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March 1, 2012

VIA EMAIL & ECFS

Marlene H. Dortch, Secretary
Federal Communications Commission
443 12th Street, S.W.
Washington, D.C. 20554

Re: WILSON ELECTRONICS, INC.
WT DOCKET NO. 10-4

Dear Ms. Dortch:

Transmitted herewith on behalf of Wilson Electronics, Inc. for consideration in the above-referenced rulemaking proceeding is a report entitled "Consumer Booster Improvement of Cell Site Coverage." The report provides information responsive to a Commission inquiry concerning the extent to which signal boosters can improve wireless broadband coverage and connectivity.

Should any questions arise with regard to this matter, please direct them to me.

Very truly yours,

Russell D. Lukas

cc: Zachary Katz
Amy Levine
Julius Knapp
Roger Noel
John Leibovitz
Joyce Jones

Consumer Booster Improvement of Cell Site Coverage

Richard (Riki) Kline, *Senior Electrical Engineer*
Patrick Cook, *Senior Research and Development Engineer*
Weston Johnson, *EE, CE*

February 29, 2012

Booster Coverage Improvement.pdf

1. Purpose

This report evaluates the increase in cell site coverage and performance when a consumer booster is used with a cell phone vs. a cell phone alone.

2. Executive Summary

A cell phone with a Wilson 'Sleek' mobile consumer booster installed in a vehicle is shown to provides a 3 times increase in the overall coverage area of a single cell site for both voice and data service vs. a cell phone without a booster. A booster increases connectivity to distant cell sites that would normally be inaccessible without a booster. In consideration of the improved connectivity to distant cell sites, the overall coverage area with a consumer booster may be significantly greater than that shown in this report which focuses upon the increased coverage of only one cell site. This shows that using a consumer booster would extend coverage into uncovered areas that are targeted by the Commission for enhancement, i.e. in the USF Order for Wireless Broadband Service (FCC 11-161).

In most cases, the booster enabled vastly improved data throughput that was better than the minimum required for mobile broadband data communications while without the booster there was no data throughput or very low throughput. In some cases where there were no data coverage with the cell phone alone, using the booster enabled data coverage with a lower throughput rate than the established criteria, but still allowing adequate data throughput for smart phones and computers.

Fixed indoor consumer booster applications are expected to show similar or better performance improvements than those shown for consumer mobile boosters. This is because fixed consumer boosters will have increased gain, will overcome higher in-building signal penetration losses (relative to a vehicle's penetration losses), have higher antenna elevations with roof mounted antennas, and have the advantage of directional antennas (with, as permissible, higher gain) pointing at base stations.

These results show significant improvements and extensions of coverage for mobile voice and broadband data service with the use of consumer boosters.

3. Test Method

The signal strength of the cell site signal (RSSI) received by two cell phones used in the same location within the vehicle was simultaneously evaluated at different locations. One cell phone was positioned at the center console of a vehicle without a booster or outside antenna. The other cell phone was connected to a signal booster with an external antenna on the roof of the vehicle. Testing was in the 800 MHz cellular band, with separate evaluations for voice (CDMA) and for 3G data (EVDO). The data presented in figures 1, 2, & 3 was taken at static test point locations with the vehicle stationary.

This study was developed and this report was prepared by Wilson Electronics. In addition, Sean Haynberg, Director of RF Technologies at V-COMM, provided technical input on the study.

4. Test Location

All measurements were performed using signals received from a single Verizon Wireless cell site located on Big Mountain (37°30'30.00"N, 113°39'41.76"W) approximately five miles south of Enterprise, Utah. Terrain maps are shown in figure 4 (for voice coverage) and figure 5 (for data coverage).

5. Equipment and Vehicle Details

Cell phones: Motorola Droid Razr

Signal Booster: Wilson 'Sleek', FCC ID: PWO2B5225

The booster is contained within the cradle that holds the cell phone.
12 to 16 dB gain less 7 dB coupling loss of cradle = 5 to 9 dB net gain
Uplink power output is limited by AGC to 28.5 dBm.

Antenna: Wilson Magnet-Mount, 11 inch overall length, Part Number: 301103

5.1 dBi antenna gain – 3.7 dB cable loss = 1.4 dBi net gain

Note: The above booster and antenna parameters comply with the currently proposed requirements for consumer boosters (submitted jointly by Verizon Wireless and Wilson Electronics).

