

**REQUEST FOR  
11-6-19 REVIEW APPROVAL**



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**Rapid City Growth  
Management Department**

Submitted: October 8, 2008

To: Rapid City Growth Management Department

From: John M. Rowe,

Buell Consulting, Inc., Agents for Verizon Wireless

# **TECHNICAL REPORT**

**PROOF OF THE NEED**

**FOR**

**A NEW**

**VERIZON WIRELESS CELL SITE**

**PROPOSED FOR**

**THE RAPID CITY METROPOLITAN AREA BASED UPON**

**A LOOMING CAPACITY SHORTAGE**

**AND**

**A REVIEW OF**

**EXISTING COMMUNICATIONS STRUCTURES**

**WITHIN**

**THE SERVICE AREA OF THE NEW PROPOSED SITE**

**AND**

**ON THE NEARBY RIDGE LINE OUTSIDE THE SERVICE AREAS**

**OF**

**THE PROPOSED SITE**

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## **11-16-19 Review Approvals Pending**

**2870 N. Haines Ave.**

**Verizon Wireless Project Reference: Rapid Mall**

**Purpose of this technical report memorandum:**

Verizon Wireless is currently applying for 11-6-19 Review approval for a new communications facility in Rapid City, SD. This location is in the city limits. The City Growth Management Staff requested some supplemental information regarding this and other recent Verizon Wireless applications. In accordance with this request, Verizon Wireless Radio Frequency Engineer, Gene Buist, created the following Memo.

The purposes of this Memo are as follows:

-To explain the objectives Verizon Wireless hopes to accomplish regarding it's Rapid City plan; namely continuing to maintain adequate system capacity, reducing interference within the system and enabling the rollout of new, enhanced wireless data services available in other markets, but not currently in Rapid City

-To explain some of the current system design issues Verizon Wireless faces as it tries to build a successful network that will keep up with the demands placed on the system by the company's valued Rapid City area customers

-To demonstrate that Verizon Wireless cell sites in Rapid City have reached service capacity limits due to the continually increasing number of customers and usage demand being placed on the network

-To explain the need for certain new wireless antenna support structures in specific proposed locations, and to explain why certain existing communications structures will not satisfy the requirements of the current and future Verizon Wireless network in Rapid City

**Method of this technical report memorandum:**

The design of a successful wireless network in any given area has many variables. Some examples of those variables include terrain, the number of possible users, the concentration of users in given areas, the types of wireless products available to those users, and the proximities of wireless communications facilities to other wireless communications facilities (in other words, the proximity of one cell site in an area to the others in that area).

In order to address the City Staff questions, Gene first explains the general service objectives for Rapid City, then he addresses several specific sites individually that Verizon Wireless has integrated into the network and the proposed site for which 11-6-19 Review approval has been requested from the City. This is followed by graphics explaining the proposed overall future coverage plan for Rapid City, and in closing there is a discussion of the impact of interference issues on system effectiveness.

Below is an outline of the contents of this Rapid City Design Memo. The last item in the outline is a Definitions section. There are a number of technical and industry jargon

terms throughout this Memo. Most of these terms are likely spelled out in the Definitions section for the reader's convenience.

If you should have any questions regarding this Memo, please feel free to contact John Rowe, Verizon Wireless representative, at 303-220-9100, or [ComRealEst@aol.com](mailto:ComRealEst@aol.com).

## **RAPID CITY SYSTEM DESIGN MEMORANDUM OUTLINE**

### **Rapid City Objectives**

- Keep up with the growing demand upon system capacity
- Reduce interference between sites that negatively affects system capacity
- Improve the signal quality to provide more uniform In-building coverage
- Provide enhanced high speed wireless data access services (i.e.-wireless internet)

### **Appendix A. Background Material for Design Philosophy**

- Map of Rapid City showing Verizon Wireless built and proposed sites as well as other existing communication structures
- Table showing the anticipated capacity exhaustion of certain sectors of existing Verizon Wireless sites in Rapid City
- Table showing the system growth in traffic demand since January, 2006
- Map showing current coverage of Rapid City from 2007 pre-existing sites
- Map showing the future coverage of the 2007 pre-existing sites, without the Dinosaur Park site and with the Century and Box Elder sites modified to eliminate and/or reduce interference to the new and proposed sites since 2007.

### **Appendix C. Design Justification for the proposed Verizon Wireless site referred to as: Rapid Mall (2870 N. Haines Ave.)**

- Map showing planned coverage service area for the Rapid Mall site along with future planned coverage of surrounding existing Verizon Wireless sites
- Map showing existing structures pertaining to Rapid Mall

**Appendix H.** Coverage map comparison showing coverage of the new & proposed sites vs. certain existing communications sites in the area.

-Map 1: Coverage of new proposed sites along with future planned coverage of the existing sites

-Map 2: Coverage of existing additional structures near search areas along with future planned coverage of the existing sites

**Appendix I.** Controlling Interference

-Map showing troublesome coverage vs. interference generated by the existing Dinosaur Park site

-Map showing troublesome coverage vs. interference generated if Verizon Wireless were to use the Western Communications existing structure in the area.

-Map showing troublesome coverage vs. interference generated if Verizon Wireless were to use the Western Wireless existing structure in the area.

-Map showing how the future planned SW Rapid site, by example, will establish its desired coverage without creating interference to other sites because of the natural barrier to signal propagation established by the surrounding terrain.

**Appendix J.** Definitions

**1900 MHz (megahertz) coverage/range/band-** A block of over-the-air communications frequency spectrum designated by the Federal Communications Commission for the provision of telephone voice and data services through the public switched telephone network.

**Capacity-** this word could apply to just one cell site at a time, or can be used in the context of discussing whole networks. Capacity is used to describe the number of users (customers) that any one cell site, or any network of cell sites can handle simultaneously.

**Data throughput-** The amount of information able to be transmitted and received through any one cell site

**Enhanced data products/services-** Examples of these products include, wireless internet access, or downloading music or other large file types to a customer's phone.

**High Speed Data Only Technology-** Newer services being offered by Verizon Wireless in other markets, which includes: wireless internet access, e-mail, text messaging, the ability to download video clips of news, sports and popular shows and the ability to download music directly to the mobile phone. Users can now receive computer files with large attachments via e-mail on their phones without significant delay.

**Offloading capacity-** Relieving the strain on a cell site or network in order to allow another cell site or another part of that same cellular network to function more efficiently.

**Sector-** A unique set of antennas that transmit in a given direction. For Rapid City, almost all the sites have three sectors that point north (0 degrees), southeast (120 degrees) and southwest (240 degrees).

**Spectrum (as allocated between wireless providers in the market)-** a range, or band, of radio frequencies. Each wireless provider in a certain area has a finite amount of spectrum available with which to provide wireless service.

**Voice carrier-** This term represents the increments by which a wireless company adds capacity to each communication site within the constraints of spectrum the given wireless company is licensed to operate in a given market. The addition of a voice carrier also translates to specific equipment within the proposed equipment shelter that handles a sub-portion of the overall capacity of the given cell site.



