, tripod shaped tower, with crisscrossing brackets. The guyed tower is not a freestanding tower and relies on the attached cables and anchors to support the facility. The flagpole is a camouflaged tower. 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 camouflaged lattice tower. The antennas are hidden above the bells and behind the artwork at the top of the structure.

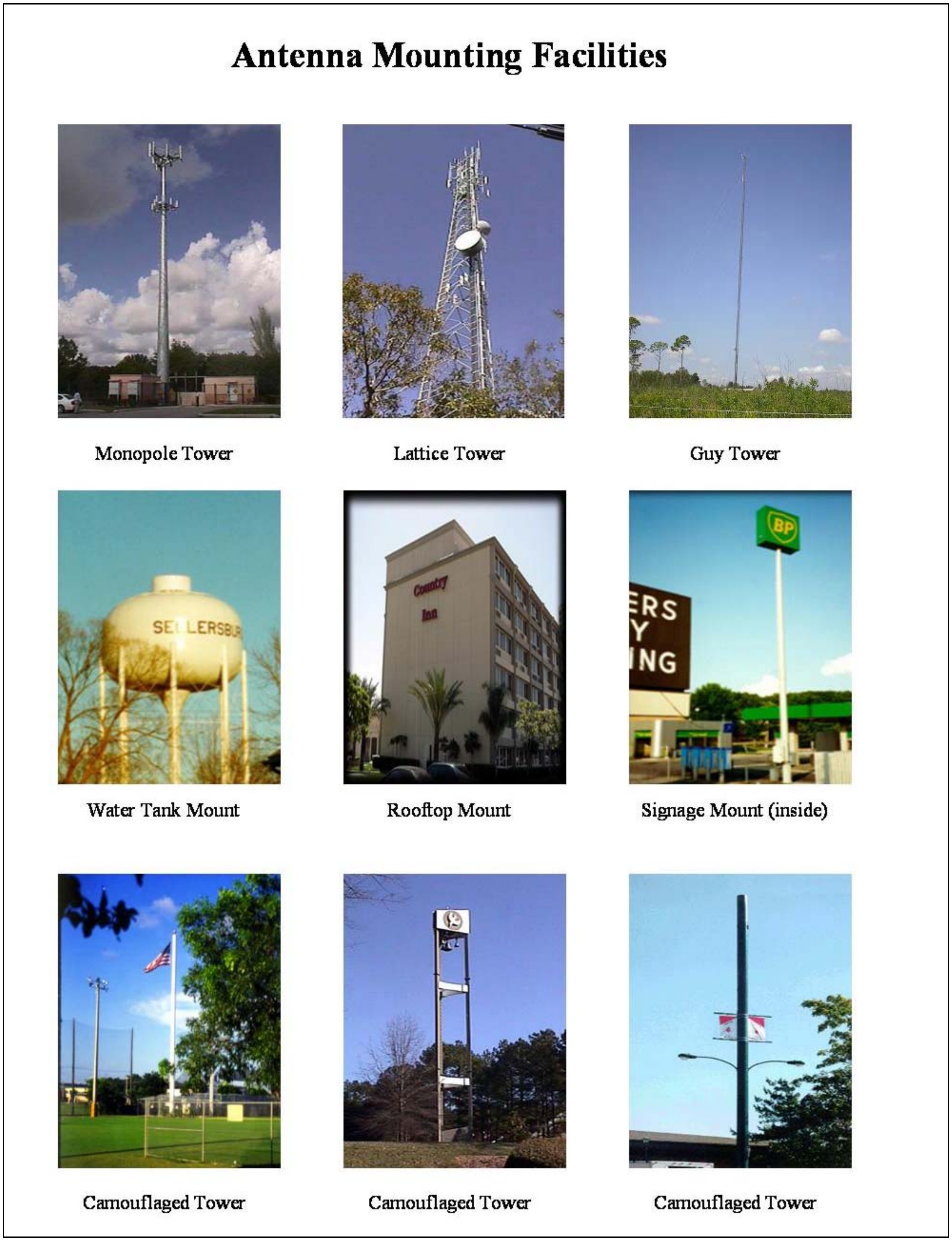


Figure 8: Example of Base Station Facilities

The location of the antenna is critical to attaining an optimum functioning network. With the deployment of 1G, there were only two competing wireless cellular providers. But with the deployment of 2G the wireless market place became furiously competitive. “Speed to market” and “location, location, location” became the slogans for the competing 1G and 2G providers. The initial strategy was for service providers to operate a single base station only for their needs. The concept of 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 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, vertical real estate, including 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 co-location.

This industry change should have benefited local governments who adopted new tower ordinances requiring co-location as a way to reduce the number of new towers. But, it did not because the vertical real estate business model for new towers was founded on tall tower structures intended to support as many wireless providers 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 such as the large sum of money paid by the 2G wireless providers 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 the prohibition of facility deployment through new zoning standards by 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.

G. Exposure to Radio Frequency Emissions

Exposure to RF emissions is one concern associated with the siting of telecommunications facilities. The FCC has rules for human exposure to electromagnetic radiation. Electromagnetic radiation should not be confused with ionizing radiation, the differences of which are described below.

Ionizing radiation is radiation that has sufficient energy to remove electrons from atoms. 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 conform to federal compliance with published standards on radio frequency exposure levels.

Radio frequency radiation attenuates, or decreases, very rapidly with distance from a wireless services antenna, and most wireless sites not accompanying broadcast facilities can easily comply with regulated levels. The RF exposure rules adopted by the FCC are based on the potential for RF to heat human tissue, which possibly could cause damage. The regulated levels of RF emissions are based on studies and rules that ensure that humans are not to be exposed anywhere near the level that can cause measurable heating. Studies on the long-term effects of RF emissions are inconclusive as to any harmful effects and there continues to be debate regarding whether or not there are biological effects associated with "non-thermal" causes, such as magnetic fields. Based on these findings the federal government has maintained jurisdiction on such issues.

1. BASE STATIONS

For the cellular and PCS bands, human exposure limitations are given in terms of power density, measured in units of milliwatts per centimeter squared (mW/cm^2). The power density associated with a cellular/PCS installation may be easily calculated or measured with instruments. One method to determine these levels is time averaging, which is used along with the level measured. This means that the level must not exceed the standard value over any period. For instance, if the standard calls for a limitation of 1.0 mW/cm^2 averaged over thirty minutes, the standard permits a level of 2.0 mW/cm^2 for up to fifteen minutes as long as this is followed by a fifteen minute period of no exposure.

The FCC sets general population/uncontrolled exposure limits for all providers. In many cases no field evaluation is required because the site complies with the regulation, based on the presumption that in its radio service there is no possibility of an excessive RF level if the provider certifies such compliance. For example, facilities on towers with the antennas higher than 10 meters (32.8 feet) and a power less than 2,000 watts require no further consideration.

In general, single provider installations on towers would be exempt because these are normally isolated and elevated structures. Multiple provider co-locations and very high power sites would require further consideration. In consideration of how conservative the evaluation method is, an engineer may wish to make actual power density measurements. In almost all cases, those measurements have been far below the calculated values. If the site truly does not comply, some alternatives include:

1. Limit the site access such that only authorized personnel can reach the vicinity of the antennas. The applicable standard then becomes for occupational/controlled use.

2. Raise the height of the antennas.

3. Reduce the power.

4. Re-position antennas such that people cannot get in close proximity to them.

In multi-transmitter facilities, it is necessary to evaluate each contributor individually. Its percent of RF emissions is computed (or measured), and added together to sum all percentage figures to determine the total site exposure.

2. PHONES

In July 2001, the Federal Drug Administration (FDA) issued a Consumer Update on Wireless Phones, which stated that "[t]he available scientific evidence does not show that any health problems are associated with using wireless phones," while noting that "[t]here is no proof, however, that wireless phones are absolutely safe."

The FCC issued a Consumer Information Bureau Publication in July 2001, which stated, "[t]here is no scientific evidence to date that proves that wireless phone usage can lead to cancer or other adverse health effects, like headaches, dizziness, elevated blood pressure, or memory loss."

Before a wireless phone model is available for sale to the public, it must be tested by the manufacturer and certified to the FCC that it does not exceed limits established by the FCC.

One of these limits is expressed as Specific Absorption Rate (SAR). SAR is a measure of the rate of absorption of RF energy in the body. Since 1996, the FCC has required that the SAR of handheld wireless phones not exceed 1.6 watts per kilogram, averaged over one gram of tissue.

Steps that can be taken to minimize RF exposure from cell phones include:

1. reduce your talk time,

2. place more distance between your body and the source of the RF, and

3. in a vehicle, use a phone with an antenna on the outside of the vehicle.

The FDA stated in reports that, "[t]he scientific evidence does not show a danger to users of wireless phones, including children and teenagers." People who wish to reduce their RF exposure may choose to restrict their wireless phone use.

H. Emerging Technologies

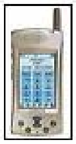
At the onset of this millennium economists and telecommunication forecasters debated the actuality of third, fourth, and fifth generations of wireless coming to fruition in the United States. Skepticism that customers would have little demand for the emerging wireless services appeared in articles and newsrooms, while others recognized the infrastructure in the United States was significantly behind schedule as compared to the European and Asian deployments. It was predicted that consumers would demand the 3G products once theoretical plans were instituted through technological advancements. This third generation deployment requires advanced handset and base station updates and due to that has progressed slower when compared to the 1G, or initial briefcase analogue phones and 2G, or digital deployments, but systems are being tested, designed, built and instituted.

For example Lucent Technologies announced the following on February 20, 2002:

> "…According to Lucent, its secure IP VPN mobility solution will help operators of 3G UMTS networks enter the emerging market for secure communications between enterprise data networks and end-users such as traveling employees or remote workers. The company said the secure IP VPN connections will enable mobile subscribers to use a service provider's wireless network as an extension of their corporate local area network (LAN) or intranet, allowing them to work from any location as if they were in the office... The end-user was authenticated and assigned an IP address, and then was able -- once the connection was established -- to successfully send and receive email, including messages with large attachments, in a fully encrypted mode, thus allowing even sensitive data to be accessed." (Intranet Journal, 02/20/02, "Lucent Demos 3G Mobile Service Connection to Corporate Intranet").

This technology is just beginning to be utilized in the United States. In December of 2002, Sprint announced they were the first United States wireless provider to introduce the next generation of services nationwide known as PCS VisionSM. The 3G upgrades to infrastructure were done primarily through software improvements at the existing Sprint base stations. The wireless phone capable of accessing these services is the SPH-i330 manufactured by Samsung.

Figure 9 illustrates the Nokia 7250 handset and the SPH-i330 handset and the new services available by Sprint.



(www.samsung.com)

- An updated version of Samsung Electronics Co. Ltd.'s Palm OS-based cellular telephone has debuted in the U.S. market.
- Has a large 256 color LCD (liquid crystal display) with 160 by 240 pixel resolution. South Korea's Samsung has built 16M bytes of memory into the handset, which is double that of its predecessor.
- The phone's radio is a dual-band, tri-mode model offering compatibility with CDMA (Code Division Multiple Access) at both 800MHz and 1,900MHz and the analog AMPS network.
- The handset is available first in the U.S. though Sprint PCS Group and is compatible with the carrier's CDMA2000 1x data service, which offers packet-based data transmission at speeds of up to 144k bps (bits per second).
- Expected to be available through Sprint.

(ITworld.com, 12/26/02, "Samsung's i330 Palm OS cell phone debuts"
Martyn Williams, IDG News Service, Tokyo Bureau)

(www.nokia.com)

- The Nokia 7250 phone has an innovative keypad layout and a versatile scroll key that makes it easy to navigate the high-resolution color display.
- Take pictures with the built-in camera and then share them with your friends or family using multimedia messaging technology.
- Eight color schemes let you personalize some of the display elements like header lines or the battery and signal strength indicators.
- Extremely appealing audio features include a selection of pre-loaded ringing tones, a built-in stereo FM radio, and the possibility to receive new polyphonic sounds through MMS, WAP, or Nokia PC Suite.
- The Nokia 7250 tri-band phone operates in three networks - EGSM 900 and GSM 1800/1900 - providing coverage on five continents.
- The Nokia 7250 phone is one of the first to have a Pop-Port™ interface connector. It supports advanced functionalities, such as digital enhancement identification, stereo audio, and fast data connectivity.

Figure 9: 3G Wireless Phones and Related Services

1. Future Wireless Generations

While the United States is starting to experience the first deployments of 3G, other parts of the world are being introduced to 4G. Proving to early skeptics that while the deployment of wireless services in the United States have slowed down, the 3G services will continue to evolve and be sold here and abroad. The article below explains the type of wireless services now being promoted in Asia, which will eventually be promoted in the United States.

> "At a Telecom Asia exhibition in Hong Kong in 2004, Samsung showed for the first time its M400 handset. Based on Pocket PC 2002 Phone Edition, the device runs on CDMA 2000 1x EvDO (Evolution Data Only) networks, which are in commercial service in South Korea and offer data transmission at speeds of up to 2.4M bps. Features of the phone, which is based on an Intel Corp. XScale processor running at 400MHz, include a display capable of showing 65,000 colors, voice recognition and a text-to-speech engine, a TV tuner and GPS (Global Positioning System). Samsung also has a handset based on Microsoft's Windows Powered Smartphone platform under development. That operating system is targeted at handsets that are more like traditional cell phones and offers a limited number of PDA-like functions." (ITworld.com 12/26/02, "Samsung's i330 Palm OS cell phone debuts" Martyn Williams, IDG News Service, Tokyo Bureau).

This same technology was introduced in the United States in January of 2006, at the Consumer Electronics Show in Las Vegas.

2. Satellite technologies

Satellite growth has surpassed the highest expectations of only a few years ago. Previously, relaying information, data, and other related materials were cumbersome and required many relay stations located in very specific locations and relatively close together. Initially satellite use was expensive because of the rarity and limited amount of available air time. With the deployment of more and more satellites, along with advancing technologies that allow more usage of the same amount of bandwidth, satellite air time has become more affordable. In addition, satellite services are in the early stages of designing a more localized aspect. As this occurs there will be even more rapid growth.

Satellite technology has its limitations, which are all based on the Laws of Physics. Licensees of satellite telephone services have petitioned the FCC to allow additional deployment of land based supplemental transmission relay stations for the ability to compete more aggressively with existing cellular and PCS services. The FCC is considering this request, even though the existing land based services are strongly objecting for various reasons. If this is allowed there will be more demands placed on governmental agencies as another service begins to construct a land-based infrastructure.

3. Enhanced Specialized Mobile Radio (ESMR)

ESMR systems, and the technology used for these systems, have been problematic to adjacent frequency channels used by other services, through to no fault of the service provider in most situations. In order to reduce any potential for future interference issues, ESMR operators petitioned the FCC, and the FCC concurred, to shift frequencies from the 800 MHz and 900 MHz band to the 2,500 MHz band. Once again this frequency shift will cause the need for additional support structures and create additional impacts to local governments.

4. PREPARATIONS FOR 3G INFRASTRUCTURE

The phasing out of analog compatibility requirements for cellular phones by the year 2008 has been approved by the FCC, although the Commission's action still allows providers the option to continue analog services as needed to meet customer needs. According to the Cellular Telecommunications & Internet Association (CTIA) about 95 percent of all wireless subscribers are already using digital technology, and wireless users generally replace their phones every eighteen months. Thus, the phase out period should be ample time to migrate the remaining analog users to digital. The carriers support this migration because conversion to all digital has the added benefit of increasing cell site capacity, as a single analogue channel can be converted to three to four digital channels. One of the reasons for delaying is the automotive industry's use of automobile communication services such as "On-Star."