Vehicle: Toyota RAV4

6. Explanation of Data

The coverage areas (see addendum) represent contiguous coverage, which are derived from the measurements collected. Standard CMRS base station equipment and operations and mobile devices were utilized in these tests. Voice service was provided by a CDMA network, and data service by a 3G EVDO network. Approximately 4,000 RSSI measurements were obtained during driving tests over roads in Southern Utah and showed that the average increase in RSSI due to the booster was 20 dB. The increase in received signal strength at the mobile station is enhanced by the booster's improved link budget using a vehicle rooftop antenna that avoids the vehicle penetration losses associated with mobile use without boosters. Figure 1 shows the locations of the data collection points, throughput, and RSSI measurements made at 37 locations. At each data point in the map inset, there are two sets of numbers and the distance to the cell site. "W" is with the signal booster, and "WO" is without the signal booster. "VC" means that CDMA voice coverage was tested and found to be acceptable. "NVC" indicates No Voice Communication, i.e. voice communication was not possible. "NDC" means No Data Connection, i.e. there was no data throughput. The numbers, in order, are: RSSI, uplink data throughput rate, and downlink data throughput rate. The units are dBm for RSSI, and kilobits per second for the data throughput rates.

7. Coverage Criteria

For broadband data coverage, the minimum data throughput rates of 200 kilobits per second in the uplink, and 768 kilobits per second in the downlink are the minimum coverage criteria that meet the requirements for 3G and 4G mobile data service (see USF Order for Wireless Broadband Service).[1]

For voice coverage, the criteria is the ability to make and hold a conversation with acceptable voice quality.

8. Results and Conclusions

Figures 2 and 3 show that there is significant improvement in cell site coverage when a signal booster is used with a cell phone vs. a cell phone alone. Figure 2 shows that voice coverage area with the booster is 3 times the coverage area without the booster. Figure 3 shows that broadband data coverage area with the booster is 3.2 times the coverage area without the booster.

The data presented in Figure 1 shows that in most cases, the booster enables vastly improved data throughput that exceeds the established Coverage Criteria (see section 7), while without the booster, there is no data throughput or very low throughput. In some cases where there were no data communications with the cell phone alone, using the booster enabled data communications with a lower throughput rate than the established criteria mentioned in section 7, but still allowing adequate data throughput for smart phones and computers (e.g. see Figure 1, data collection points 4, 5, 15, 25, 26, 27, 34, 35, & 37).

The results are for a device operating in the 800 MHz cellular band. Based upon experience, other bands (i.e., PCS & AWS bands) can be expected to give similar improvements on a percentage basis, or increases in performance, i.e. three times the coverage area, while the actual distances would be considerably less for both cases for the PCS & AWS bands. For example, for PCS & AWS bands, the signal strength is expected to be approximately 7 to 10 dB lower than in the cellular band due to frequency propagation differences which would result in approximately half the distance ranges observed as compared to the cellular band case in this study. But, relative performance improvements (with and without a booster) can be expected to be similar to those shown in this report.

The coverage ranges (15 to 25 miles without a booster) are greater than expected due to two factors. With the vehicle stationary, the required fade margins for motion are decreased. In addition, this study shows coverage improvement and extension into areas with no coverage. For such cases, the coverage range extends further because there are no transmissions from other base stations that increase spectrum noise levels

[1] USF Order, FCC 11-161, Pg 130, "Recipients that commit to provide supported services over a network that represents the latest generation of mobile technologies, or 4G, must offer mobile transmissions to and from the network meeting or exceeding the following minimum standards: outdoor minimum of 768 kbps downstream and 200 kbps upstream to handheld mobile devices."

that reduce the range, thereby extending coverage into these uncovered areas that are targeted by the Commission for enhancement, i.e. in the USF Order for Wireless Broadband Service (FCC 11-161). Nevertheless, for moving vehicles, the area and distance ratios of improvement with and without a booster would be similar to the results for a non-moving vehicle as presented in this report.

Coverage and performance improvements for voice and data services are expected in rural and suburban commercial wireless markets. In urban markets, the consumer booster would usually be turned off to protect nearby cell sites which would be the expected result from meeting the proposed specifications.

It's expected that consumer boosters will also provide significant improvements in rural markets for LTE broadband service. It is our view that because of increased power and bandwidth for LTE and less path loss in the 700 MHz band relative to the 800 MHz band, that the LTE data rates would be approximately five times the 3G data rates for the same coverage areas shown in figures 2 and 3.

Consumer boosters will significantly improve and extend wireless broadband data service. The performance improvement in uplink and downlink throughput will occur throughout the cell coverage area and not just at the fringe of service. This improves and enhances the user experience, capacity of the network, and spectrum efficiency.
The consumer booster data throughputs (relative to the cell phone alone) increase on average by approximately 250% in the extended data coverage area (i.e. the yellow area in figure 3). For locations that are generally closer to the cell site (i.e. the red area in figure 3), the average increase in data throughput is approximately 150%.

In areas with no data coverage without the booster, by accepting reduced throughput rates of 300 kbps in the downlink and 100 kbps in the uplink, using the booster enables data coverage throughout approximately 80% of the extended voice area for 3G (shown as the yellow area in figure 2). With LTE, throughput rates in the same area will be significantly greater.

Consumer boosters will significantly improve and extend wireless voice service. The coverage improvement will extend voice service into areas with no coverage at all – including areas that may have no landline voice service available and areas that would not otherwise connect to 911 and other emergency services.