## Memo

**To:** Rapid City Planning Commission  
**From:** Gene Buist  
**Date:** 03/01/2007  
**Re:** Rapid City Design

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### **Rapid City Objectives**

The main objectives of the new Verizon Wireless proposed Rapid City sites are twofold. First, Verizon Wireless is anticipating running out of network capacity in the next two years within the market based on our current customer growth pattern. Currently, Verizon Wireless owns 32.5 Megahertz (MHz) of spectrum within Rapid City, 22.5 MHz in the 850 MHz range and 10 MHz in the 1900 MHz range. Both blocks of spectrum currently handle voice calls and data services (i.e. internet access, text messaging, picture messaging, email, etc.). Currently, Verizon Wireless is utilizing all but a small portion of this spectrum to support its customers within Rapid City. Verizon Wireless is currently unable to launch its high-speed data only service in Rapid City due to the lack of spectrum. This technology includes the ability to download video clips of news, sports, and popular shows, download music directly to the mobile, and customers can receive files with large attachments in email without significant delay. To achieve these higher speeds, a separate block of spectrum is required that does not support voice calls. Current data services utilize the same spectrum as voice. The current data services allow for an average throughput of 60-80 kilobits per second (kbps), just slightly faster than dial up capability. The high-speed service enhances the customer experience by increasing received throughputs to an average of 500-700 kbps. The proposed sites would allow for an increase in system capacity to better utilize the spectrum Verizon Wireless owns and allow for enhanced data only services currently not available in Rapid City. Three ways to increase capacity are discussed below. The second objective is to provide reliable in-building coverage to our customers. The reliable in-building coverage enhances the customer experience for both voice and data.

### **Keeping Up With Growing Demand on System Capacity**

When a cellular system is first introduced into a market, the objective is to provide coverage to the most people with the fewest sites. For a significantly varying elevation region like Rapid City, this usually requires the first few sites to be placed on higher elevations with two hundred to three hundred foot towers. These size towers can provide coverage to a large geographic area. An example of this is the Dinosaur Park site, which is visible from almost everywhere within the city limits. However, as the number of users continues to increase on the system, these large towers hit a capacity limitation. The long-term solution to this problem is to build new cell towers around these large towers with the intent to abandon the large tower. As the number of users increases, the concentration of users in a given area increases as well. These new towers need to be able to handle a similar number of users as the initial tower, but covering a smaller geographic area. Therefore, they are built at smaller heights than the initial sites. For a town like Rapid City, these new towers are placed in lower



elevation areas surrounding the initial site. An example of this would be in the downtown area of Rapid City. Verizon Wireless currently has cells roughly two miles apart to handle the current traffic levels. The addition of these sites adds capacity into the network.

### **Reducing Interference Among Sites that Negatively Impact Network Capacity**

Another method of increasing capacity is through the control of the radio frequency (RF) signals between towers. When signals from different towers significantly overlap, fewer users can be placed on a tower due to the interference created. This interference causes more power per user to be required. Given amplifiers have a maximum output power, the number of users capable of being supported is reduced if the power per user is high. Once the amplifier power limit is reached, the capacity limit is achieved. Therefore, to increase capacity, the power per user must be minimized. Because of this, a site like Dinosaur Park, which transmits over the top of the nearby smaller sites creating widespread interference, requires removal to increase capacity. An ideal design would be to place sites equidistant from each other with similar elevations and tower heights. This provides the best way to control the interference between towers and provides the best distribution of traffic between sites. In Rapid City, which has significant changes in terrain, this becomes a difficult issue. Removing a site like Dinosaur Park can remove coverage from areas that are blocked by terrain from the smaller, lower elevation sites. Therefore, it requires a few more sites strategically placed among the terrain to cover the most customers while continuing to provide reliable service.

### **Purchasing Additional Spectrum**

A final method of offloading capacity is through the purchase of additional spectrum. To open up competition in the wireless industry and to allow for enhanced services besides traditional voice, the federal government opened up additional spectrum in the 1900 MHz range for purchase. Verizon Wireless has already pursued this method by purchasing an additional 10 MHz of spectrum in the 1900 MHz band. Given that an 850 MHz signal is more robust for in-building coverage, the 1900 MHz signal does not perform as well with the current system design. Even with this additional spectrum, towers such as Dinosaur Park, Century, and Box Elder are reaching spectrum exhaust. Many of the smaller towers are nearing capacity limitations as well. The additional proposed towers not only would increase system capacity, they would also improve the overall customer impact across both the 850 MHz and 1900 MHz spectrums.

### **Improving In-building Coverage and Providing Reliable High-Speed Data Services**

In addition to the capacity issue, Verizon Wireless would like to improve in-building coverage to many homes within the area for three reasons. First, many of our customers have begun to forego the traditional landline in the home in favor of their Verizon Wireless mobile phone. Many people desire one phone number as well as one bill to pay. Homes that are over two miles from many of these sites are marginally covered for in-building penetration. Most of the proposed sites are strategically placed to significantly improve in-building coverage. The second reason is to improve the customer experience when serviced on the 1900 MHz block throughout Rapid City. Given the current number of sites, Verizon Wireless must utilize this additional spectrum to support the current traffic demands throughout Rapid City. Numerous customer complaints recently have been recorded due to the poorer performance of this spectrum block. The final reason to improve in-building coverage is to enhance our data products. These wireless data services require solid coverage to produce the highest possible data rates. Current data rates experienced by our customers within Rapid City generally fall below the desired average throughputs expected within Verizon Wireless networks. The proposed sites are designed not only to increase capacity but also to improve the data throughput.