For a long period of time text messaging was limited to only customers of the same provider; therefore, the need for additional facilities was not a substantial requirement. The CTIA recently announced wireless carriers are now participating in a program that allows a customer of one carrier to communicate through text messaging with a customer of another carrier, again creating more demand to facilities. One of its many benefits is as an electronic alternative to a postage stamp, allowing the customer to send text messages from anywhere and that can be delivered anywhere at anytime. Text messaging has been proven to very successful in other countries. In Australia, a recent Coca-Cola promotion resulted in over seven million text messages over a span of thirteen weeks. In Europe, one company quit issuing paychecks to its employees and instead now sends employees a text message confirming that the funds have been deposited.

At the turn of the century there were one billion messages sent a day globally. Every digital phone that is sold today in the United States has messaging capability. In Europe last year, 15 percent of the carriers' revenue came from text messaging. The growth of text messaging in the United States will undoubtedly lead to a greater demand for wireless facilities because the additional spectrum use by text messages will create a system capacity demand for providers. Third, four and fifth generations of wireless deployment will bring the next phases of wireless technology and place great demands on network capacity. With voice, text, 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.

5. EMERGING TECHNOLOGIES

Wireless providers are presently deploying new technology equipment in the United States to support data services over the wireless interface. One such example of this type of deployment has been a Global System for Mobile Communications (GSM) overlay on top of existing facilities, in recognition of the GSM data-handling capability. This is a service used internationally and allows customers to use services worldwide. 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.

II. WIRELESS TECHNICAL ISSUES

A. Introduction

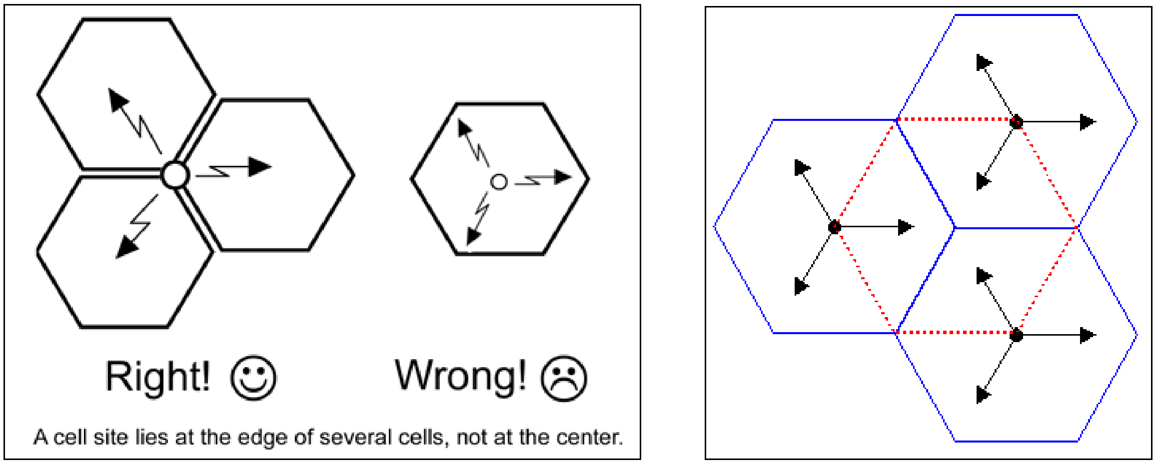
Cellular and PCS wireless providers attain service coverage through a network of ground equipment base stations and elevated antennas located on towers, water tanks, buildings or other similar elevated structures, as described above. The height and location of the elevated antenna platform on the elevated structure is critical to two aspects of RF 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. However, each facility has network capacity limitations that are becoming more apparent in some of the older, 800 MHz cellular operators such as Cingular (the new AT&T Wireless), Verizon, and Nextel. Base stations located in geographic areas where there are a large number of wireless subscribers and the usage of airtime minutes is higher operate at maximum capacity, and on some occasions is over-capacity, which causes busy signals and direct-to-message incoming calls for many subscribers. To help remedy this situation, smaller antenna configurations are used and/or the antenna heights are mounted at lower elevations than would be necessary for coverage. This is defined as “capacity” planning.

For example, when Cingular’s system was initiated in 1984, the entire wireless network could provide coverage from Baltimore, Maryland to Rock Creek Park, Washington D.C. with about 10 cell sites (towers). Today there are several hundred antenna locations covering that same area due to the increase in wireless subscribers and the effects that subscriber growth has on network capacity.

The second engineering issue concerns the relationship between tower location and frequency planning. Cellular and PCS wireless providers carefully choose the frequencies deployed at each base station to avoid mutual interference. Rules of frequency planning require a certain physical distance between base stations to minimize this interference. Slightly different considerations apply to some PCS providers using code division multiple access (CDMA) technology (Sprint PCS and Verizon). In a CDMA system, all base stations in a coverage area use the same, or a very limited set of several frequencies. However, wireless service customers experience interference from other subscribers and from signals from other base stations when subscriber usage increases. Avoidance of this interference requires precise location of antennas.

As demonstrated in Figure 10, 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 areas. 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 10: Network Grid

B. Search Area within Proposed Coverage Areas

The search area for new wireless infrastructure is ideally specified in a document provided to site search consultants by the provider 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.

C. Search Area Radii

Search areas for the 800 MHz (cellular and ESMR) frequencies and 1900 MHz (PCS) frequencies are computed in the tables below. The tables utilize the "Okumura-Hata" propagation path loss formula for 800 MHz, and the "COST-231" formula for 1900 MHz. Using the tables in Figure 11, maximum coverage radii for typical in-vehicle coverage is calculated for various tower heights. All computations have mathematic formulas to account for the various operational requirements, all intended to provide a certain level of service and smooth transition between cell base stations.

Okumura-Hata Formula for 800 MHz

Antenna mounting height	50’	80’	100’	115’	150’	180’
Radius, miles	2.53	3.20	3.60	3.88	4.50	5.00
Allow for hand-off	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

COST 231 for 1900 MHz

Antenna mounting height	50’	80’	100’	115’	150’	180’
Radius, miles	1.33	1.64	1.82	1.95	2.23	2.45
Allow for hand-off	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

Figure 11: Search Area Radii

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 hand-off overlap of about twenty percent is added. One fourth of this distance is the search area radius.

D. Height Considerations

Higher structures (towers, rooftop, and water tanks) may offer more opportunity for co-location, which could theoretically decrease the number of additional towers and antennas required in an area. The extent to which height may increase co-location opportunity must be verified by an RF engineering review on a case-by-case basis. Where there is high customer telephone usage or terrain concerns, the build-out plans for some areas may require very low antenna location heights, especially in densely populated areas. Antennas located at a higher level on a facility are more attractive in some rural areas, but in many cases, the wireless providers seek to limit the height in more populous areas. Thus, wireless providers may need differing heights on a single tower, reducing the potential for interference, both between the same provider and a competing wireless provider.

III. ENGINEERING GUIDELINES FOR THE GAP ANALYSIS AT ROCK CREEK PARK

A. Analysis Design Process

This analysis evaluates Rock Creek Park wireless telecommunications coverage gaps and the infrastructure required to address those gaps, and is accomplished by:

1. Researching the inventory of existing antenna-supporting structures and buildings in the vicinity of the park. Projection of the existing service utilizing only these facilities (Figure 13).

2. Identifying areas within the park that have a certain level of cellular and PCS coverage, including terrain information and existing wireless support structures to determine the existing as-built conditions.

3. Providing an engineering analysis of existing coverage based on the inventory of facilities in and around the park, and regulatory height restrictions.

B. Park Property and Existing Antenna Locations

The analysis of coverage gaps started with a base map of the park, including all 99 administered units. It was determined and then confirmed by the carriers that the only section of the park in which additional support structures were needed is with Reservation 339, its tributaries, and the Rock Creek and Potomac Parkway (referred to as the main section of the park). Existing facilities that surround the park were then added onto the map (Figure 14). In the vicinity of the main section of the park, there are currently 54 wireless telecommunications facilities. Of these 54 facilities, 2 tower facilities, pictured below in Figure 12, are located within the park boundary and the remaining facilities are around the perimeter of the park. In Washington D.C., existing buildings are overwhelmingly used for facilities rather than towers, due to land availability and local zoning restrictions.

Figure 12: Existing Park Facilities

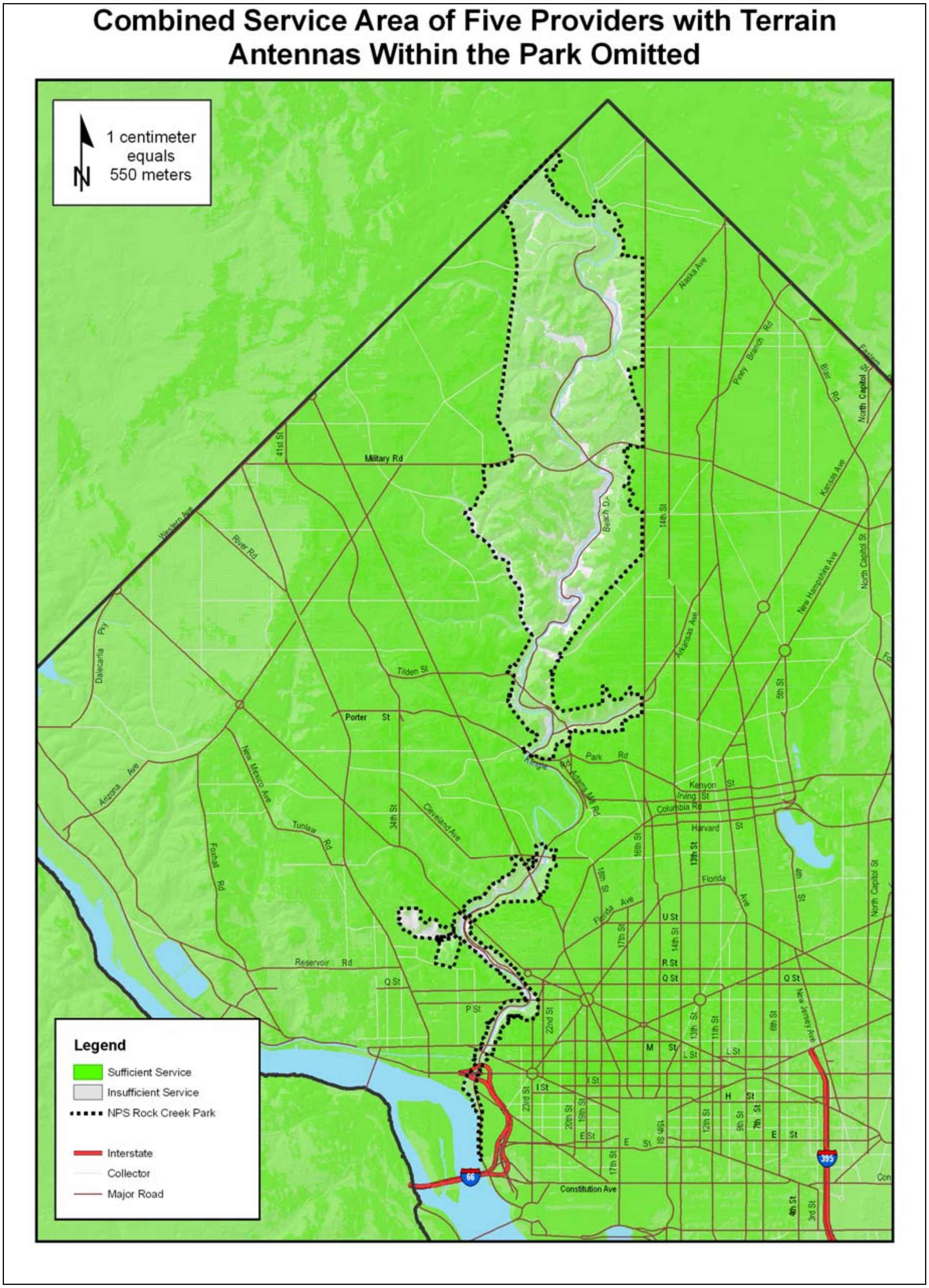


Figure 13: Combined Service Area – Five Providers

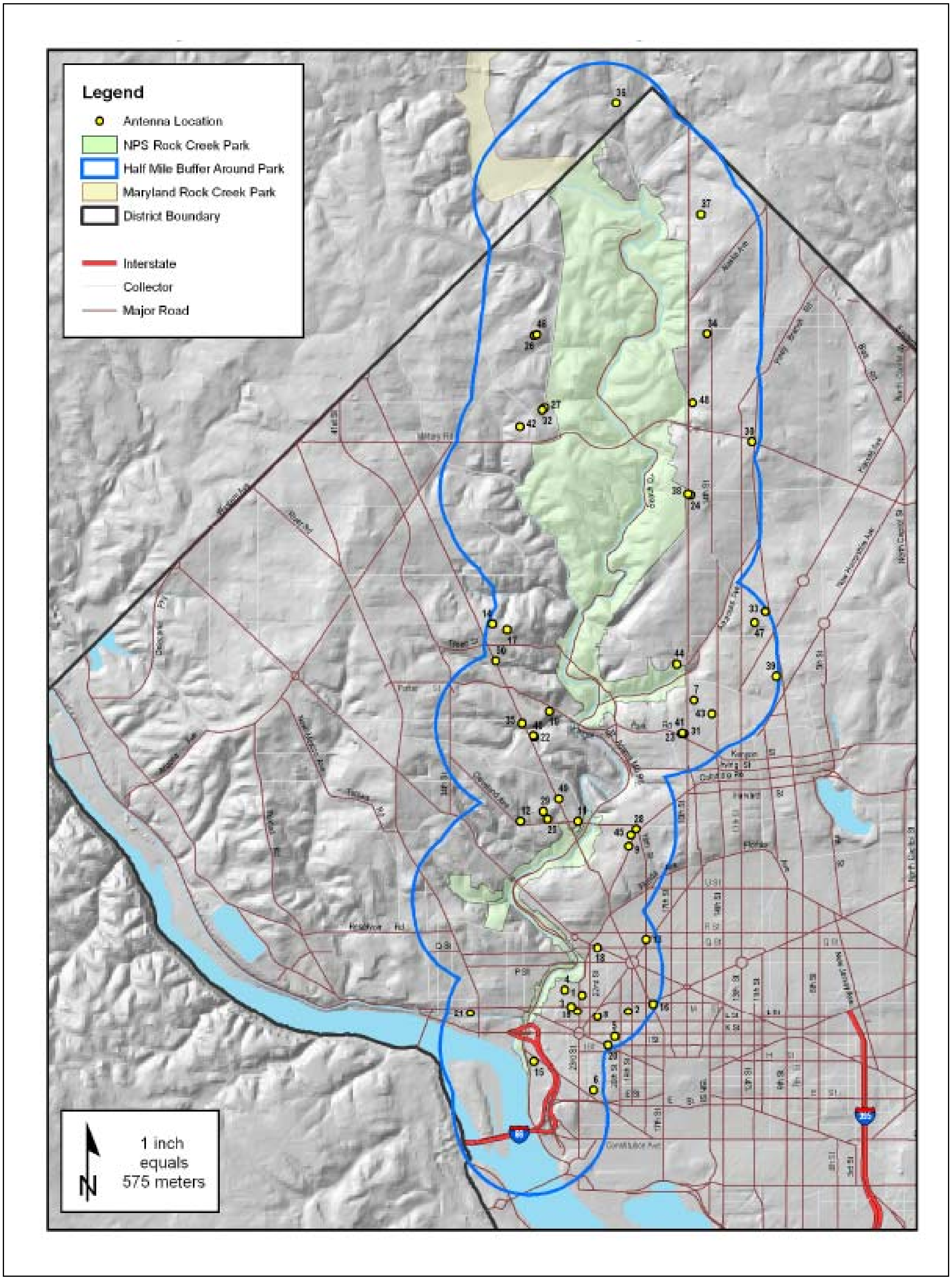


Figure 14: Main Park Section (including existing facilities)

C. Engineering Analysis

The foundation for the engineering analysis is based on legally defensible wireless deployment guidelines that are consistent with accepted engineering practices, and the use of the 800 MHz and 1900 MHz band systems. As explained in Section II, generally accepted 800 MHz engineering principles establish a reasonable search area for a wireless base station as a circle with a radius about one-quarter that of the proposed cell, centered on the ideal location for the cell according to the wireless provider's deployment plan.