The consumer booster improves and extends wireless service both indoors and in vehicles that would otherwise not have service, and for which it would not be practical to provide service in many rural markets from traditional base station deployments.

It is expected that 4G technology networks will provide increased data speeds in comparison to 3G technology networks that were evaluated in this report.

Addendum

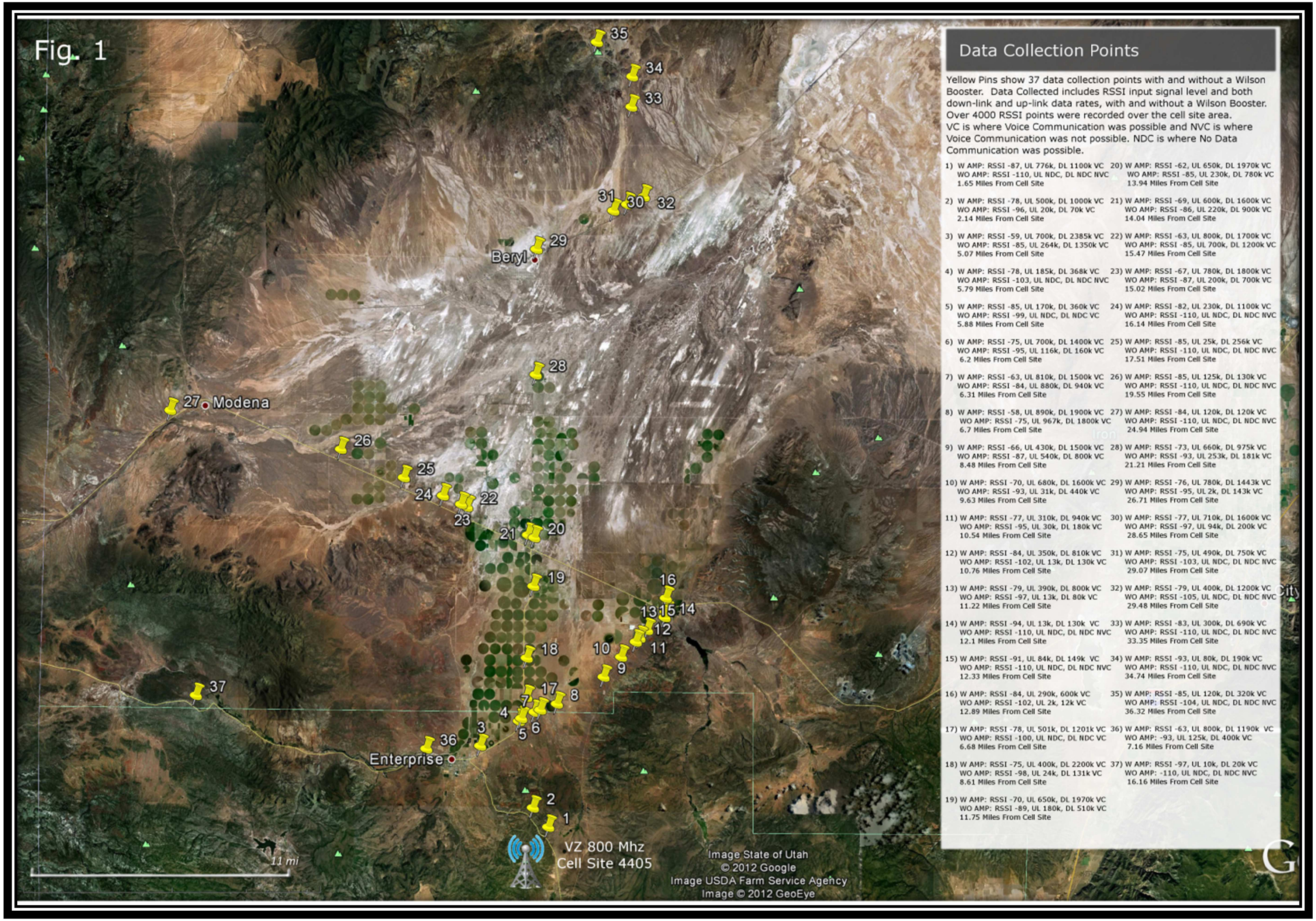
Fig. 1
Data Collection Points
Yellow Pins show 37 data collection points with and without a Wilson Booster. Data Collected includes RSSI input signal level and both down-link and up-link data rates, with and without a Wilson Booster. Over 4000 RSSI points were recorded over the cell site area. VC is where Voice Communication was possible and NVC is where Voice Communication was not possible. NDC is where No Data Communication was possible.
1) W AMP: RSSI -87, UL 776k, DL 1100k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 1.65 Miles From Cell Site
2) W AMP: RSSI -78, UL 500k, DL 1000k VC WO AMP: RSSI -96, UL 20k, DL 70k VC 2.14 Miles From Cell Site
3) W AMP: RSSI -59, UL 700k, DL 2385k VC WO AMP: RSSI -85, UL 264k, DL 1350k VC 5.07 Miles From Cell Site
4) W AMP: RSSI -78, UL 185k, DL 368k VC WO AMP: RSSI -103, UL NDC, DL NDC NVC 5.79 Miles From Cell Site
5) W AMP: RSSI -85, UL 170k, DL 360k VC WO AMP: RSSI -99, UL NDC, DL NDC VC 5.88 Miles From Cell Site
6) W AMP: RSSI -75, UL 700k, DL 1400k VC WO AMP: RSSI -95, UL 116k, DL 160k VC 6.2 Miles From Cell Site
7) W AMP: RSSI -63, UL 810k, DL 1500k VC WO AMP: RSSI -84, UL 880k, DL 940k VC 6.31 Miles From Cell Site
8) W AMP: RSSI -58, UL 890k, DL 1900k VC WO AMP: RSSI -75, UL 967k, DL 1800k VC 6.7 Miles From Cell Site
9) W AMP: RSSI -66, UL 430k, DL 1500k VC WO AMP: RSSI -87, UL 540k, DL 800k VC 8.48 Miles From Cell Site
10) W AMP: RSSI -70, UL 680k, DL 1600k VC WO AMP: RSSI -93, UL 31k, DL 440k VC 9.63 Miles From Cell Site
11) W AMP: RSSI -77, UL 310k, DL 940k VC WO AMP: RSSI -95, UL 30k, DL 180k VC 10.54 Miles From Cell Site
12) W AMP: RSSI -84, UL 350k, DL 810k VC WO AMP: RSSI -102, UL 13k, DL 130k VC 10.76 Miles From Cell Site
13) W AMP: RSSI -79, UL 390k, DL 800k VC WO AMP: RSSI -97, UL 13k, DL 80k VC 11.22 Miles From Cell Site
14) W AMP: RSSI -94, UL 13k, DL 130k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 12.1 Miles From Cell Site
15) W AMP: RSSI -91, UL 84k, DL 149k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 12.33 Miles From Cell Site