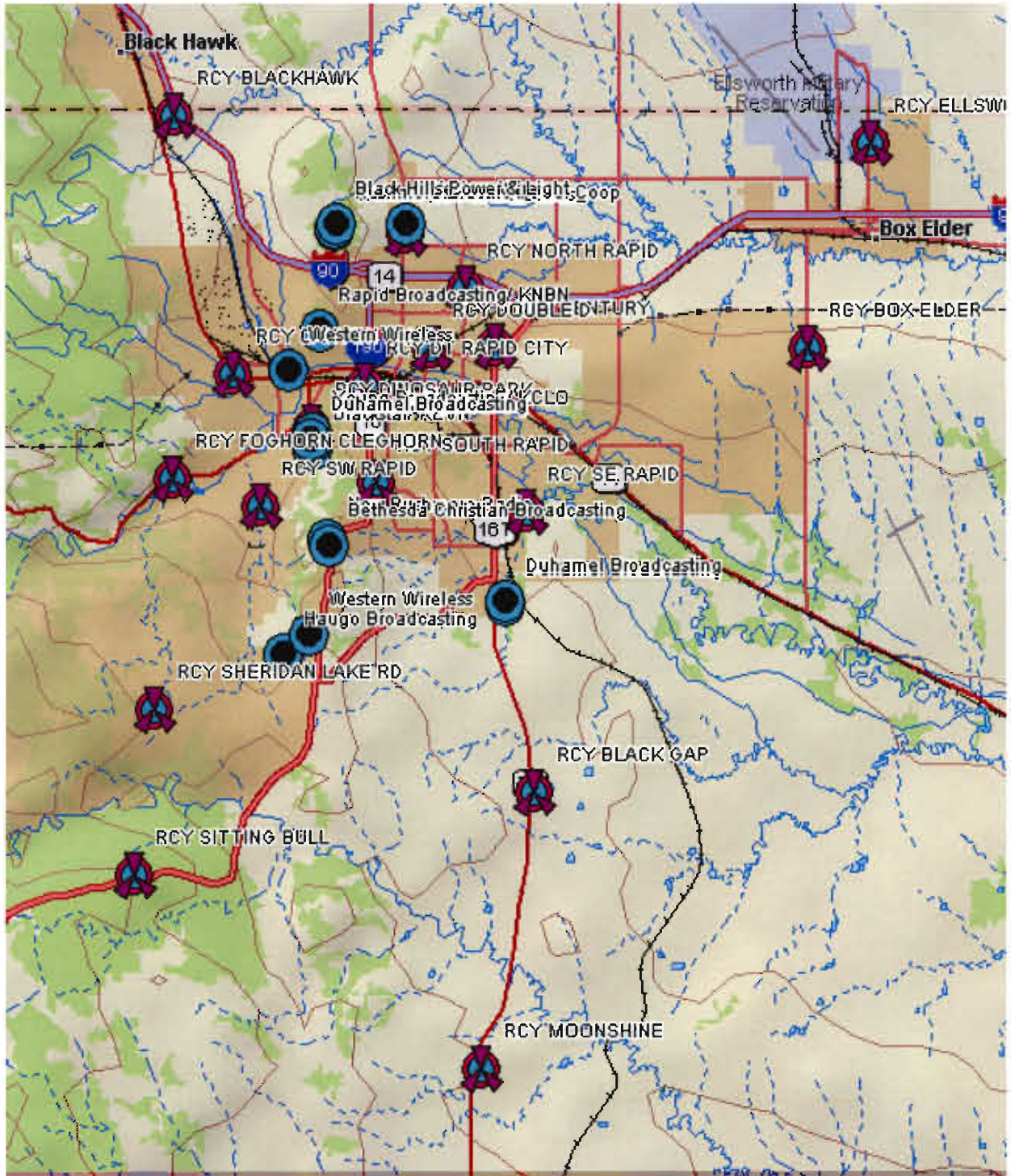
As previously stated, Verizon Wireless is quickly approaching spectrum limitations within Rapid City due to these large and/or higher elevation sites, i.e. Dinosaur Park, Box Elder, and Century. The proposed sites not only address the capacity issues but also have been selected to aid in the removal and/or alteration of these higher elevation sites. The end result with these sites is to significantly increase the system capacity, allow for the introduction of new services, and improve the overall customer experience.

The design rationale of each site is discussed in the attached appendices. Coverage maps are also provided to show the significant improvement.

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## Appendix A. Background Material for Design Philosophy

Here is a snapshot of the proposed design for Rapid City. The existing structures are shown as well. This will be helpful in understanding the design philosophy going forward.

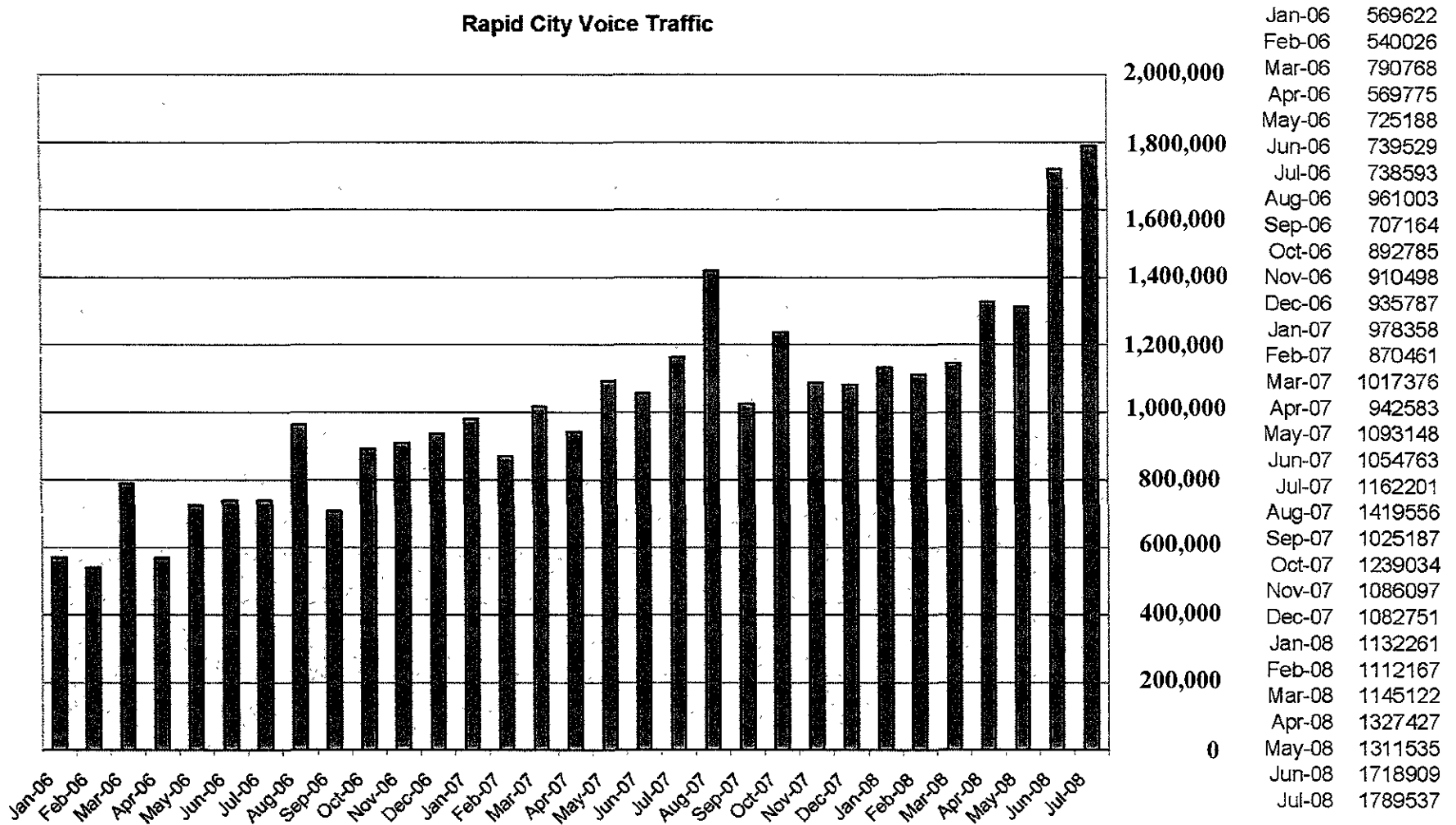


Here is a table showing the capacity needs for the sectors approaching capacity limitations in Rapid City. A sector is generally defined as a unique set of antennas that transmit in a given direction. For some sites, only one set of antennas exists that transmits in all directions. For Rapid City, almost all sites have three sectors that point north, southeast, and southwest. The sectors highlighted in red show a capacity limitation over the next two years. To support the growth trend with the current system design, the remaining spectrum owned by Verizon Wireless must be utilized to handle the available voice and data services presently provided in Rapid City. Doing so would prevent Verizon Wireless from implementing its high-speed data only service into Rapid City with the current number of sites.