The following figures (see Figures 16-36) provide a series of maps starting with no terrain variables (i.e. looking at theoretical coverage as there was no terrain to account for) for initial cellular, ESMR, and PCS coverage.

D. Basic Coverage Predictions and Wireless Coverage Hand-off

Wireless telecommunication networks are comprised of elevated antenna arrays attached to a base station that transmit and receive radio signals allowing wireless telephone handsets to operate satisfactorily. The RF 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 antenna array successfully relays, or hands-off, the radio signal to another antenna array without causing an interruption in service. Successful network hand-off is only possible when the geographic coverage areas from individual antenna arrays properly overlap and when the base station at each array has available capacity. Geographic areas with good site hand-off and available capacity will also have good wireless coverage and generally provide uninterrupted service.

This analysis will show the gaps in coverage for wireless telecommunications in and around Rock Creek Park and provide technical information for the NEPA process for the park's wireless telecommunication facilities plan/EA. As part of this analysis, the design criteria of a wireless network are further explained with theoretical propagation maps. This begins with developing maps that illustrate theoretical coverage if there were no external considerations, such as topography or population.

Figures 16 and 17 illustrate wireless telecommunications signal coverage in a perfect RF environment, without population or terrain concerns, based on existing facilities. These variables can significantly influence the effectiveness of the wireless signal between the antenna and a wireless telecommunication handset as illustrated in the following figures.

According to the 800 MHz "Okumura-Hata" propagation path loss formula coverage as shown in Figure 15, a reasonable coverage area for an antenna mounted at 150 feet for cellular deployment on flat terrain is 3.60 miles. These sites represent a theoretical build out for antennas mounted at the 150 foot elevation at equal dispersion and assume no consideration of adjacent community wireless deployment for a single cellular provider, assuming no suitable existing structures have been constructed and population variables do not exist. The smaller circles shown within the larger circles in Figure 16 represent the limits of the search area for locating the facility. Although two cells could cover the vast majority of Rock Creek Park for one provider, this does not include the concept of capacity or terrain concerns. Figure 16 illustrates the hand-off radius applicable to 800 MHz between two above ground antenna locations demonstrating that initial cellular coverage without considerations of population or topographic variables could be obtained with only two sites. Population and terrain of specific geographical areas and the total number of minutes used by the wireless subscribers within that designated area can have significant affects on the circumference of the coverage area.

Referring to the 1900 MHz "COST-231" formula coverage as shown in Figure 15, a reasonable coverage area for an antenna for a PCS site on flat terrain is 1.64 miles. Figure 17 shows the theoretical need for only three sites located within Rock Creek Park jurisdictional boundaries. These sites represent a theoretical build out of 80 foot antenna locations at equal dispersion for one cellular provider again with no consideration of adjacent community wireless deployment, no terrain or population considerations, and assuming no suitable existing structures are available.

Figure 17 further illustrates the hand-off radius applicable to 1900 MHz from three above ground antenna locations within Rock Creek Park, demonstrating that initial PCS coverage without considerations of population and topographic variables would be almost 100 percent complete. The hand-off radius for 1900 MHz is reduced because of the difference in PCS operating frequencies and technologies as compared to the 800 MHz frequency.

800 MHz

Antenna Height	35'	50'	80'	100'	115'	150'
Radius, miles	2.14	2.53	3.20	3.60	3.88	4.50
Allow for handoff, miles	1.71	2.03	2.56	2.88	3.10	3.60
Search Area, miles	0.43	0.51	0.64	0.72	0.78	0.90

1900 MHz

Antenna Height	35'	50'	80'	100'	115'	150'
Radius, miles	1.15	1.33	1.64	1.82	1.95	2.23
Allow for handoff, miles	0.92	1.07	1.31	1.46	1.56	1.79
Search Area, miles	0.23	0.27	0.33	0.36	0.39	0.45

Figure 15: 800 and 1900 MHz Coverage Tables

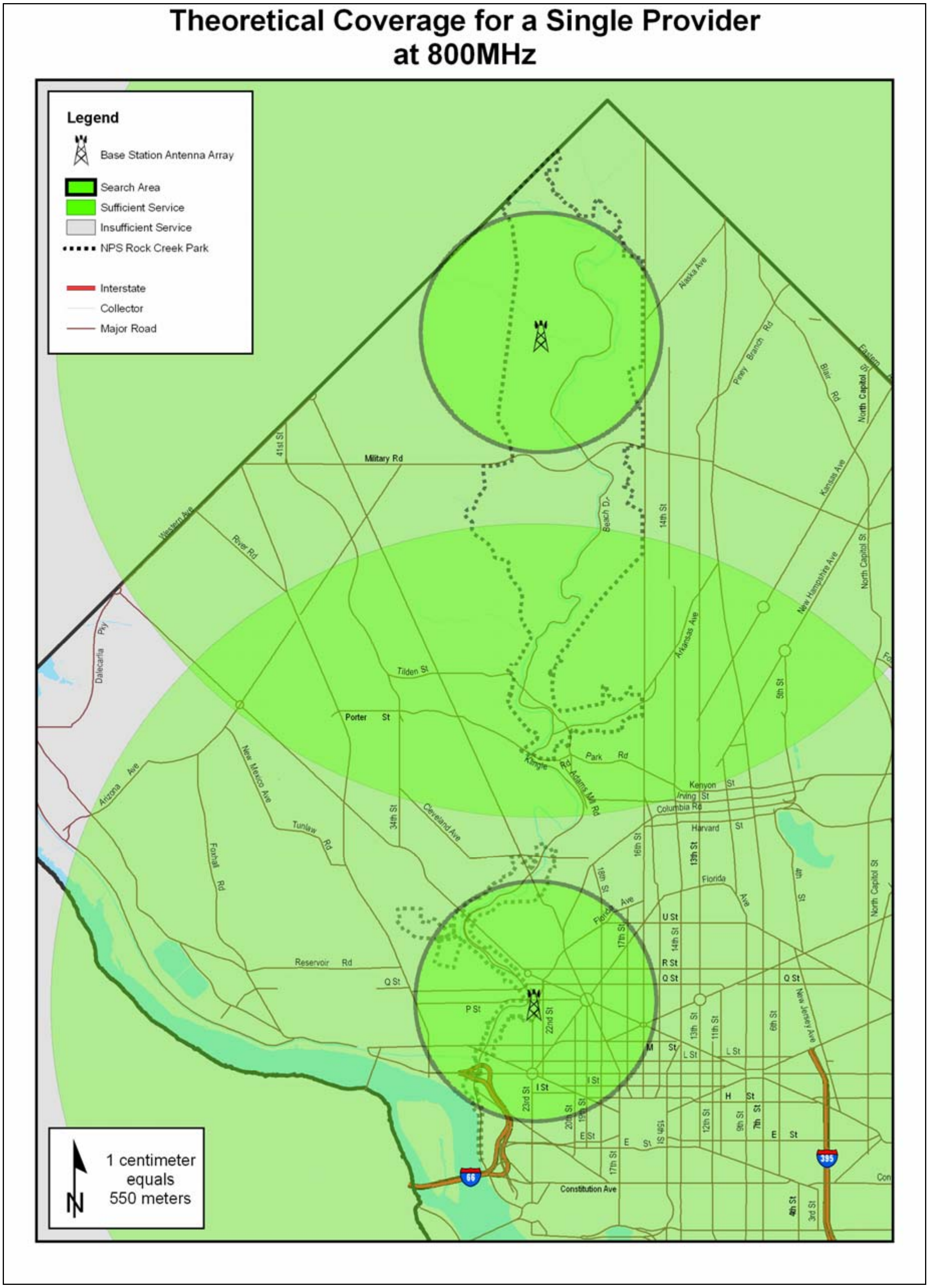


Figure 16: Theoretical Flat Terrain Service for 800 MHz

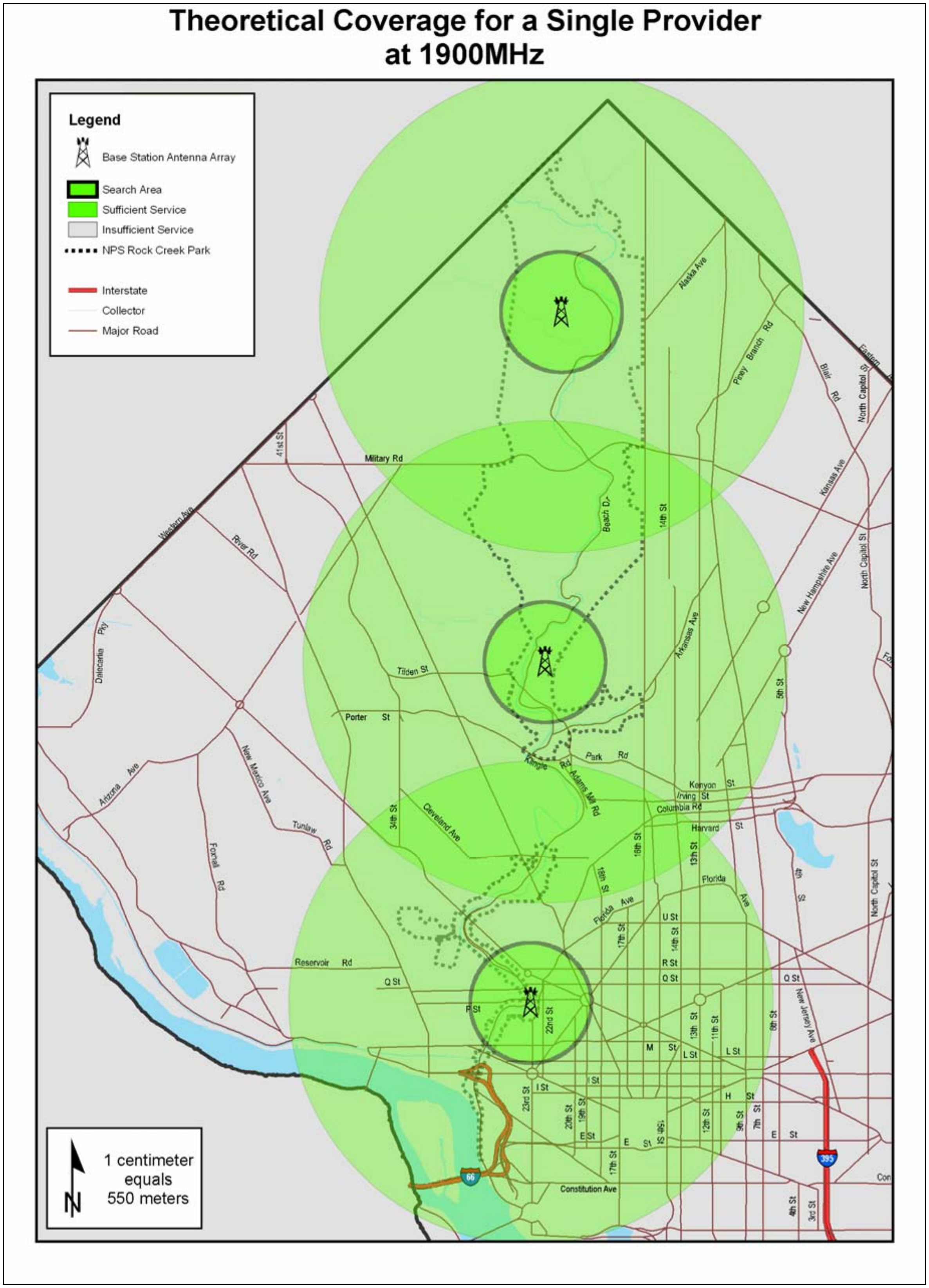


Figure 17: Theoretical Flat Terrain Service for 1900 MHz

E. Coverage Predictions Including Topographic Variables

As previously described, in an area with flat terrain and a low density population, base station prediction to determine service coverage is not as complicated. When wireless telephone usage increases both in minutes spent on-line and more people using cell phones, service areas shrink in size. The impact terrain has on a service area is the most dramatic. Radio frequency propagation is loosely based on line-of-sight technology. Therefore on flat terrain service areas in the coverage network forms a circular pattern. In areas with varying terrain conditions, the line-of-sight reach would be substantially altered by higher and lower ground elevations. For example the signal would be stronger in high elevation locations and the signal would be weak or non-existent in lower ground elevations. Rock Creek Park has sufficient topographical variation to provide gaps or less than minimal service from the existing facilities both in and surrounding the park. For illustration purposes using the same random theoretical antenna locations as identified in Figures 16 and 17, it is shown in Figures 18 and 19 how wireless service coverage areas become distorted when the topographic variables are added to the propagation formulas. The areas shown in gray illustrate a need for improved service.