16) W AMP: RSSI -84, UL 290k, 600k VC WO AMP: RSSI -102, UL 2k, 12k VC 12.89 Miles From Cell Site
17) W AMP: RSSI -78, UL 501k, DL 1201k VC WO AMP: RSSI -100, UL NDC, DL NDC VC 6.68 Miles From Cell Site
18) W AMP: RSSI -75, UL 400k, DL 2200k VC WO AMP: RSSI -98, UL 24k, DL 131k VC 8.61 Miles From Cell Site
19) W AMP: RSSI -70, UL 650k, DL 1970k VC WO AMP: RSSI -89, UL 180k, DL 510k VC 11.75 Miles From Cell Site
20) W AMP: RSSI -62, UL 650k, DL 1970k VC WO AMP: RSSI -85, UL 230k, DL 780k VC 13.94 Miles From Cell Site
21) W AMP: RSSI -69, UL 600k, DL 1600k VC WO AMP: RSSI -86, UL 220k, DL 900k VC 14.04 Miles From Cell Site
22) W AMP: RSSI -63, UL 800k, DL 1700k VC WO AMP: RSSI -85, UL 700k, DL 1200k VC 15.47 Miles From Cell Site
23) W AMP: RSSI -67, UL 780k, DL 1800k VC WO AMP: RSSI -87, UL 200k, DL 700k VC 15.02 Miles From Cell Site
24) W AMP: RSSI -82, UL 230k, DL 1100k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 16.14 Miles From Cell Site
25) W AMP: RSSI -85, UL 25k, DL 256k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 17.51 Miles From Cell Site
26) W AMP: RSSI -85, UL 125k, DL 130k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 19.55 Miles From Cell Site
27) W AMP: RSSI -84, UL 120k, DL 120k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 24.94 Miles From Cell Site
28) W AMP: RSSI -73, UL 660k, DL 975k VC WO AMP: RSSI -93, UL 253k, DL 181k VC 21.21 Miles From Cell Site
29) W AMP: RSSI -76, UL 780k, DL 1443k VC WO AMP: RSSI -95, UL 2k, DL 143k VC 26.71 Miles From Cell Site
30) W AMP: RSSI -77, UL 710k, DL 1600k VC WO AMP: RSSI -97, UL 94k, DL 200k VC 28.65 Miles From Cell Site
31) W AMP: RSSI -75, UL 490k, DL 750k VC WO AMP: RSSI -103, UL NDC, DL NDC NVC 29.07 Miles From Cell Site
32) W AMP: RSSI -79, UL 400k, DL 1200k VC WO AMP: RSSI -105, UL NDC, DL NDC NVC 29.48 Miles From Cell Site
33) W AMP: RSSI -83, UL 300k, DL 690k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 33.35 Miles From Cell Site
34) W AMP: RSSI -93, UL 80k, DL 190k VC WO AMP: RSSI -110, UL NDC, DL NDC NVC 34.74 Miles From Cell Site
35) W AMP: RSSI -85, UL 120k, DL 320k VC WO AMP: RSSI -104, UL NDC, DL NDC NVC 36.32 Miles From Cell Site
36) W AMP: RSSI -63, UL 800k, DL 1190k VC WO AMP: -93, UL 125k, DL 400k VC 7.16 Miles From Cell Site
37) W AMP: RSSI -97, UL 10k, DL 20k VC WO AMP: -110, UL NDC, DL NDC NVC 16.16 Miles From Cell Site
Modena
Beryl
Enterprise
VZ 800 Mhz
Cell Site 4405
11 mi
Image State of Utah
© 2012 Google
Image USDA Farm Service Agency
Image © 2012 GeoEye