Cell Name	sector	Current BHCCS	Capacity	1Q07	2Q07	3Q07	4Q07	1Q08	2Q08	3Q08	4Q08
DINOSAUR	N	6836	9593	7317	7808	8300	8786	9275	9763	10251	10739
DINOSAUR	SE	8223	9567	8801	9392	9984	10568	11156	11743	12330	12917
DINOSAUR	SW	8234	10039	8814	9406	9998	10584	11172	11760	12348	12936
BOX ELDER	SW	6852	9128	7334	7827	8320	8807	9297	9786	10275	10764
CENTURY	SE	8419	9470	9012	9617	10222	10821	11423	12024	12625	13226
CENTURY	SW	7597	11294	8131	8677	9224	9764	10307	10849	11392	11934
DT RAPID	N	8004	11701	8567	9143	9718	10287	10859	11431	12002	12574
CANYON LAKE	SE	6174	8596	6608	7052	7496	7935	8376	8817	9257	9698
SOUTH RAPID CITY	SE	9135	11248	9777	10434	11091	11741	12394	13046	13698	14350

# Verizon Wireless

## Rapid City Voice Traffic

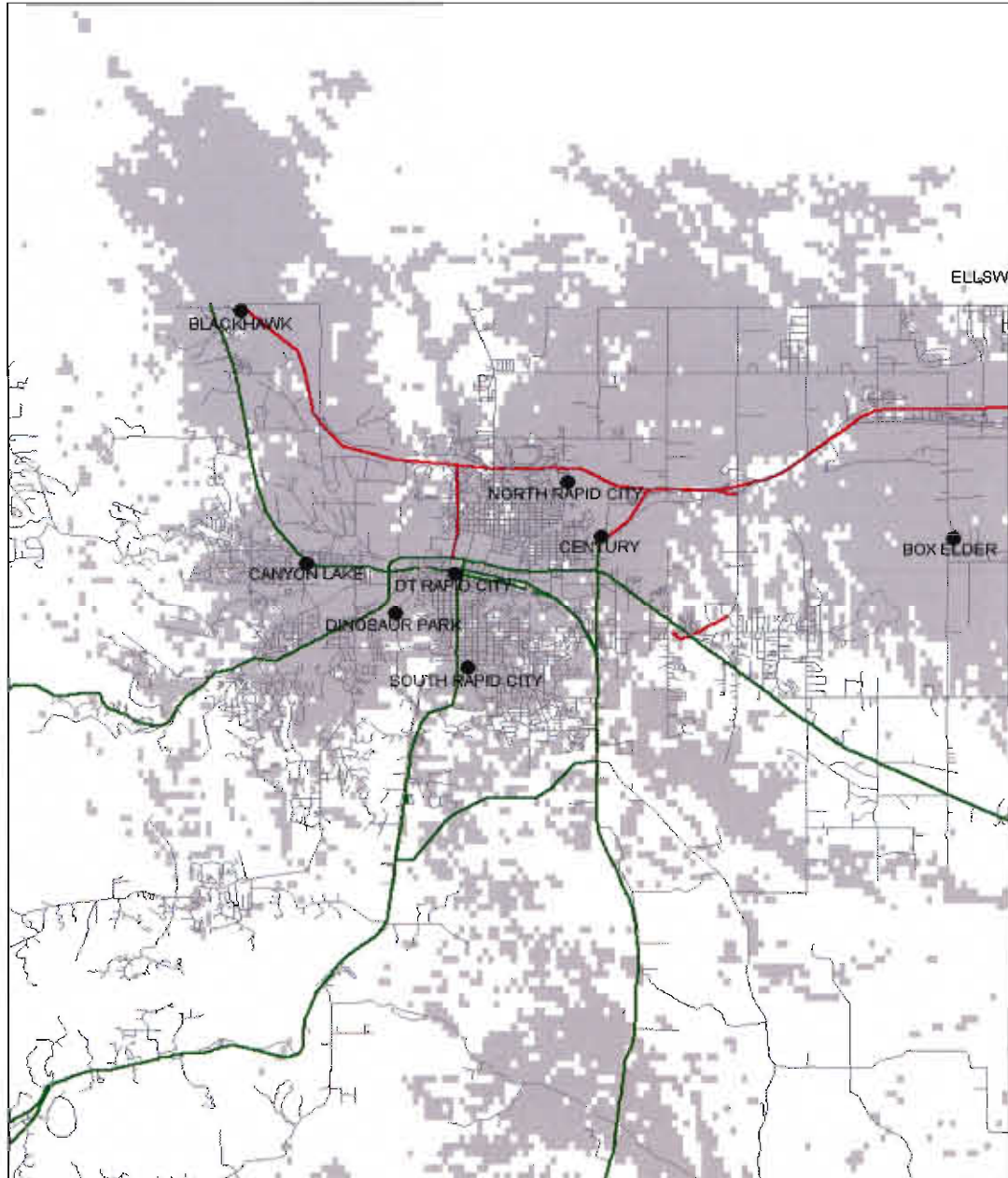


**Rapid City Area Verizon Wireless System Traffic Growth  
January, 2006 to July 2008  
Measured in the number of calls processed**