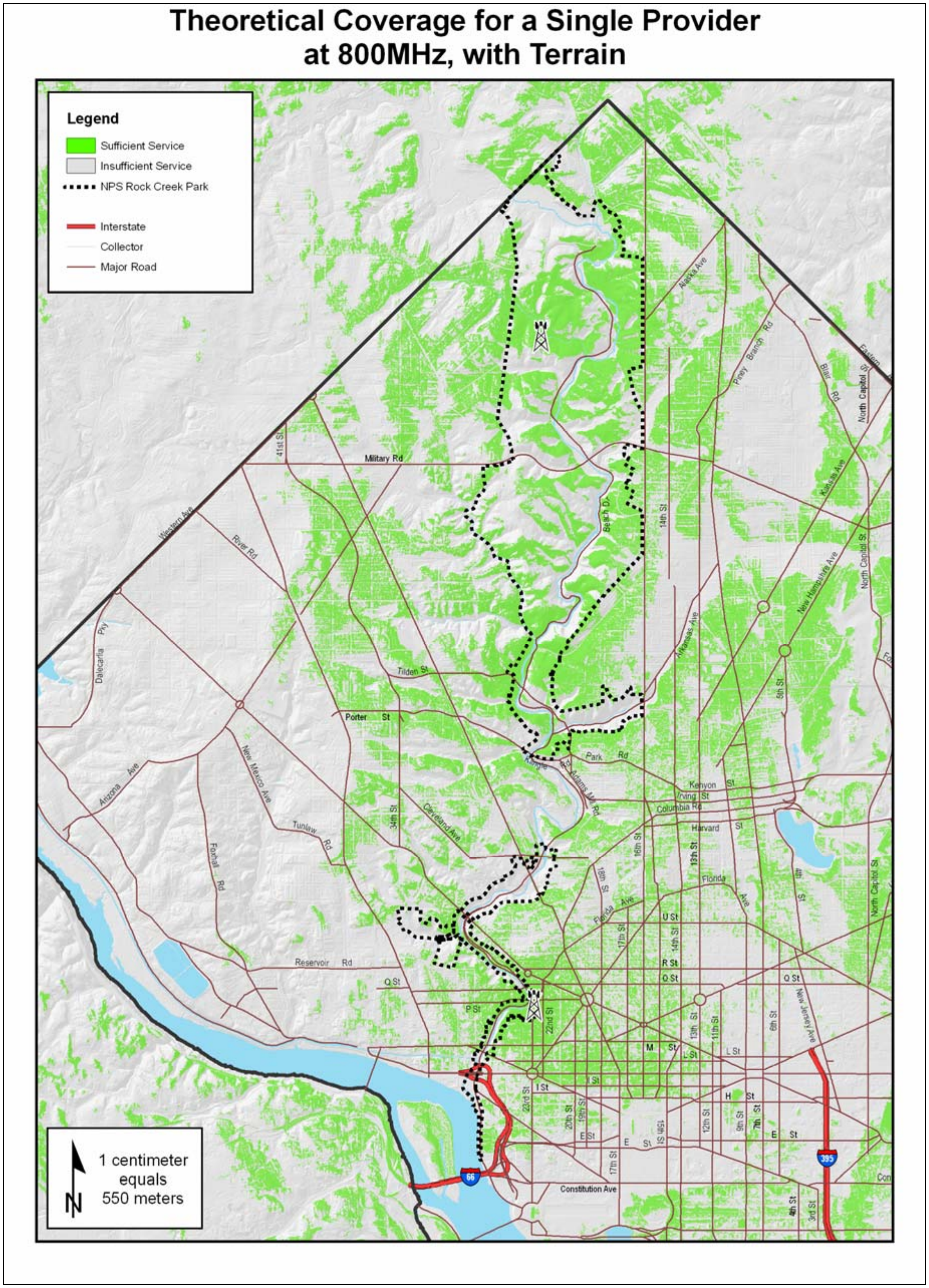


Figure 18: 800 MHz Theoretical Coverage with the addition of terrain features

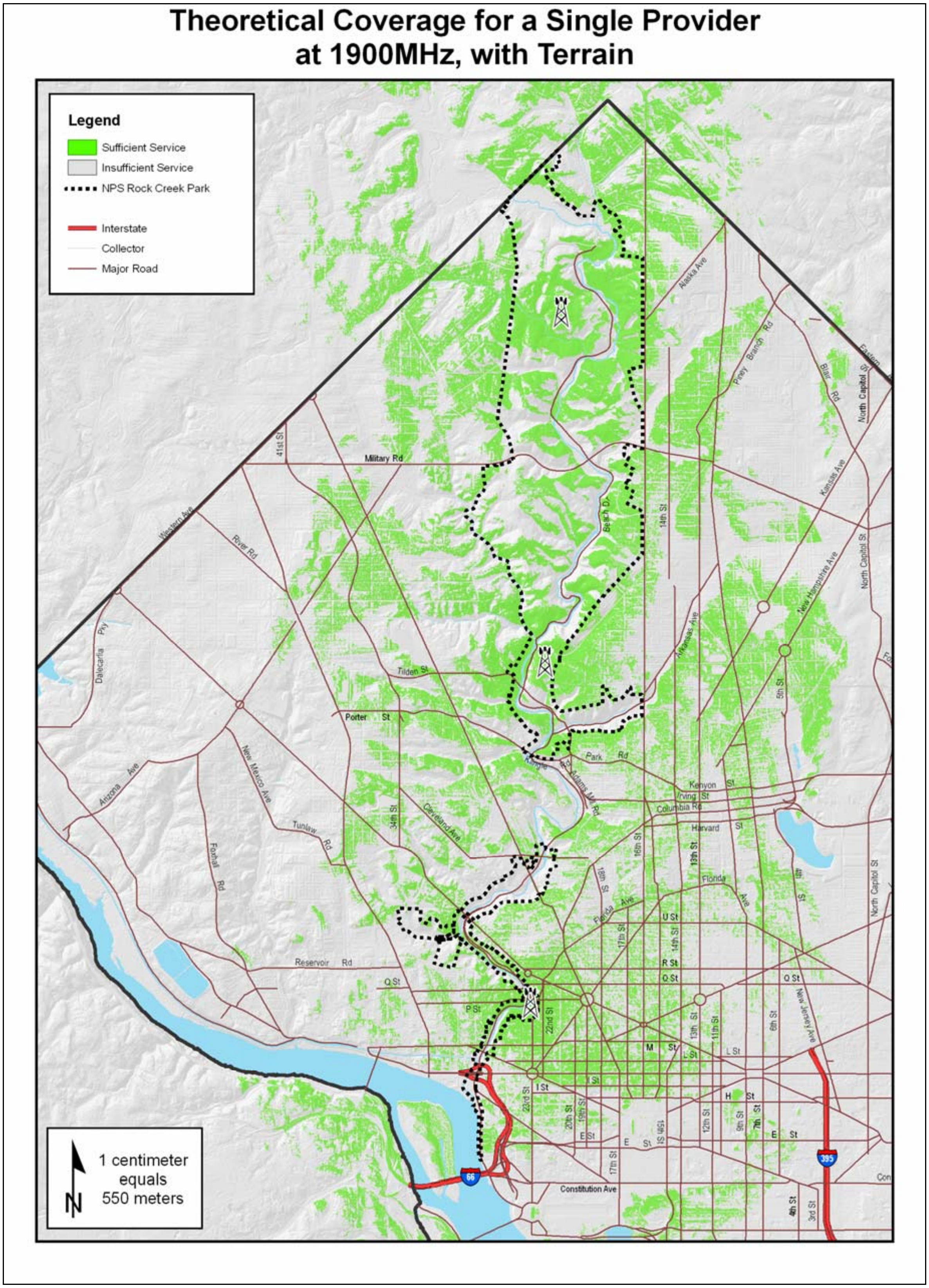


Figure 19: 1900 MHz Theoretical Coverage with the addition of terrain features

F. Effects of Topography on Coverage

Most of the park area has challenging topography, resulting in issues related to the abrupt changes in the ground level when considering wireless telecommunication service. Wireless services operate generally in line-of-sight methods. Radio frequencies in these bands travel in straight lines, so any obstructions in the signal path will cause a signal change, normally a reduction or complete loss of signal. In addition, natural vegetation affects wireless services, resulting in different levels of service during different times of the year. This is caused by the loss of leaves from trees and even the moisture content of the vegetation which all impact the line-of-sight. As part of this analysis, once a range of alternatives has been developed by the NPS, an analysis will be prepared to confirm the various alternatives with propagation maps that will consider the varying seasons, showing three levels of services for each carrier within the park, including in-building, mobile, and pedestrian.

Providing service inside park buildings from locations outside the boundaries of the park would be virtually impossible, mostly due to the terrain. As the following analysis details, addressing coverage gaps within the park along the creek bed and Beach Drive is not feasible from solely outside the park due to terrain. For example, park terrain has varying ground elevations. This demonstrates why new or improved facilities located outside the park do not provide a solution to the coverage gaps. The terrain within the park has elevations doubling, both higher and lower, in short distances in many areas. In some places, the park ground elevation can vary as much as 300 feet in very short distances, sometimes as short as a city block. This is the fundamental problem carriers have in achieving service into the park as shown below in Figure 20.

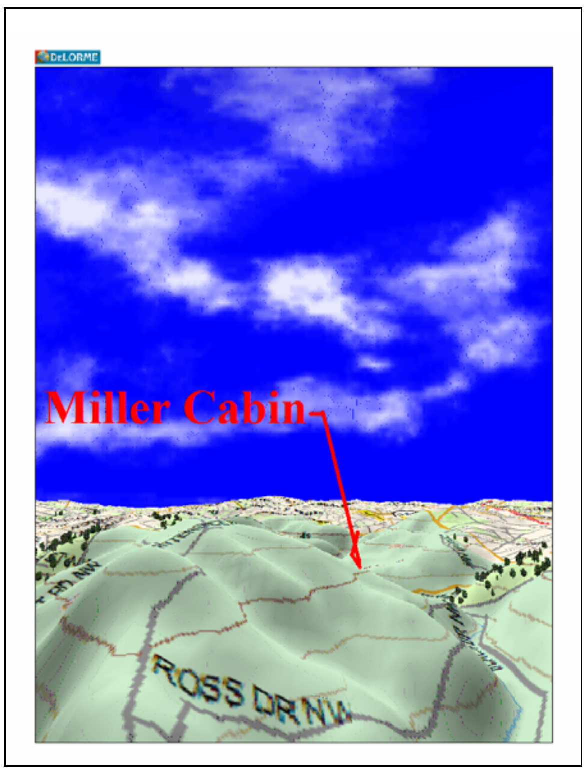


Figure 20: Park Topography

Because radio signals travel in a straight line, obstructions such as those present from topography will either degrade or completely disrupt the signal. To service the Beach Drive area from a close proximity from outside the park, a facility of over 1,200 feet above ground would be required to provide a signal to the area, as shown in this section. There is no method available to construct a facility that size, and even if it could be done, the facility would likely cause severe interference to other like facilities, and would only serve a small portion of Beach Drive due to the curves in the road and the non-linear terrain features. As a result, such a facility is not practical. Based on this gap coverage analysis, it was determined that to address the existing coverage gaps, a combination of sites inside and outside of the park boundaries would need to be used.

The following figures illustrate the coverage gaps determined through this analysis by carrier. This analysis considered one level of signal strength prediction, considered by the industry to be on-street service or -95dBm because the areas with coverage gaps are primarily not in buildings, and this level would allow each carrier a level of service that would allow for necessary connectivity along primarily roadways. For the purpose of this analysis, all maps are intended to show coverage gaps in a clear and contrasting format with areas in green considered satisfactory service and those in white considered unsatisfactory service.

Figure 21 represents all service providers' composite coverage and the resulting coverage gaps. There are a total of 5 carriers and each has been labeled a designated color for anonymity purposes. Figures 22 through 37, illustrate coverage gaps for all providers, starting with the first carrier labeled as Blue Service in the primary area of concern, followed by Green, Orange, Purple and Red. Each color represents an individual service provider.

G. Expanded Area of Concentration

The next step in the analysis was to enlarge the areas of the park where coverage gaps occurred for all carriers. The figures following each carrier's overview enlarge each of the carrier's propagation maps, showing more details in gap coverage for both the north and south parts of the park.

The analysis found coverage gaps for each carrier along the creek bed and Beach Drive. The analysis showed that there is an additional coverage gap in the southern section where there is virtually no signal and appears to be a severe terrain void common to all carriers. This is likely due to natural causes and based on interviews with each carrier it was determined that there is little to no interest in filling the coverage gaps in this area.