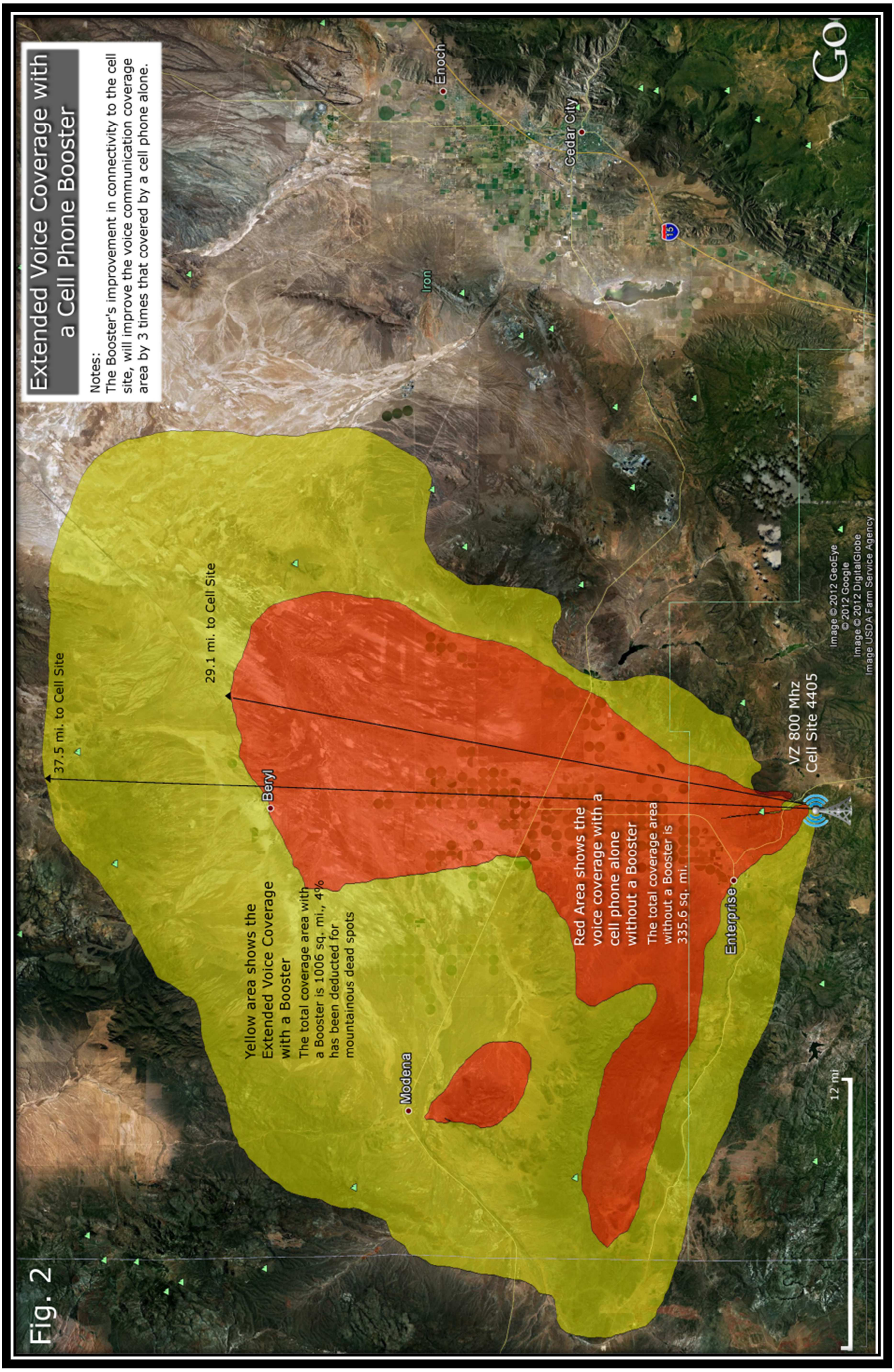
Fig. 2
Extended Voice Coverage with a Cell Phone Booster
Notes:
The Booster's improvement in connectivity to the cell site, will improve the voice communication coverage area by 3 times that covered by a cell phone alone.
37.5 mi. to Cell Site
29.1 mi. to Cell Site
Yellow area shows the Extended Voice Coverage with a Booster
The total coverage area with a Booster is 1006 sq. mi., 4% has been deducted for mountainous dead spots
Red Area shows the voice coverage with a cell phone alone without a Booster
The total coverage area without a Booster is 335.6 sq. mi.
VZ 800 Mhz Cell Site 4405
Beryl
Modena
Enterprise
Enoch
Cedar City
Iron
12 mi
Image © 2012 GeoEye
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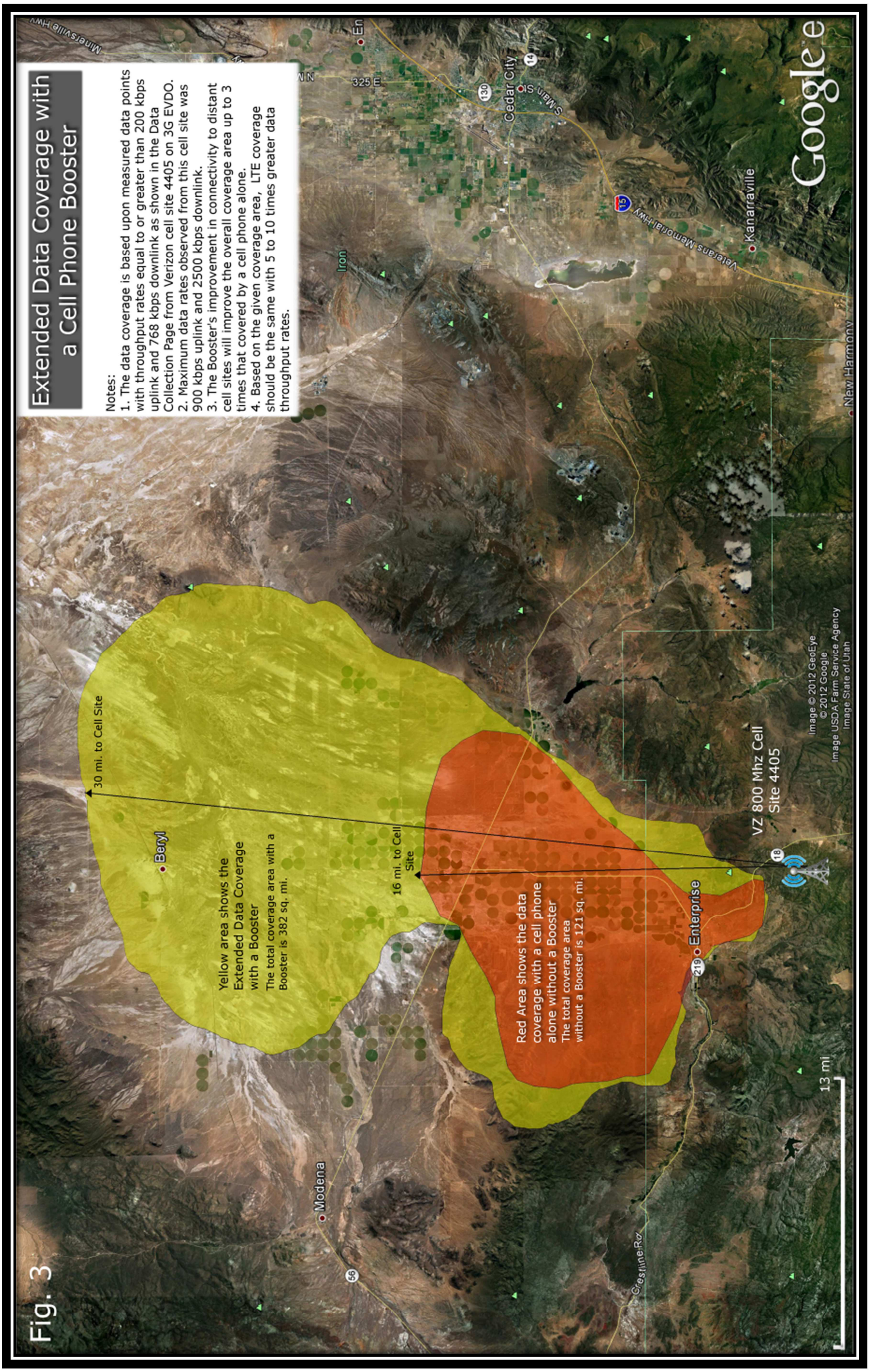
Image © 2012 DigitalGlobe
Image USDA Farm Service Agency