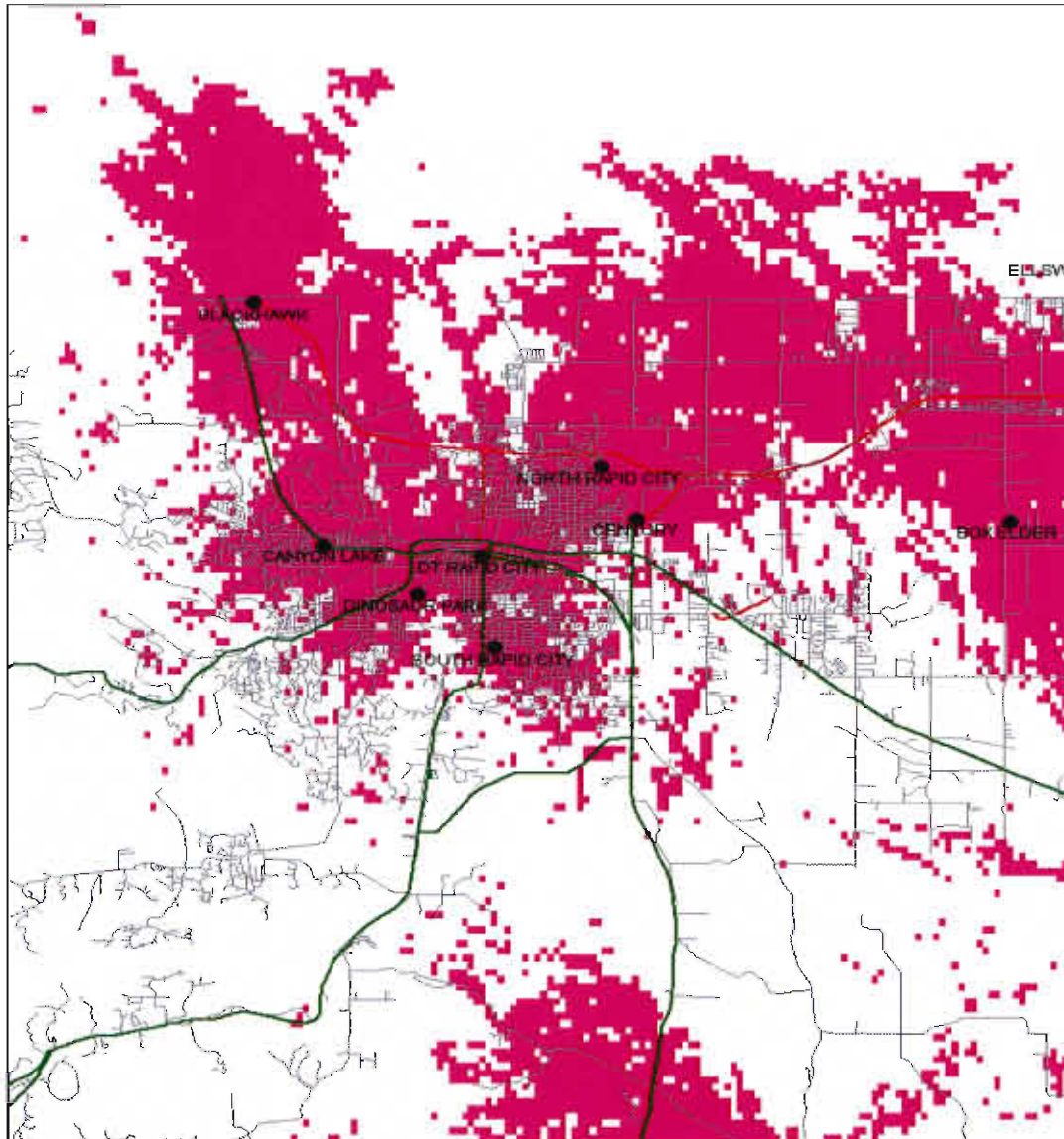
The following plot shows the current system solid in-building coverage in Rapid City. Notice the lack of solid coverage to the south. Because of the great distance from existing sites that are providing them coverage, customers to the south are using more power, thus reducing system capacity. Higher elevation sites are providing coverage in these areas. Looking at the sectors nearing capacity limitations, it is not surprising to see Dinosaur Park, Box Elder, and Century showing capacity exhaust.

**Rapid Coverage Today**



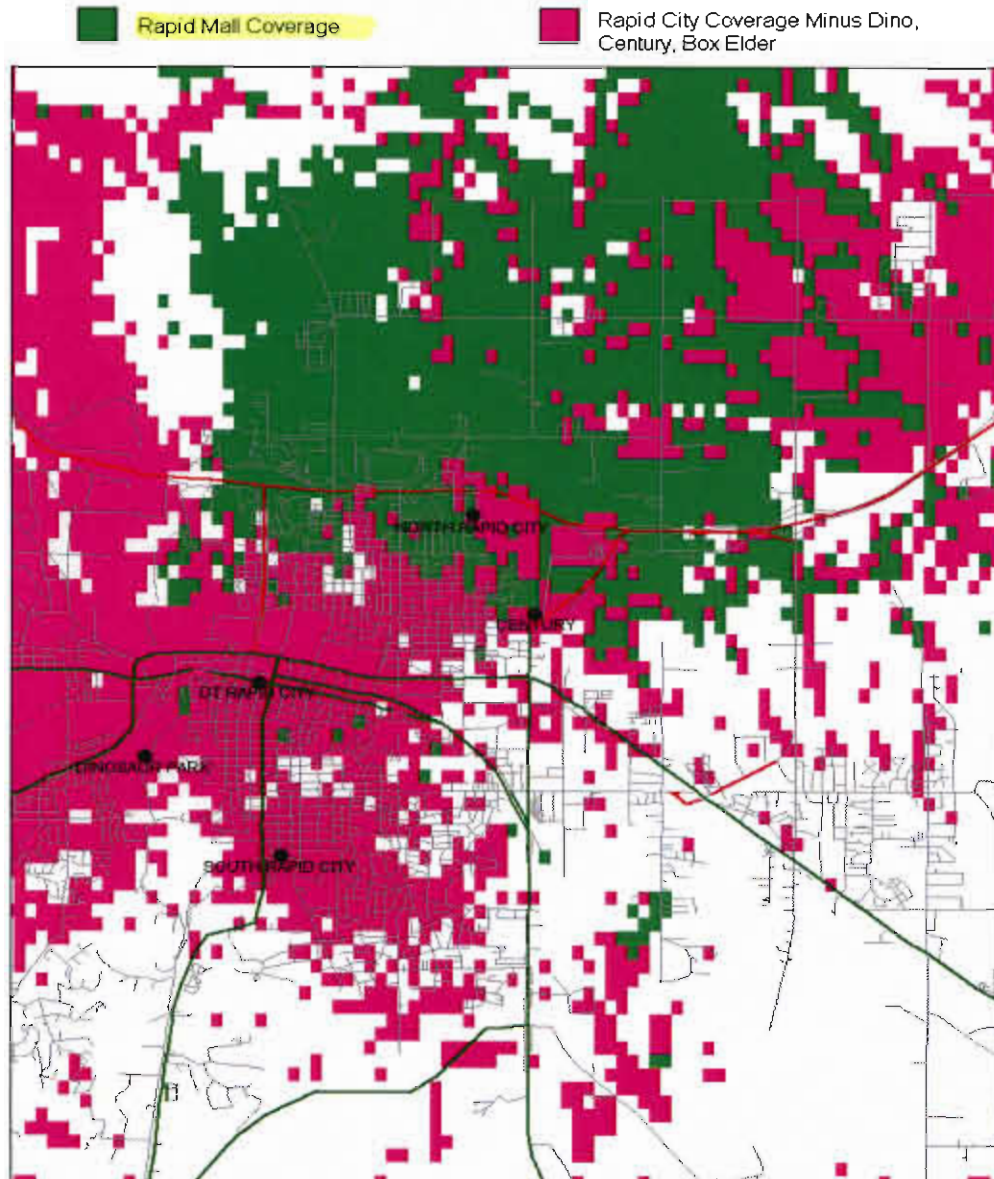
The higher elevation sites were chosen for modification due to the positive capacity impact to the system by removing and/or modifying them. For the proposed design, Dinosaur Park was removed entirely. Century was modified to leave the north-facing sector in place, with the two southern facing sectors removed. Box Elder had its southwest-facing sector removed. For the future coverage shown below, none of the proposed sites have been added. Notice that the solid in-building coverage does not change drastically by removing these higher elevation sites. These sites are providing coverage to outer lying areas but not impacting coverage nearby the sites. By building sites in these outer lying areas, solid in-building coverage is improved and capacity is enhanced. The following Appendices will show the impact of the proposed sites to the future coverage.