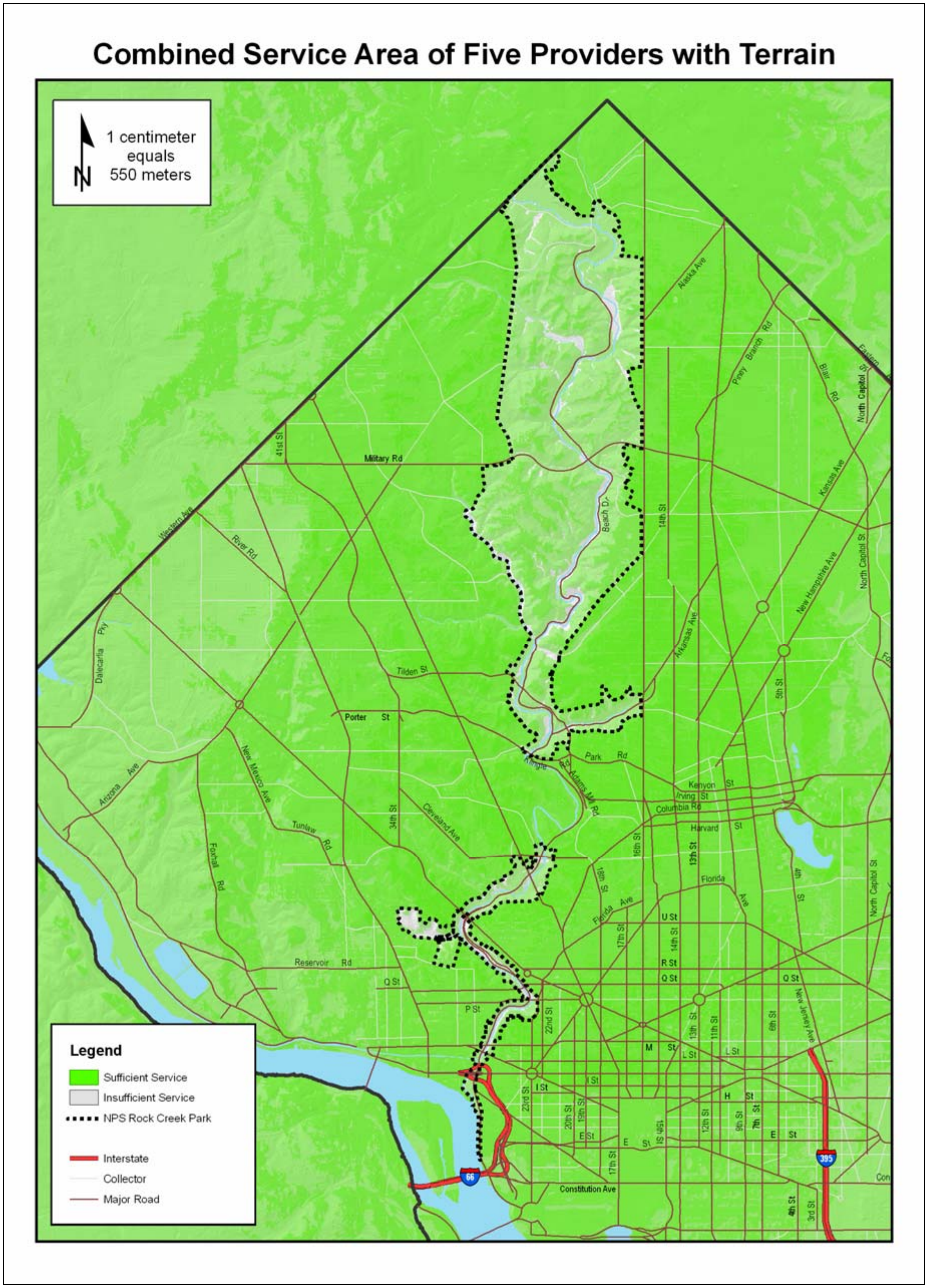


Figure 21: Composite Service Area

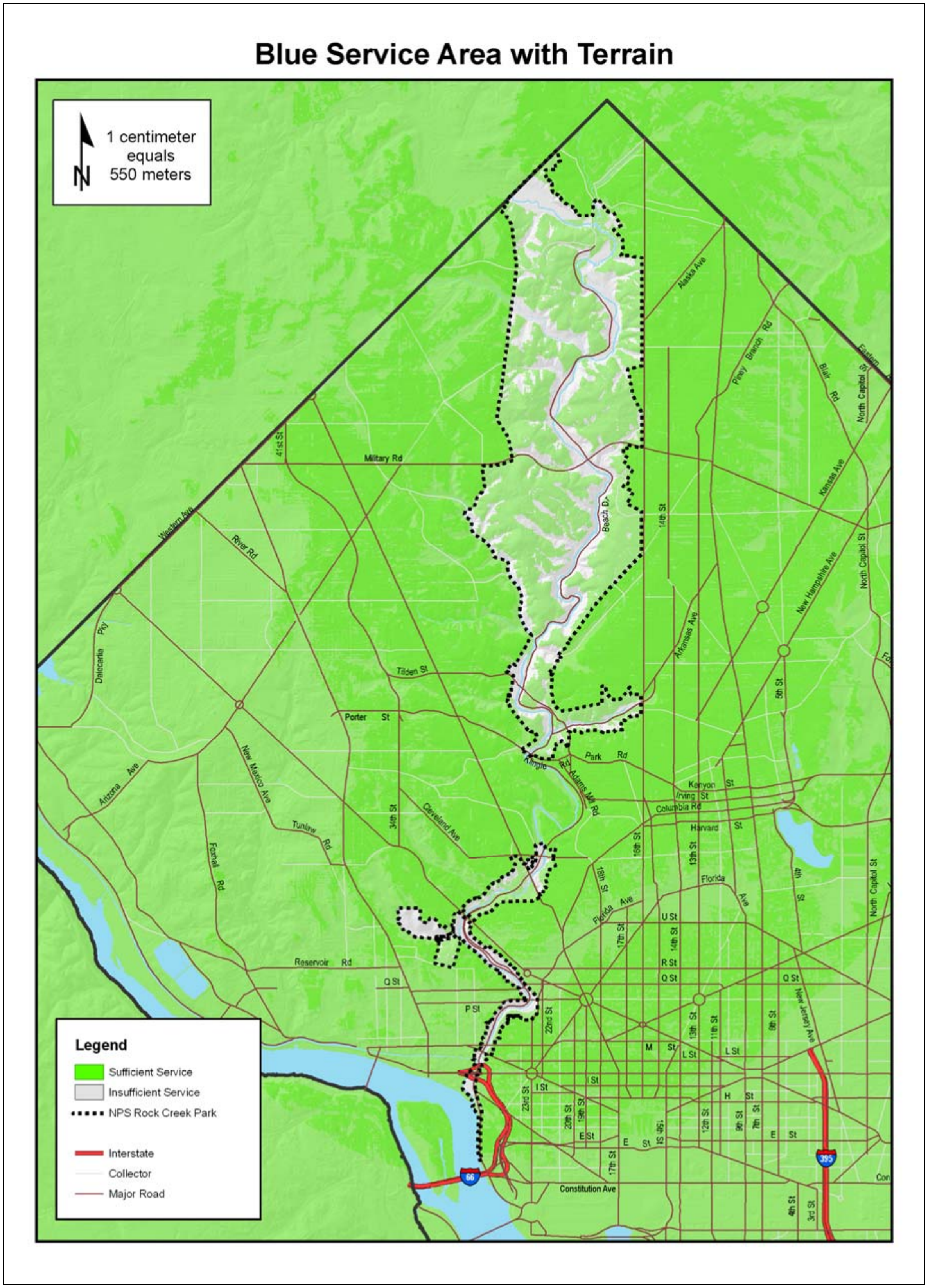


Figure 22: Blue Carrier Service Area

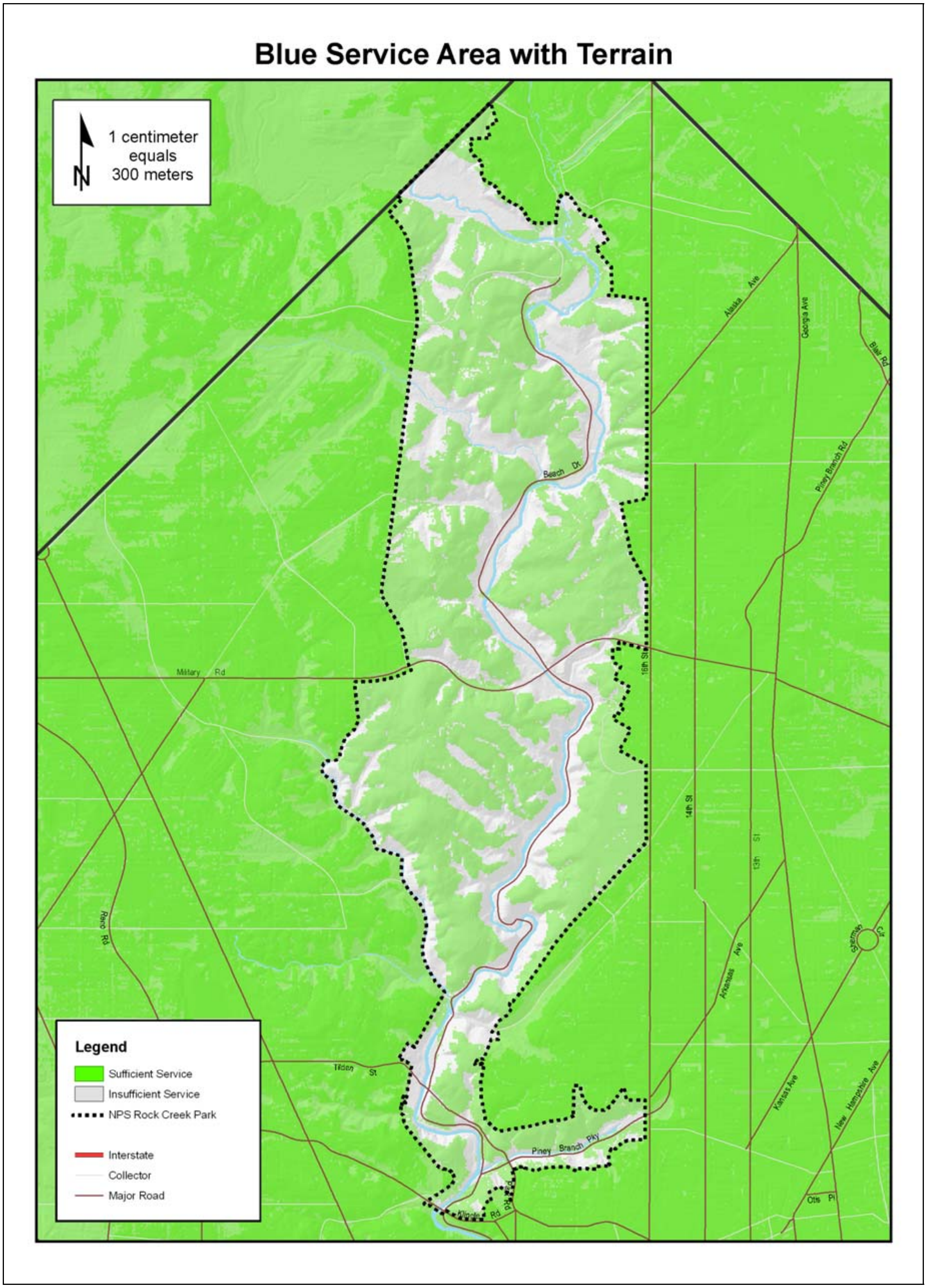


Figure 23: North Blue Carrier Service Area

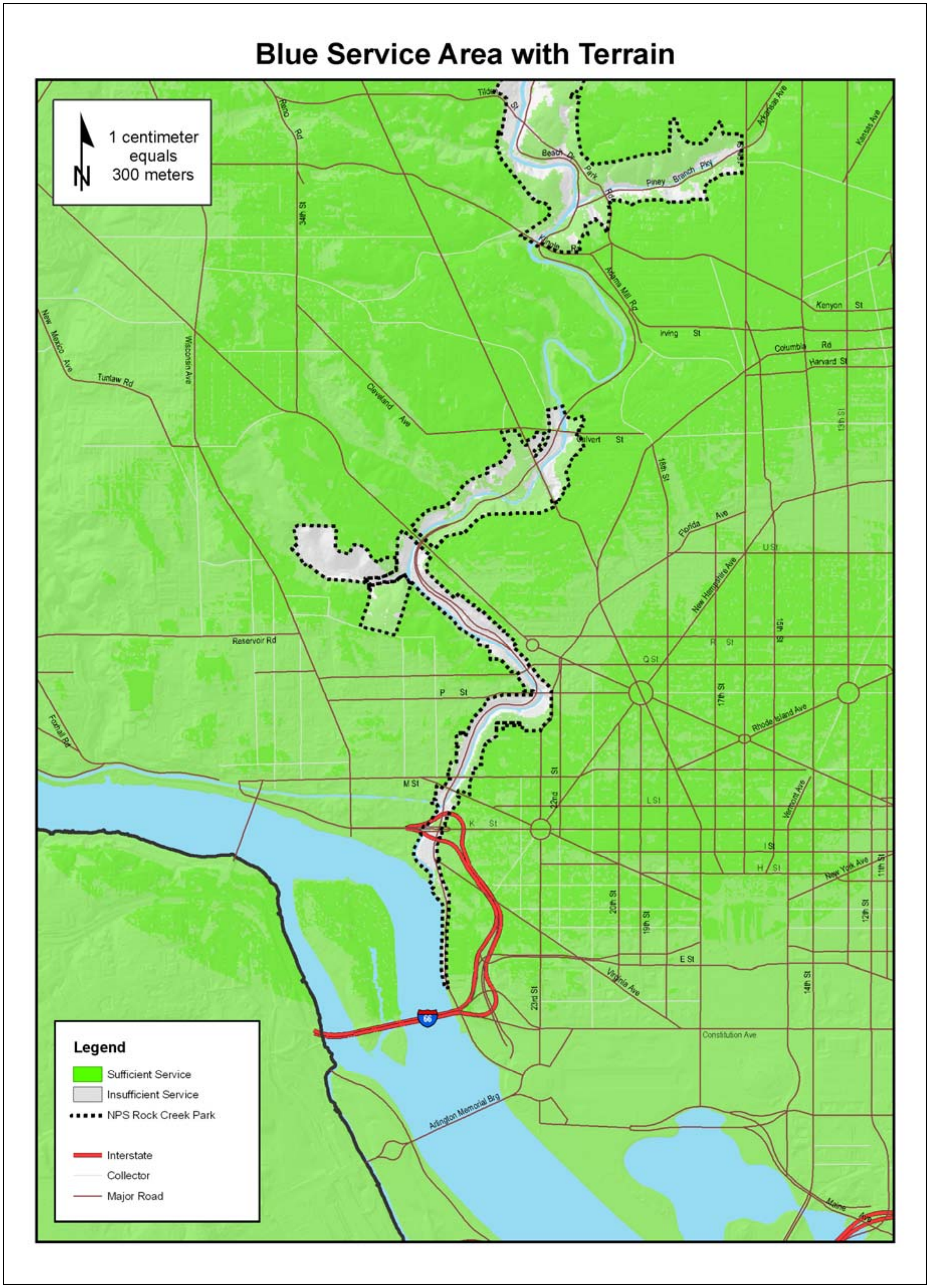


Figure 24: South Blue Carrier Service Area

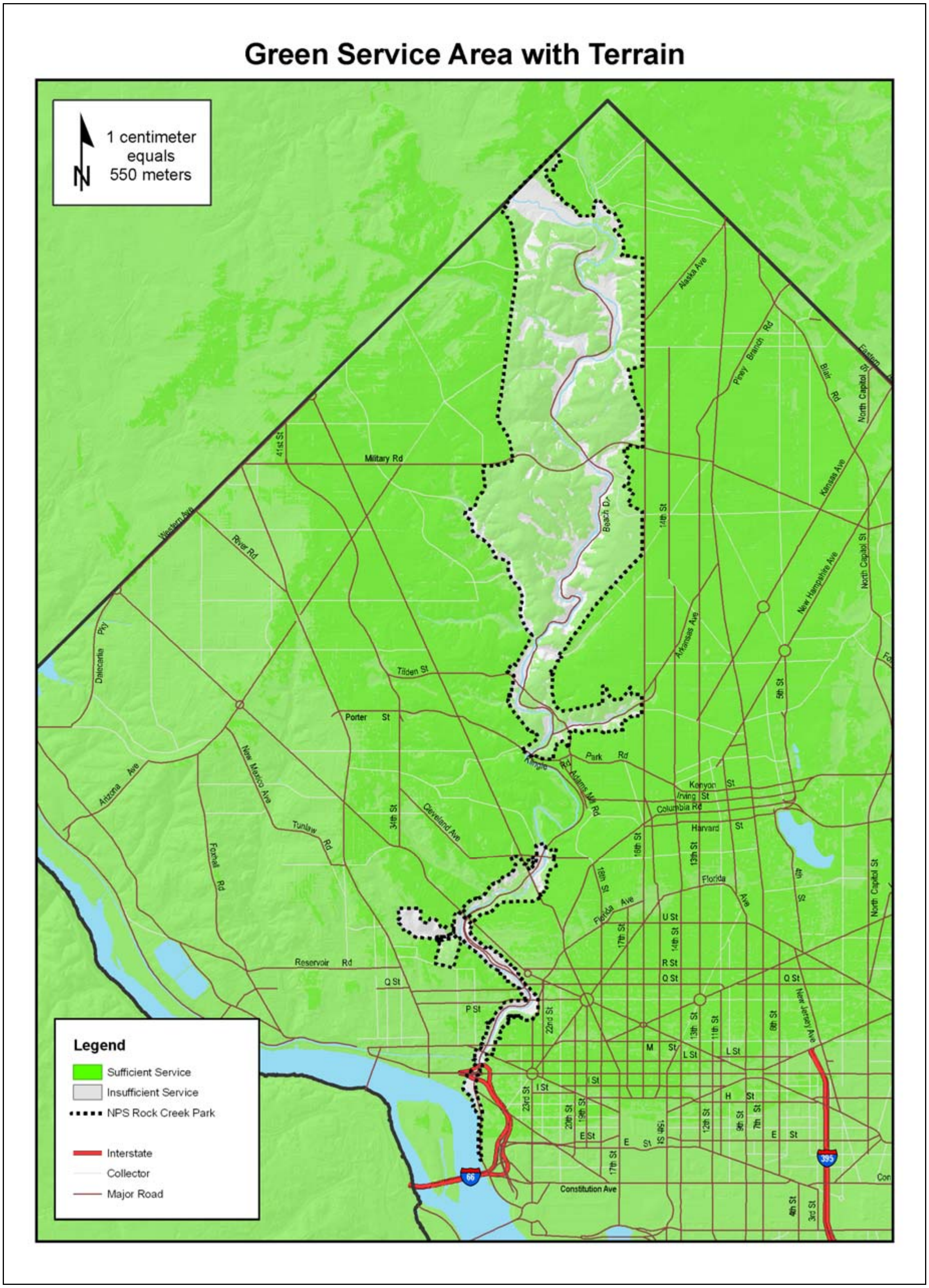


Figure 25: Green Carrier Service Area

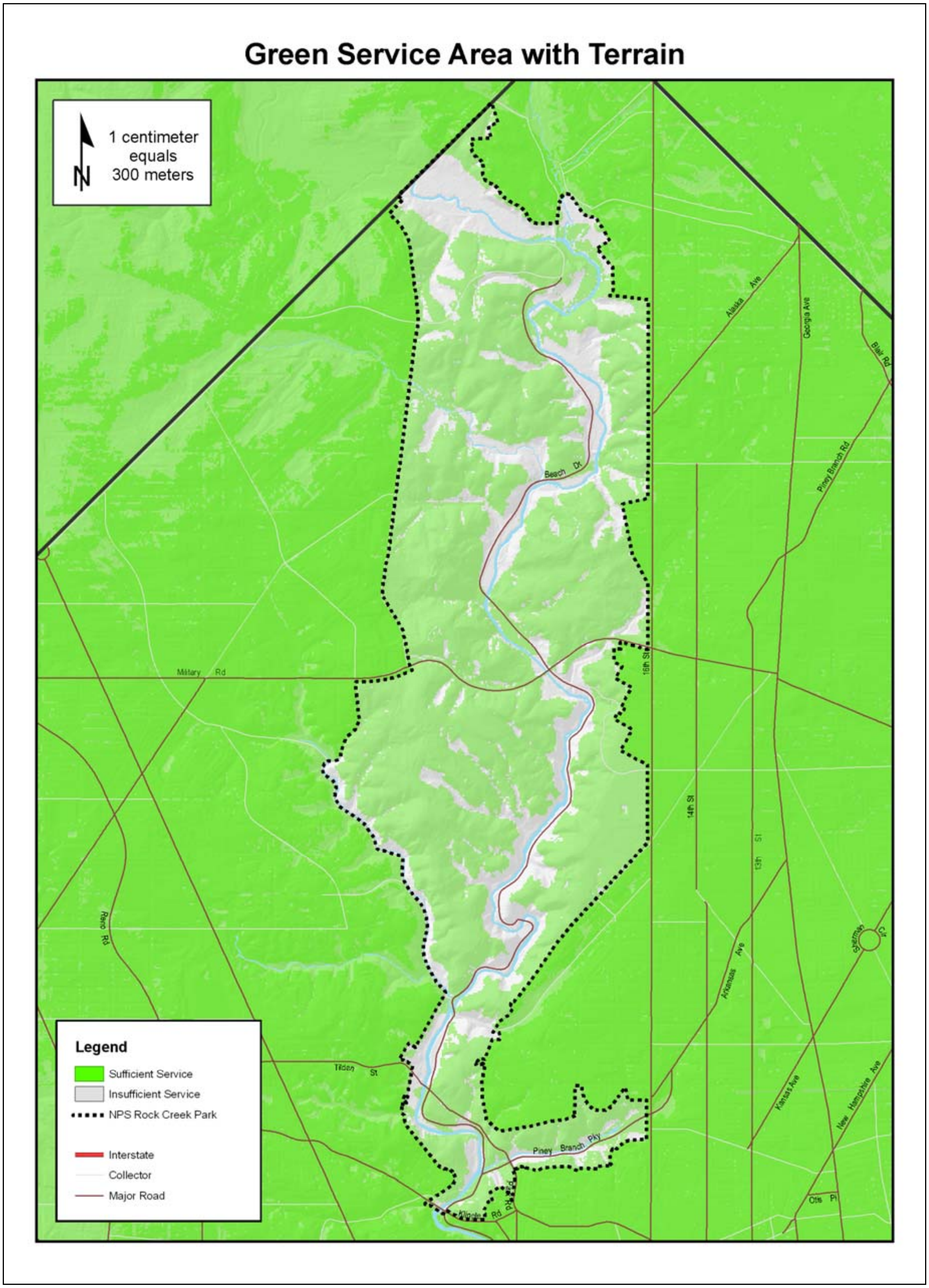


Figure 26: North Green Carrier Service Area

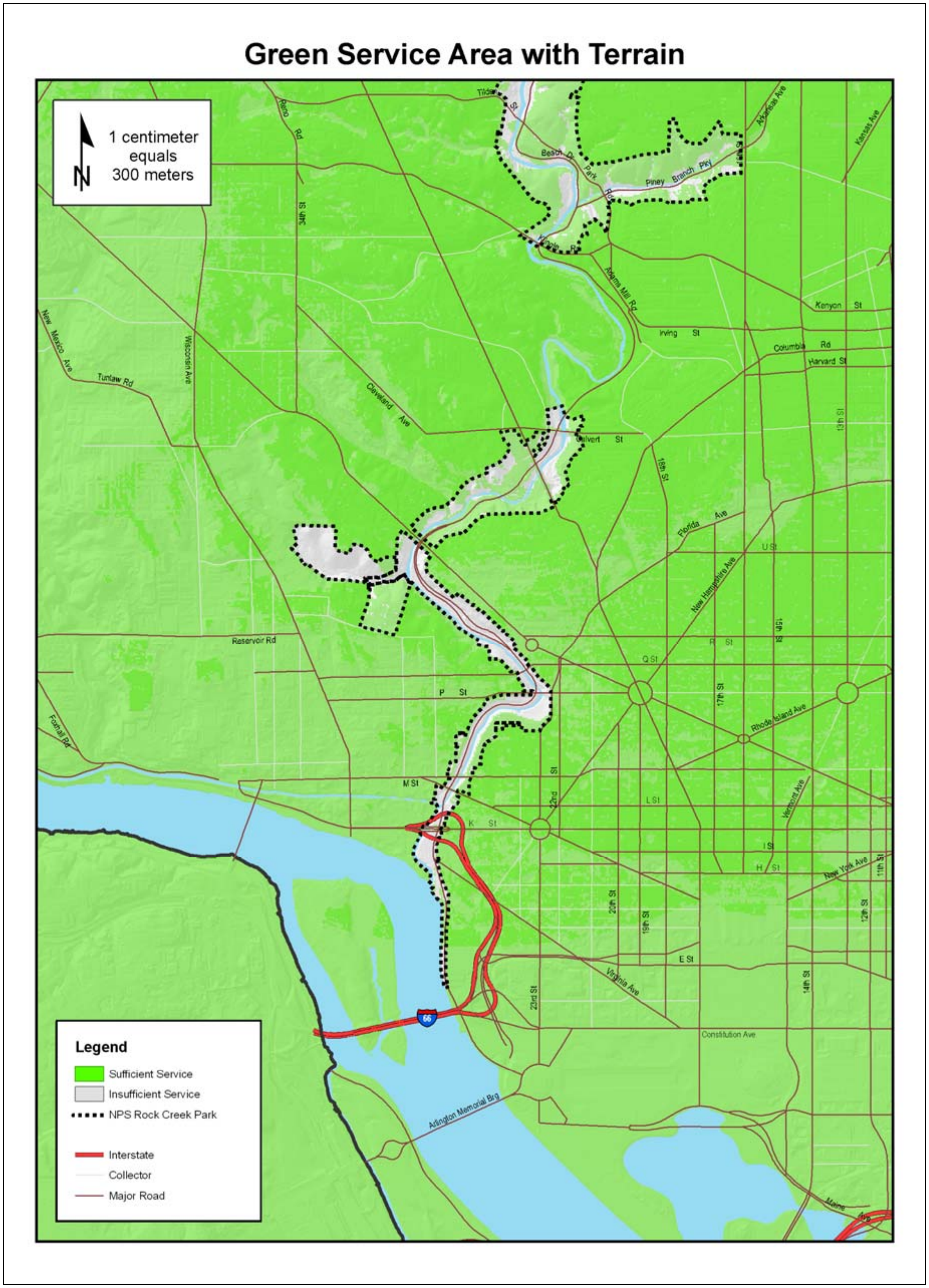


Figure 27: South Green Carrier Service Area

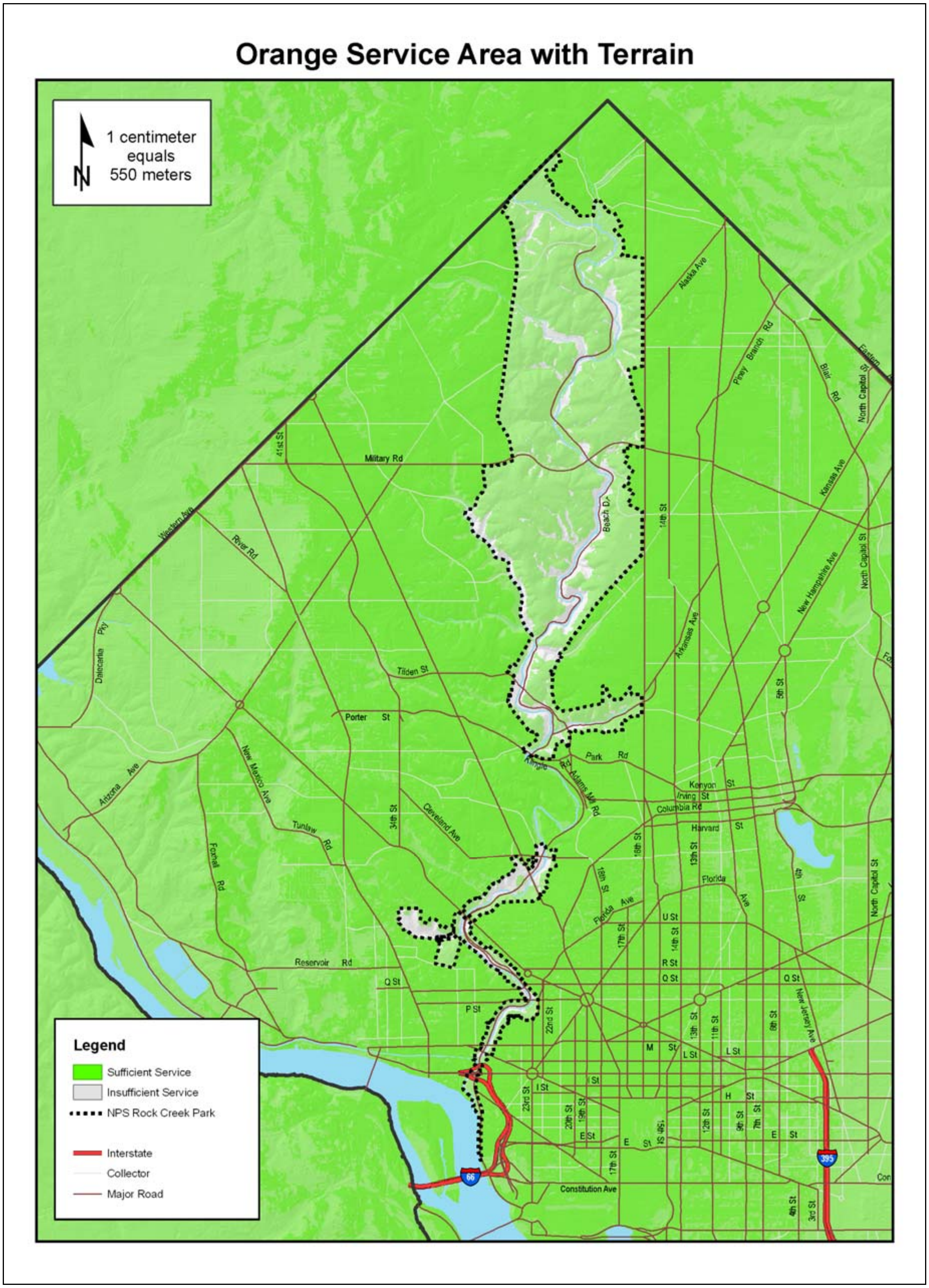


Figure 28: Orange Carrier Service Area

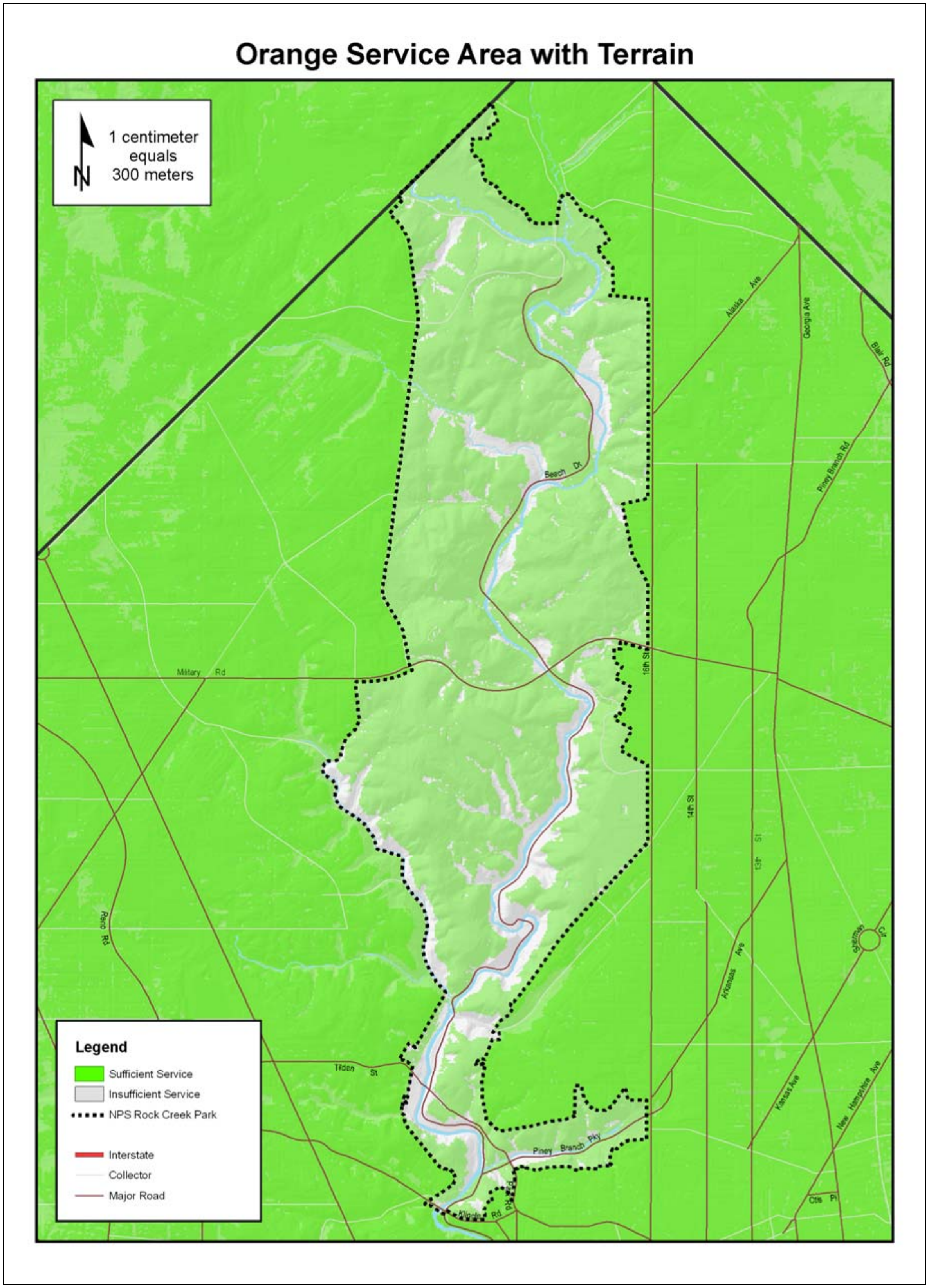


Figure 29: North Orange Carrier Service Area

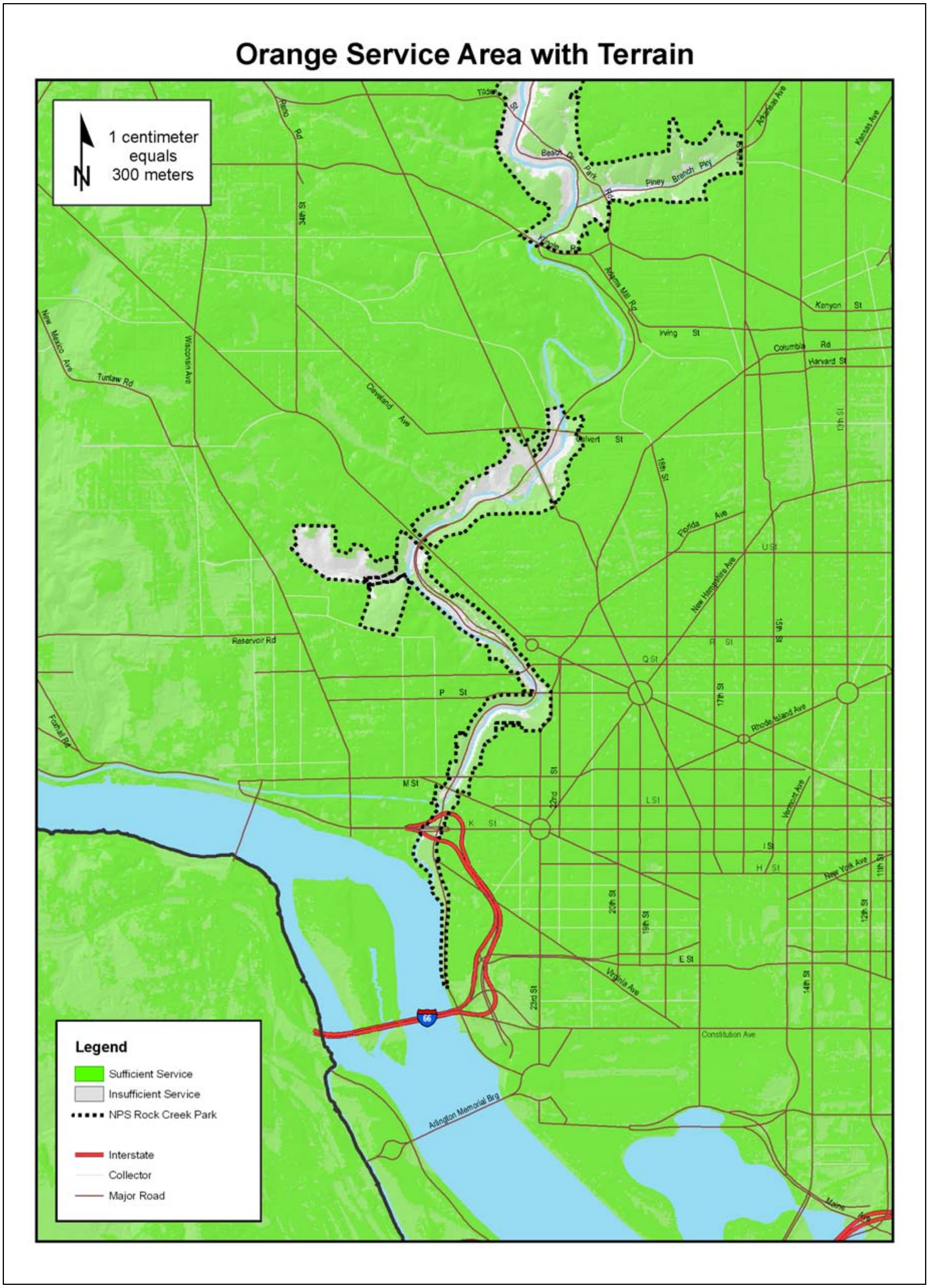


Figure 30: South Orange Carrier Service Area

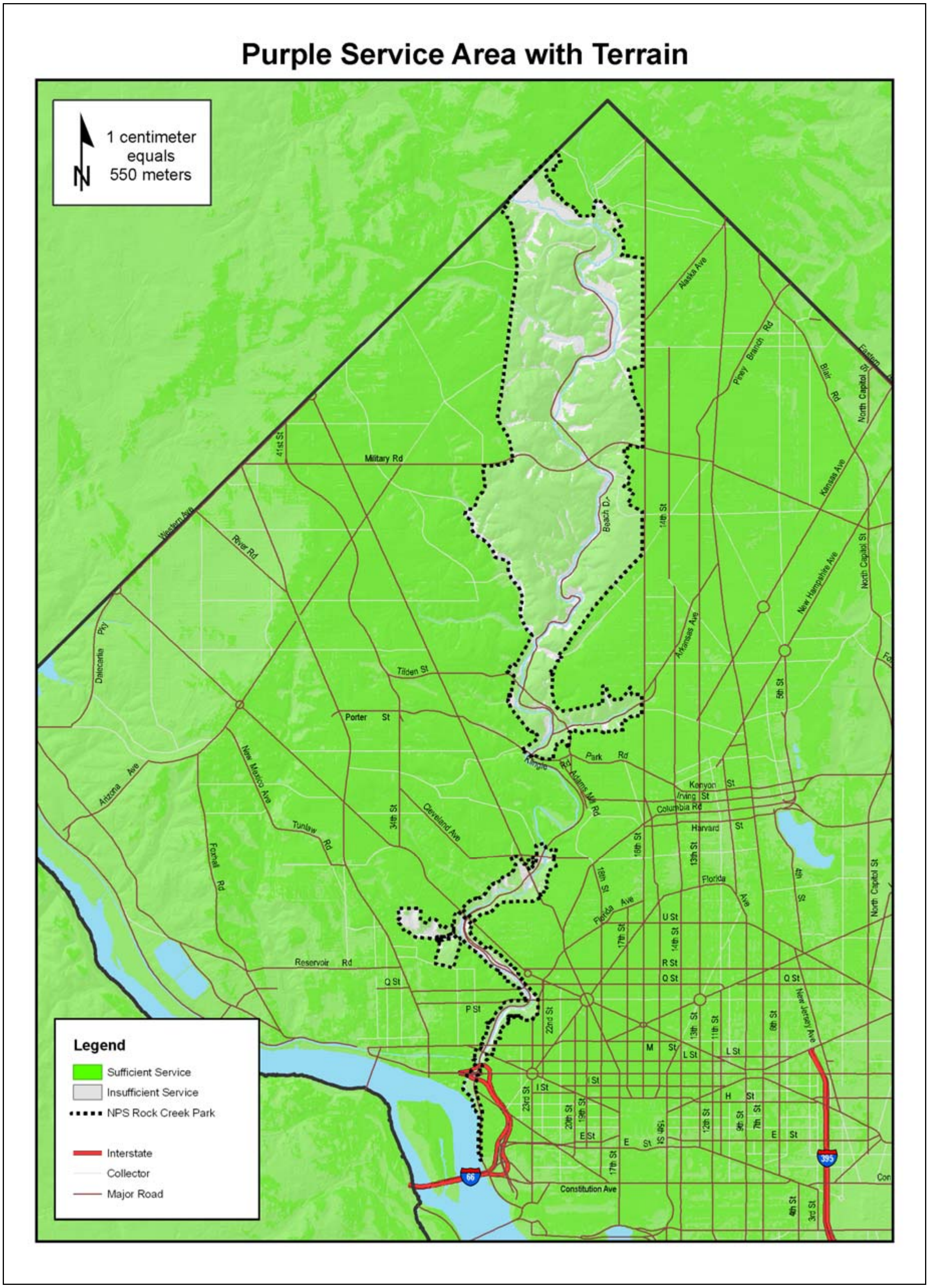


Figure 31: Purple Carrier Service Area

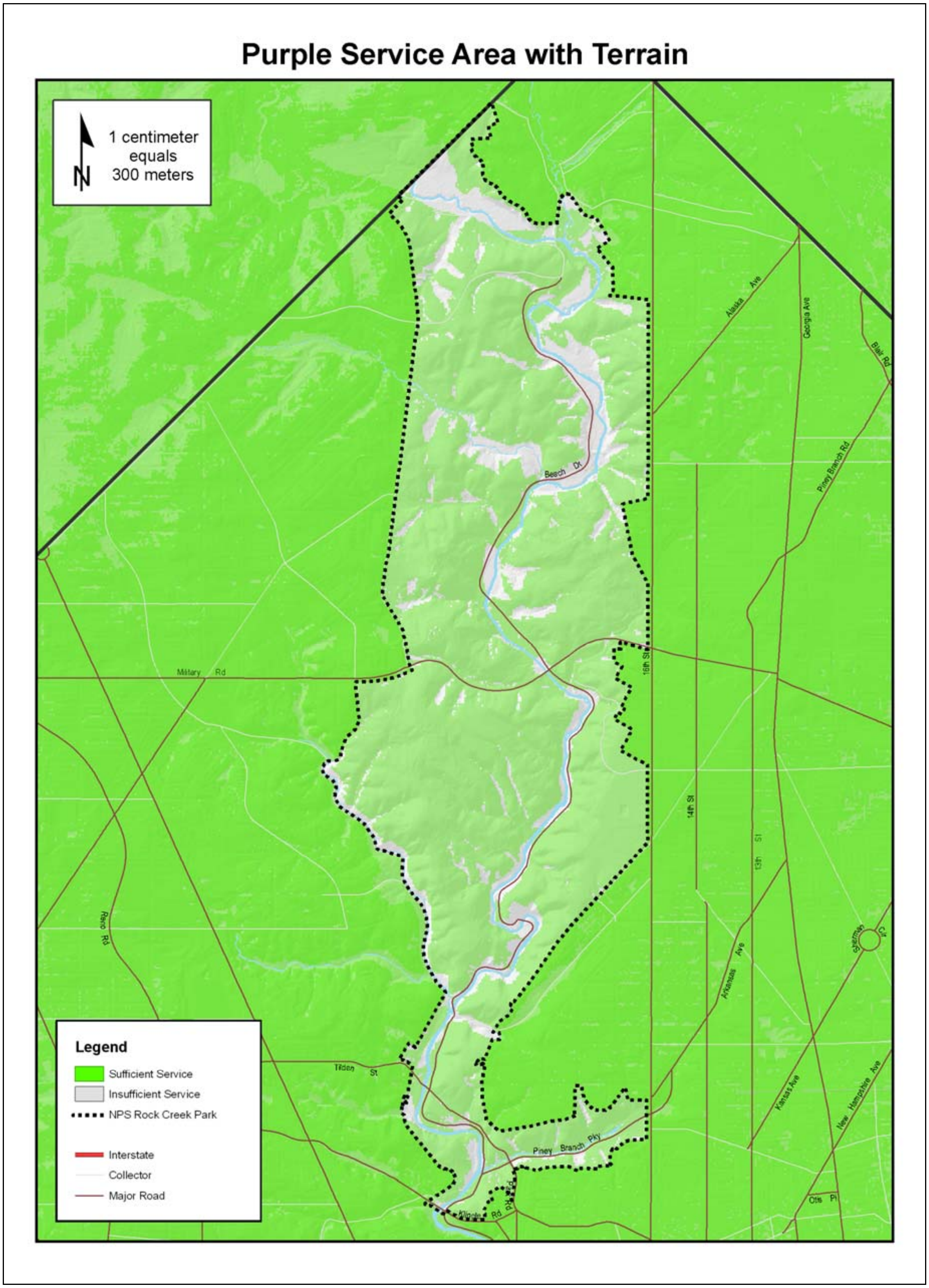


Figure 32: North Purple Carrier Service Area

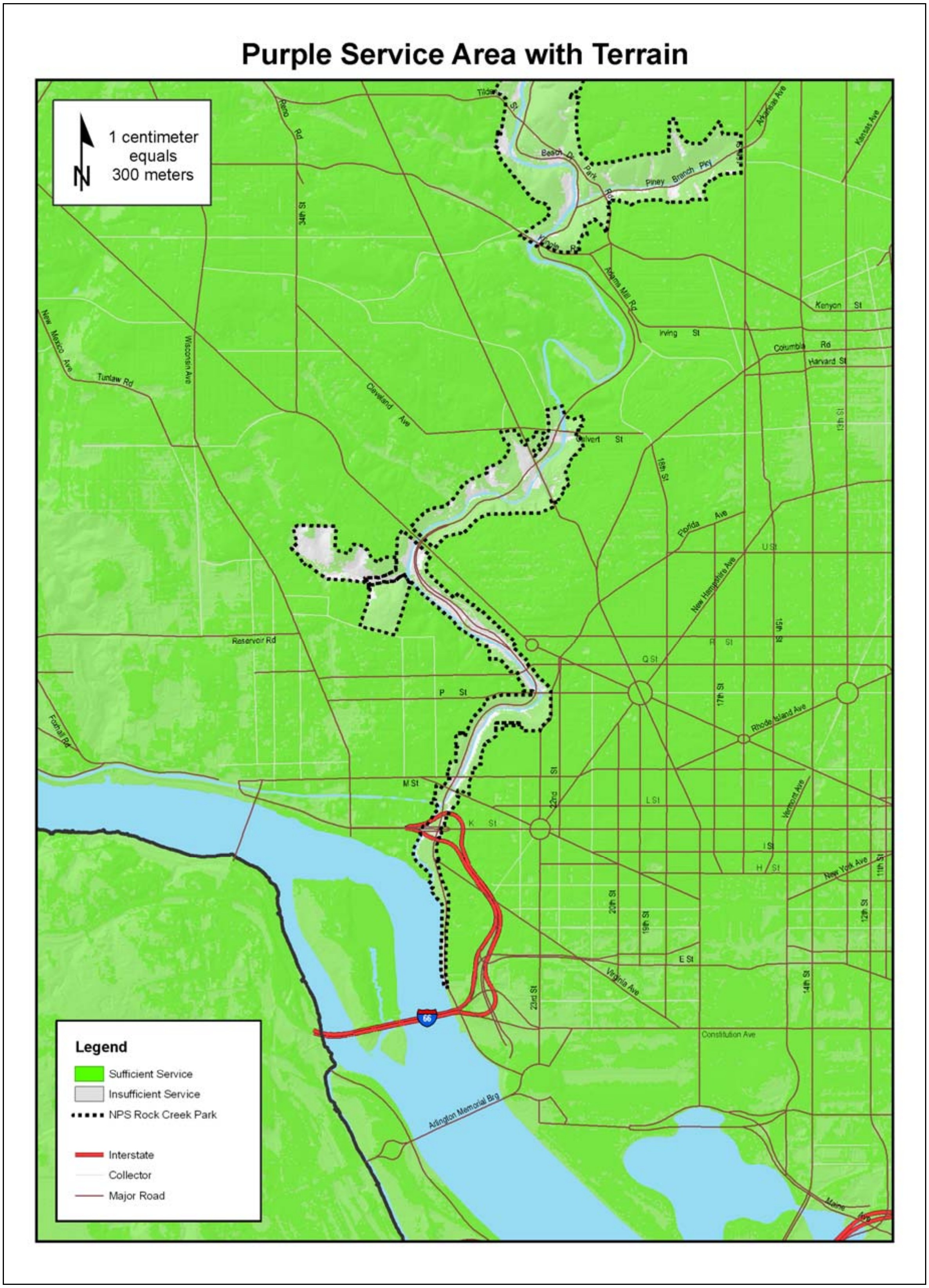


Figure 33: South Purple Carrier Service Area

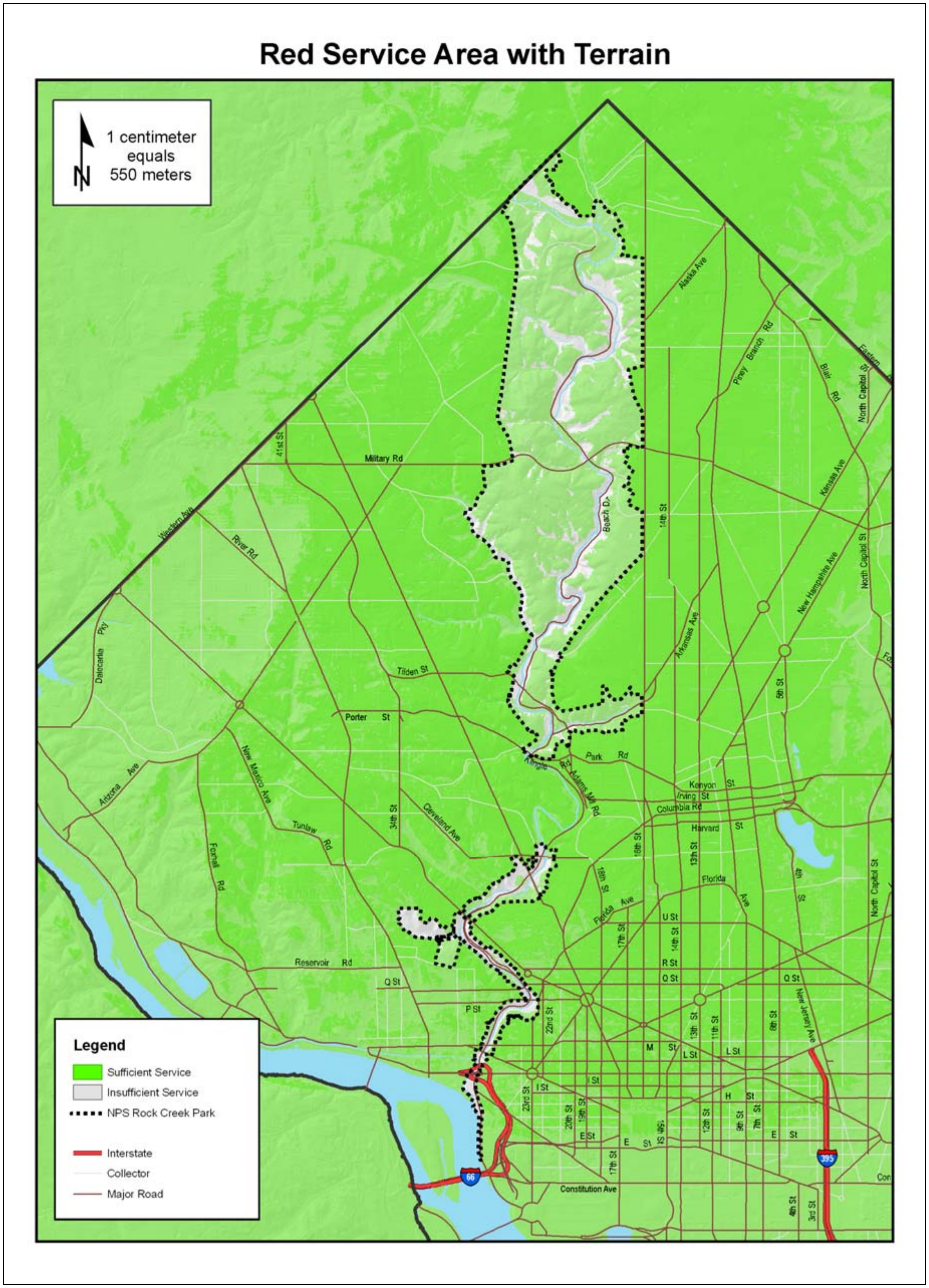


Figure 34: Red Carrier Service Area

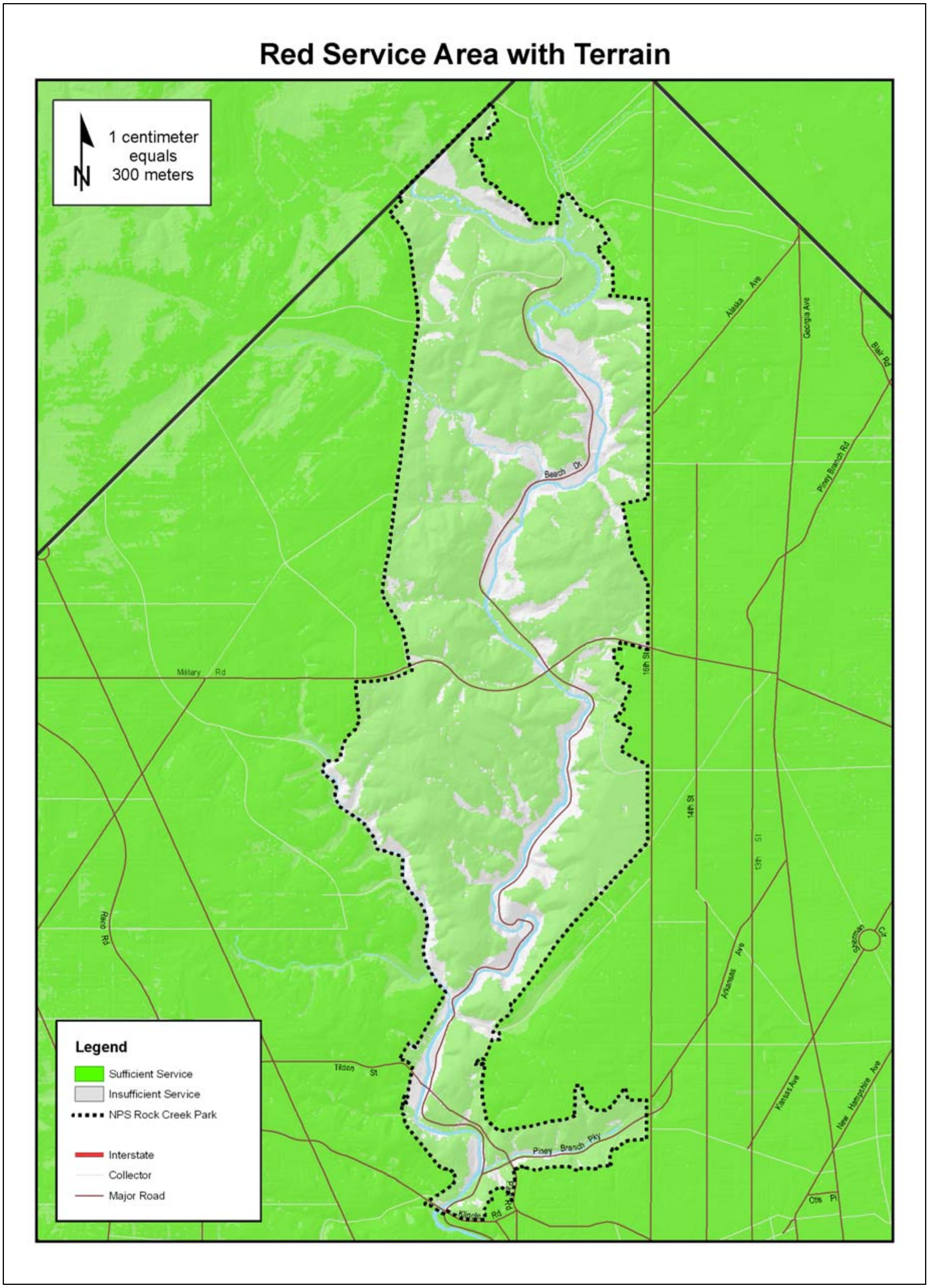


Figure 35: North Red Carrier Service Area

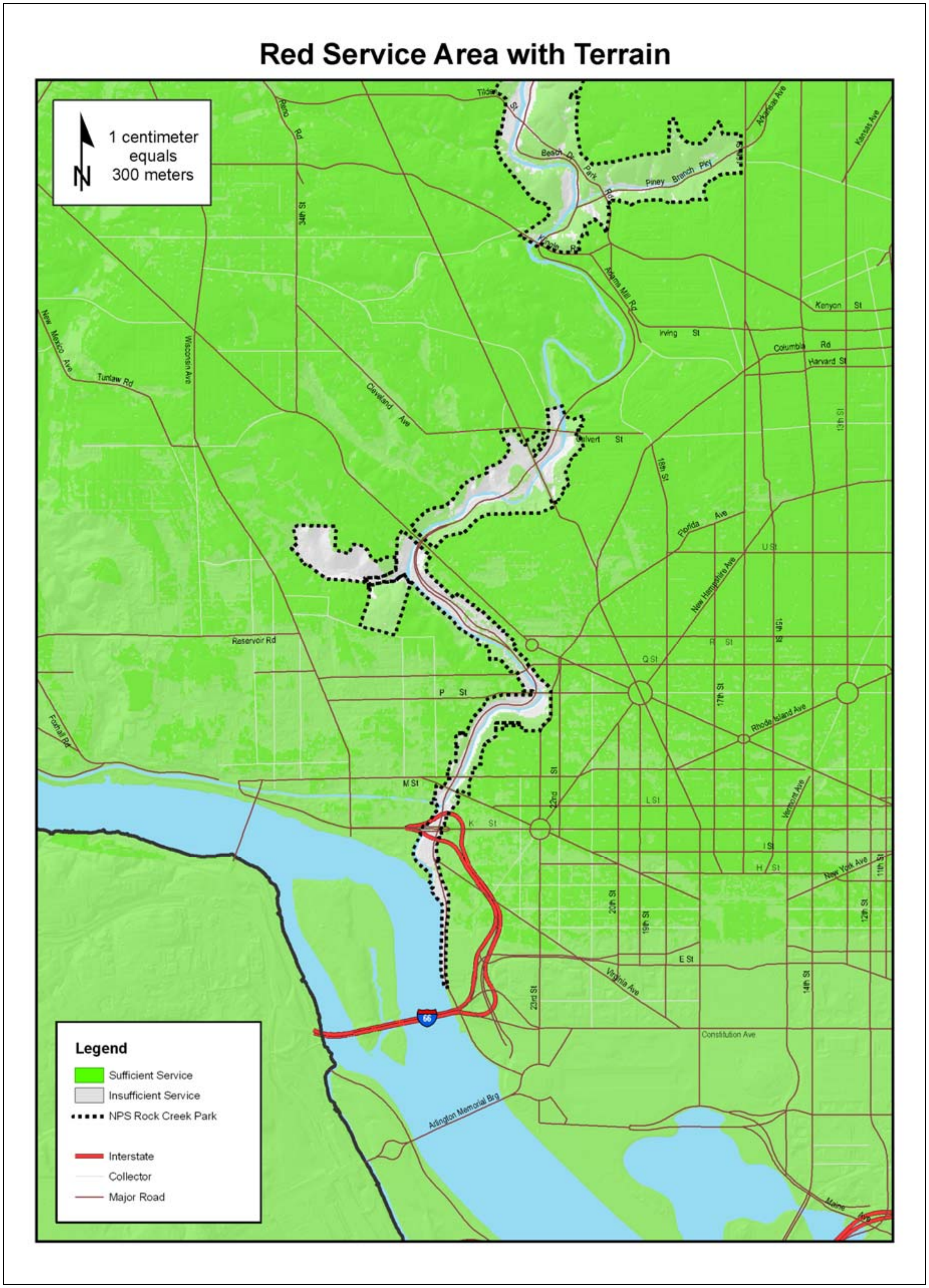


Figure 36: South Red Carrier Service Area

IV. SITING CONSIDERATIONS

A. Future Siting Considerations

When looking at developing wireless telecommunication facilities, it is important to note the history of siting these facilities. Historically wireless service providers have developed their networks individually and on an as-needed basis. This ad hoc method has resulted in a non-uniform development of infrastructure, with each carrier only addressing their particular needs. This is normal