Extended Data Coverage with a Cell Phone Booster
Notes:
1. The data coverage is based upon measured data points with throughput rates equal to or greater than 200 kbps uplink and 768 kbps downlink as shown in the Data Collection Page from Verizon cell site 4405 on 3G EVDO.
2. Maximum data rates observed from this cell site was 900 kbps uplink and 2500 kbps downlink.
3. The Booster's improvement in connectivity to distant cell sites will improve the overall coverage area up to 3 times that covered by a cell phone alone.
4. Based on the given coverage area, LTE coverage should be the same with 5 to 10 times greater data throughput rates.
Yellow area shows the Extended Data Coverage with a Booster
The total coverage area with a Booster is 382 sq. mi.
Red Area shows the data coverage with a cell phone alone without a Booster
The total coverage area without a Booster is 121 sq. mi.
30 mi. to Cell Site
16 mi. to Cell Site
VZ 800 Mhz Cell Site 4405
Fig. 3
Beryl
Enterprise
Modena
Cedar City
Kanarraville
New Harmony
Iron
Veterans Memorial Hwy
Minersville Hwy
13 mi
Google

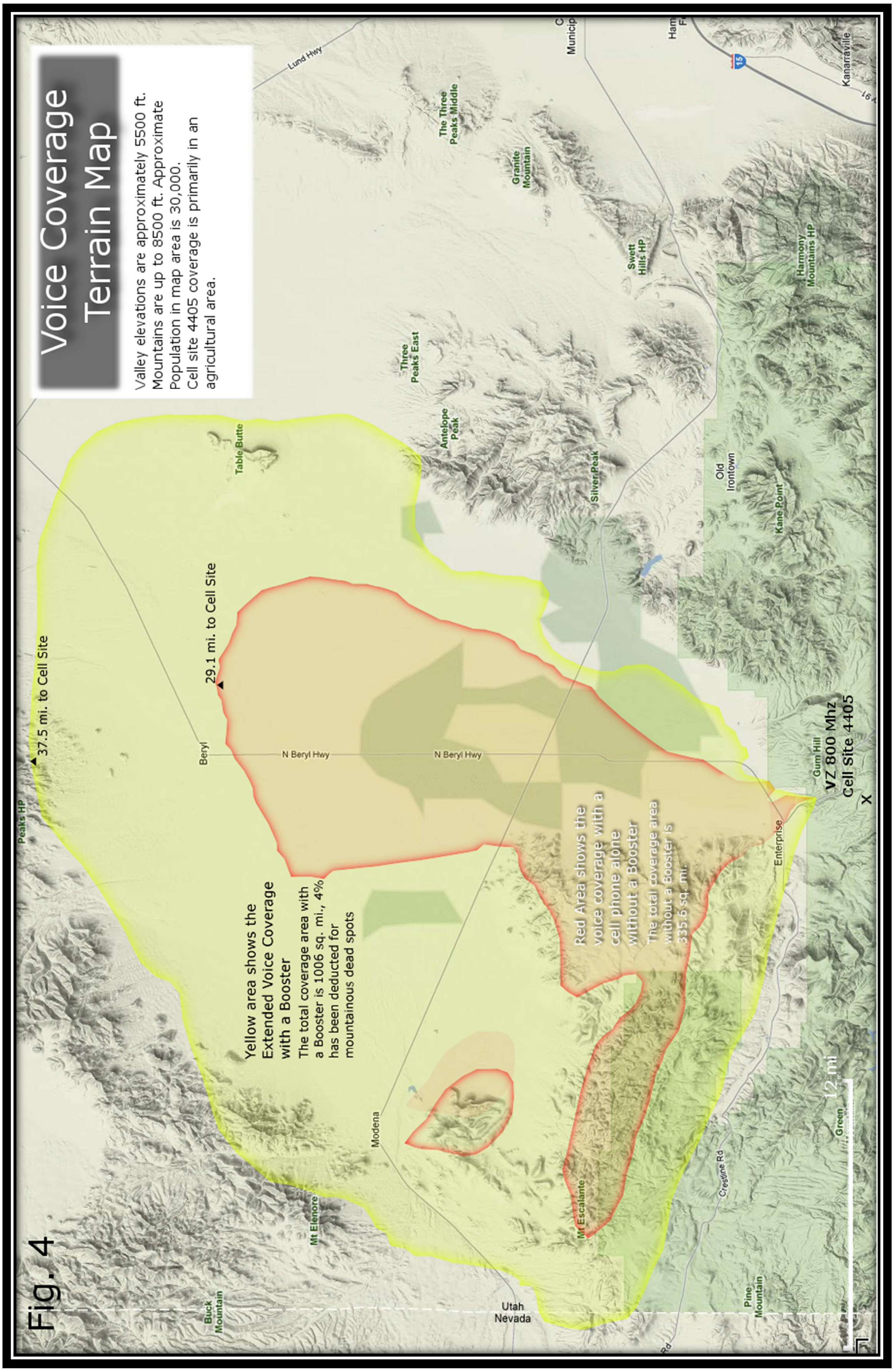
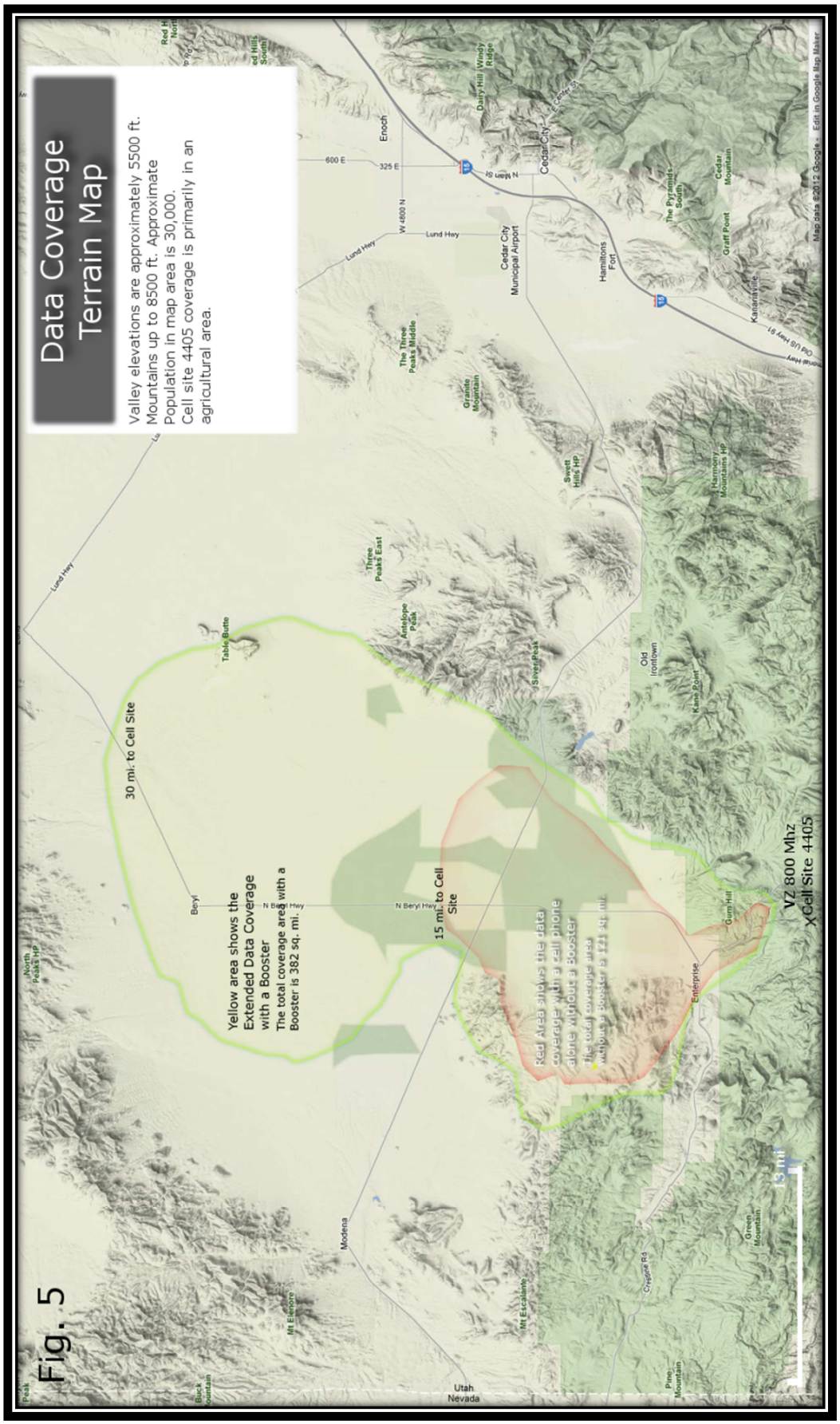