 Rapid Future Coverage with Dinosaur Park Removed, Century SE and SW removed, and Box Elder SW Removed



## Appendix C. Rapid Mall Design

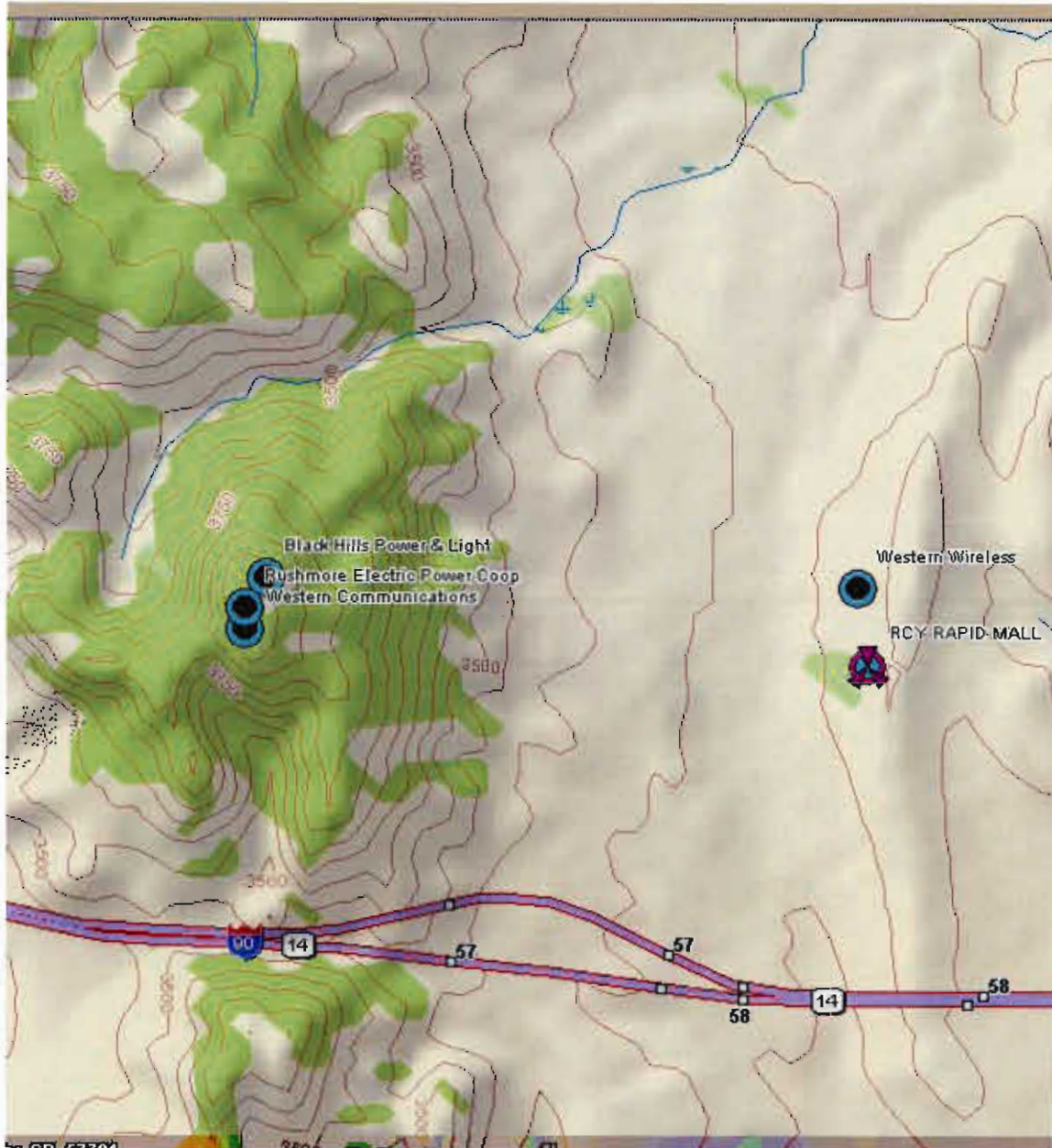
The purpose of the Rapid Mall site is to offload demands upon system capacity from the north facing sectors on Dinosaur Park, Century, DT Rapid, and North Rapid. During the holiday season these sites experience an increase in traffic, averaging over 7,000 calls each during the busiest hours. Given much of this traffic is from within the mall and surrounding stores, it requires more power per user to maintain the call. This lowers our capacity. Therefore, the desire is to place a site as near to the mall and other shopping as possible to provide the best coverage while offloading numerous sites.





Co-location  
info

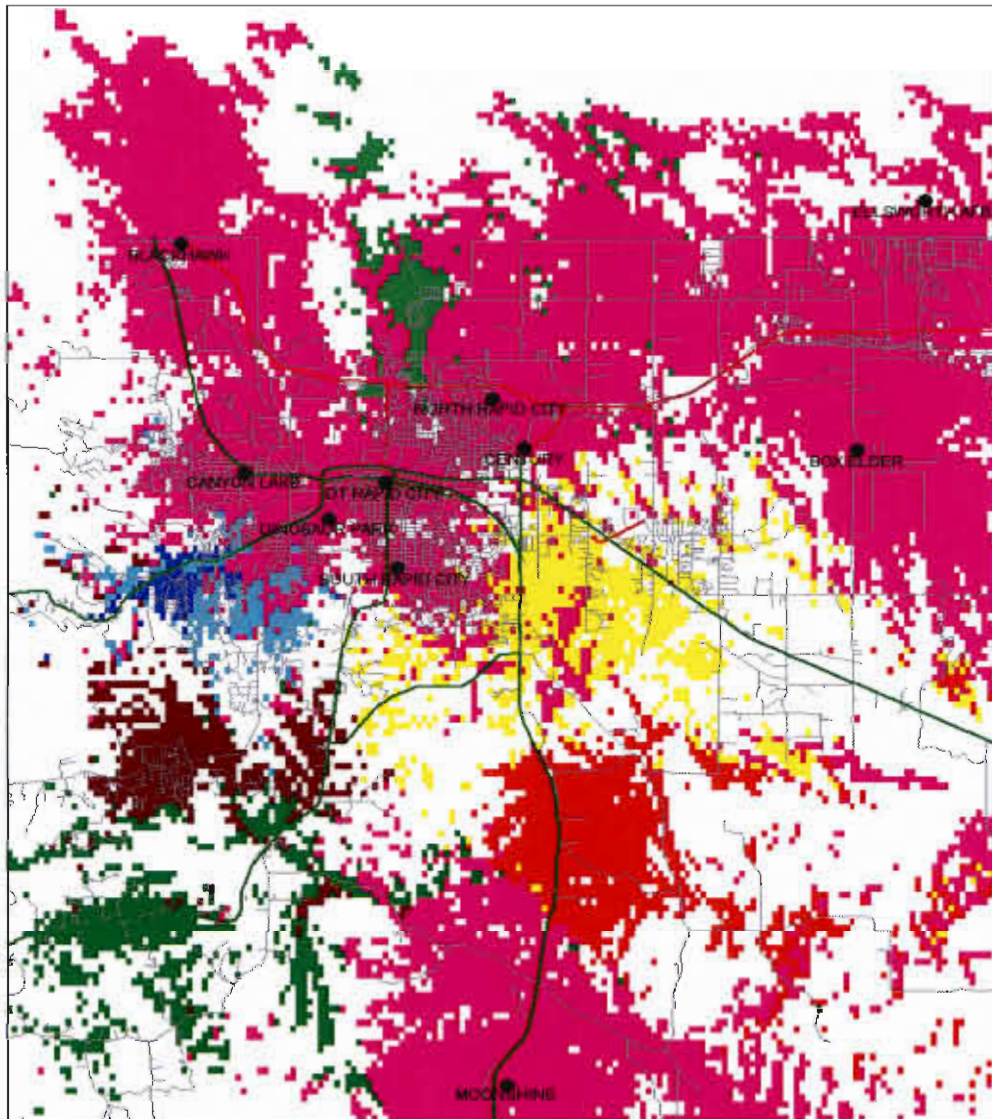
The tower located nearest to our proposed location is lacking ground space in which Verizon Wireless wishes to place equipment. Verizon Wireless would like to co-locate on this tower but is unable to because of this issue. Verizon Wireless is pursuing alternative options to co-locate on the tower at all costs to prevent additional towers in the area. All other towers in the area are a mile to the west approximately six hundred feet higher in elevation. This elevation would produce another Dinosaur Park situation given the challenge in controlling RF from higher elevations. Again, it is an issue of designing for capacity, not coverage.