and not either illegal or inappropriate, allowing the provider a speed to market. Once a sensitive area is defined, a carrier has interest in rectifying the problem as quickly as they can and having to coordinate with other carriers could slow the process. In addition, from a competitive standpoint sometimes cooperation will work against the individual carrier's success. In recent years there has been more cooperation between carriers, including, but not limited to, communications between carriers of interest in developing sites at the outset of planning.

As part of this analysis, interviews were conducted with firms related to the wireless service providers to explore options that could assist the park in developing alternatives. As the analysis showed, most of the areas that were considered by the interviewees as problematic were in the deep crevices of the creek bed and it was determined that this could not practically be addressed from outside the park boundaries alone, as discussed in Section III. Some technical considerations to consider when addressing coverage gaps in Rock Creek Park include:

- locate facilities directly in the area with no signal, inside park boundaries,
- use a combination of facilities inside and outside the park boundary,
- locate away from the general public on park property, such as at the maintenance yard,
- place concealed facilities along the ridgelines within the wooded areas, all outside of public traffic and view, and/or
- use a combination of facilities in the wood line, and others directly along Beach Drive.

A proposal was presented to the Park by Crown Castle to develop facilities along Beach Drive (Figures 37, 38, and 39). This approach would directly address the known signal void areas, but would require further study to determine an optimum height of each support structure and a reasonable assumption of how many would be needed. Further exploration of this proposal would occur within the context of the alternatives development for the wireless telecommunication facility plan/EA that is currently being prepared. During discussions with providers, the idea of a private infrastructure development, such as Distributive Antenna Systems (DAS), scenario was discussed and all carriers voiced concerns that over pricing would be an issue.

1. Establishment of a Hierarchy

The following shows a hierarchy demonstrating a typical order of siting preference. This is for demonstration only, as a hierarchy would be the sole decision of the park. This example is provided to demonstrate how some municipalities/others have approached telecommunications siting plans.

Example:

Siting of a new transmission structure and new antennas shall be in accordance with the following siting hierarchy:

1. Mounting concealed antenna upon existing structures

   (a) Within pubic parks and open spaces and on other publicly-owned land
   (b) Within the rights-of-ways

2. Replacement of concealed transmission structures

   (a) Within pubic parks and open spaces and on other publicly-owned land
   (b) Within the rights-of-ways

3. Concealed collocation on an existing transmission structure

   (a) Within pubic parks and open spaces and on other publicly-owned land
   (b) In certain right-of-way

4. New concealed transmission structure

   (a) Within pubic parks and open spaces and on other publicly-owned land
   (b) In certain right-of-way

The order of ranking preference, from the highest ranking to the lowest ranking; 1a, 1b, 2a, 2b, and so on. Where a lower ranking alternative is proposed, the applicant must file relevant information 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 ranking options are not technically feasible, or justified given the location of the proposed wireless communications facility.