Fig. 4
Voice Coverage
Terrain Map
Valley elevations are approximately 5500 ft. Mountains are up to 8500 ft. Approximate Population in map area is 30,000.
Cell site 4405 coverage is primarily in an agricultural area.
Yellow area shows the Extended Voice Coverage with a Booster
The total coverage area with a Booster is 1006 sq. mi., 4% has been deducted for mountainous dead spots
Red Area shows the voice coverage with a cell phone alone without a Booster
The total coverage area without a Booster is 335.6 sq. mi.
37.5 mi. to Cell Site
29.1 mi. to Cell Site
VZ 800 Mhz
Cell Site 4405
X
12 mi
Lund Hwy
N Beryl Hwy
N Beryl Hwy
Beryl
Modena
Enterprise
Utah
Nevada
Table Butte
Antelope Peak
Three Peaks East
The Three Peaks Middle
Granite Mountain
Swett Hills HP
Silver Peak
Old Irontown
Kane Point
Harmony Mountains HP
Gum Hill
Peaks HP
Mt Elenore
Mt Escalante
Buck Mountain
Pine Mountain
Crestone Rd
Kanarraville


Data Coverage
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The total coverage area
without a Booster is 121 sq. mi.
VZ 800 Mhz
xCell Site 4405
Beryl
N Beryl Hwy
Lund Hwy
Modena
Enterprise
Cedar City
Enoch
Utah
Nevada

Fig. 5