## Appendix H. Future Coverage With Existing Sites

The following shows the future coverage with all new Verizon Wireless proposed sites. The plot shows the new areas of solid coverage anticipated. The yellow coverage represents the proposed Verizon Wireless co-location on an existing Western Wireless/Alltel tower at 2200 E Fairmount Blvd referred to as "SE Rapid City" by Verizon Wireless. A significant improvement in coverage is produced through the proposed sites.

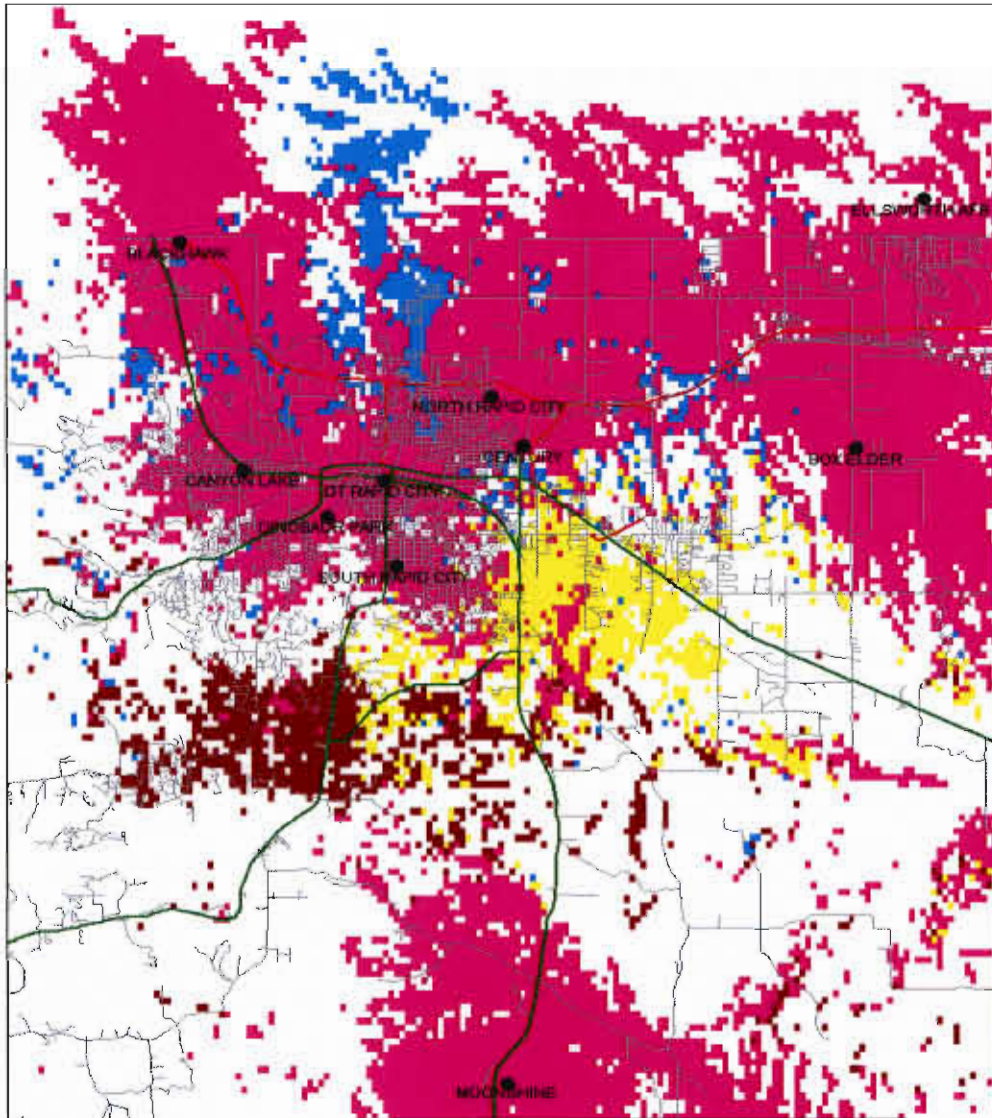
Rapid City Coverage Minus Dino, Century, Box Elder with Proposed Sites





Looking at the existing structures, only two possible structures could be utilized for Verizon Wireless co-locating on cell towers. In the event the Western Wireless tower near the mall was not feasible, the Western Communications tower to the west was chosen for analysis at a centerline of eighty feet. Given three Verizon Wireless proposed towers exist south of the last existing structure, the Western Wireless along US 16 was chosen as well to see the impact to the south with a centerline of eighty feet. The following shows the impact of these two towers to the network from a coverage standpoint alone.

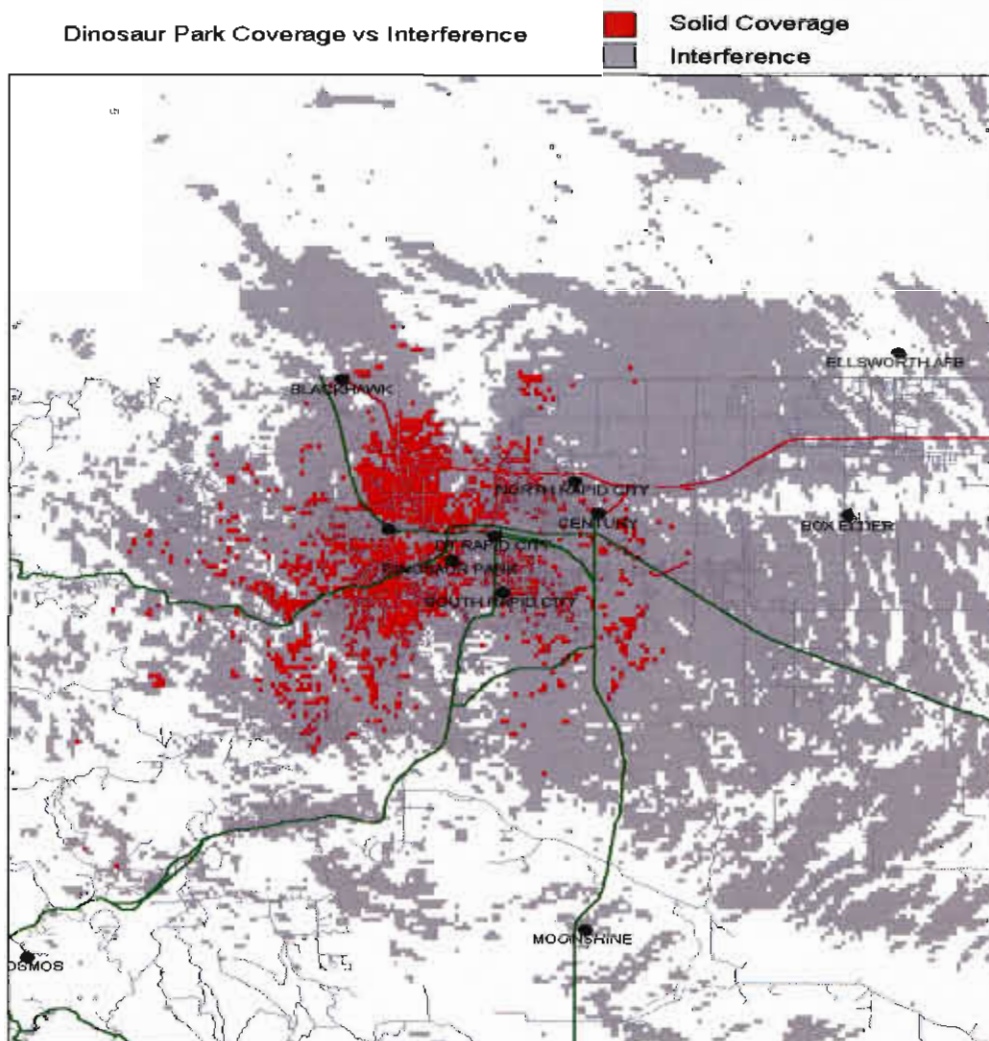
Rapid City Coverage Minus Dino, Century, Box Elder with Existing Structures