2. Consideration of Existing Facilities

An objective of this analysis was to recognize the co-location possibilities of existing sites, present a scenario that minimized new facility construction, and determine future demands for the use of park-owned lands for new infrastructure.

Presently there are two wireless telecommunications facilities on park property. During initial interviews, service providers were questioned about the co-location potential of the Verizon owned facilities. Verizon has had inquiries concerning availability of these structures for additional carriers, however currently there are no carriers with plans to add facilities to these structures. One potential reason for lack of co-location could be cost as carriers expressed that Verizon has a substantial up-front capital investment requirement to any new co-locators. This information was confirmed with the structure owner, Verizon, who explained that they felt it was fair for any new carrier be required to share in the cost Verizon incurred initially to construct the facilities.

3. Designated Areas of the Park for Consideration of Applications

When looking at potential future demand for wireless telecommunication facilities, several areas of the park property may at some point fit into the network design objectives of a wireless provider. The purpose, however, of this document is to identify coverage gaps and technologies that may address them.

Figure 37: Crown Castle – Typical DAS Installation

Figure 38: Crown Castle – Typical DAS Installation

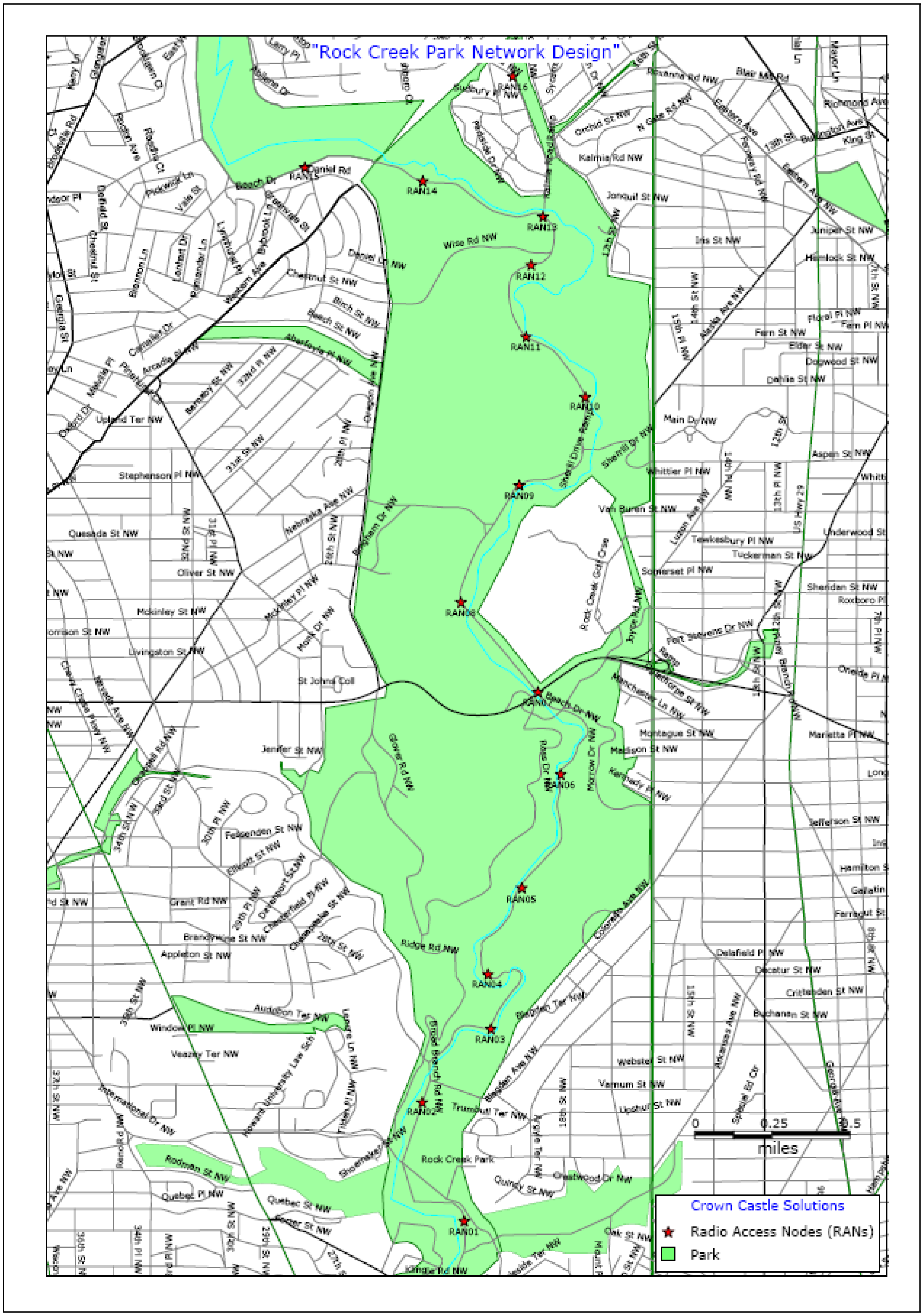


Figure 39: Crown Castle - Projected Locations of DAS Facilities