Looking at the coverage, improvements are made through the sites, just to a smaller extent than the proposed Verizon Wireless sites. Coverage to the south is still marginal at best. The problem one encounters with these existing structures lies with the elevation. Controlling the RF from these towers is difficult, especially when trying to reduce interference.

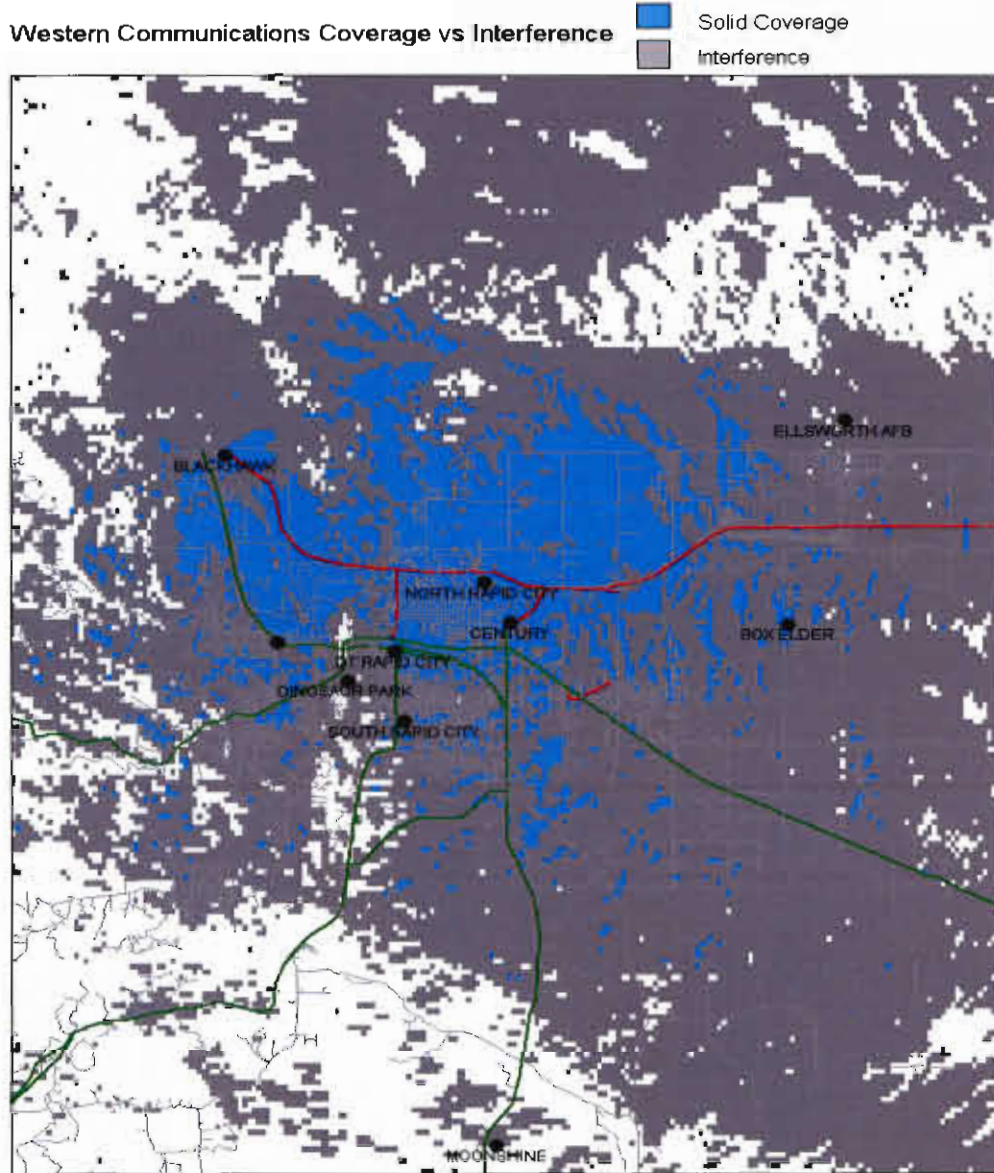
## Appendix I. Controlling Interference

The following shows the interference footprint of Dinosaur Park in relation to the solid coverage provided by the site. The interference blankets the entire existing solid coverage throughout the city. This interference not only makes it more difficult for cells in the area to provide quality service to customers, those customers that acquire the site from far away utilize more of its power, reducing capacity. It is easy to understand why this location is ideal for a new system with few customers as its coverage footprint extends across the city and beyond. To offload a site like Dinosaur Park, the first step is to build sites nearby. For the current system design in Rapid City, sites have been built off of the SE facing sector in the heart of town. As a result, the power has been significantly reduced on the SE sector of Dinosaur Park to minimize its impact. As shown below, the solid coverage is minimal off of this sector. However, the interference footprint is still significant. **It is in the interest of Verizon Wireless to remove this sector from the network.** To do so, new sites are required to the SE of town. For the N and SW sectors, few sites have been built to aid in the capacity. **Therefore, a significant number of sites are required to aid in the offload of these sectors.**





Here are the interference footprints if the two existing structures are utilized. These are provided to show the difficulty with remaining at higher elevations.



The Western Communications tower to the north of I-90 becomes another Dinosaur Park if chosen for collocation. If Verizon Wireless were to move to this location, the site would go into capacity overload almost immediately. It would also significantly impact the sites around it causing more power per user, reducing the capacity to the nearby sites. The power per sector from this location would be reduced significantly, limiting the solid coverage from the site, yet still producing significant interference in the distance.