

**To the Mayor, Council, and Residents of Waite Hill
 A Report on Research and Findings to Date
 By the Waite Hill Wireless Committee
 November 1, 2017**

WHWC Committee Members:

Bill Crosier	Rebecca Platz
Jim Gibbs	Karl Scheucher (Chair)
Janet Mann	Mike Sherwin

Ex-officio Members:

Bob Ranallo, Mayor	Chief Keith DeWitt, Police Chief
Ryan Cox, Council President	Robbi Laps, Clerk Treasurer

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Executive Summary

This report is the first in a series from WHWC. Divided into seven (7) Task Areas (TA 1 to TA 7), it represents what has been learned to date and is being provided to the Mayor, Council, and the residents as mandated by the Committee mission: "to fulfill the Mayor's assignment to find the best solution to our communication challenges, taking a two-pronged approach to 1) quantify the problem, and 2) evaluate solutions and reporting Committee findings to the Mayor, Council, and all residents of Waite Hill". This report aims to deliver, at this juncture, on a best-effort basis, practical, factual information useful to the Administration, Council, and residents pertaining to cellular coverage in the Village.

Both subjective data (survey responses) and objective data (signal power measurements) reveal troublesome and potentially dangerous deficits in cellular coverage in Waite Hill. 17% of 96 Waite Hill survey respondents no longer have land lines in their homes adding to the importance of reliable wireless coverage in the Village (see TA 2 and 4).

One finds in ongoing studies that the concerns over the potential negative health implications of a cell tower are overshadowed by experts' concerns over radiation from a user's handset, thousands of times greater than from a tower and by far the most likely to impact user's health. This latter concern, handset radiation, is universally understood to be highest where coverage is weak such as Waite Hill. Studies are ongoing. (TA 5)

Impacts on real estate sales and prices in areas having cell towers as well as areas having poor cellular coverage are known concerns. Regarding towers, while WHWC remains interested in additional data, two articles are cited in the report revealing negative, neutral, and positive impacts with negative effects being associated with buyers' perceptions of human health impacts. (TA 5 and 6)

An added incentive to good cellular coverage is the proliferation of mobile apps related to individual health. To wit: the FDA as of August, 2016, enumerates 27 categories of mobile (cell phone) applications it considers to be medical devices and regulates. (TA 5)

Industry experts and nearby Villages we have interviewed provide significant evidence that a cell macro site (tower and base station) represents an economically viable and technically effective solution to coverage deficits. Enhanced coverage for the Verizon network is a priority since, at present, it is the carrier chosen by the majority of residents and Verizon's coverage is the poorest. (TA 1, 2, and 4)

Small cell technology generally used to augment macro site (tower) coverage and capacity is increasing worldwide while its implementers continue to prioritize network densification in high population areas starved for capacity (bandwidth). This is not the requirement in Waite Hill where coverage rather than capacity is the highest priority issue. In principle, the advantages and disadvantages of small cell systems are known. In practice, proponents of this technology such as the Small Cell Forum do not address the many attendant issues requisite to a real world implementation. A use case comparable to Waite Hill is not known. Neither is a network operator interested in engineering and deploying a small cell system in Waite Hill available. (TA 1 and 5)

The individual homeowner / cell user has some control over coverage in the domicile by adopting such technologies as network extenders, BDAs, or WiFi calling. Each relies, however, on adjoining infrastructure, a dependence that elicits safety concerns especially when considering emergency or disaster related circumstances. It is sometimes suggested that individuals choose a carrier that provides better local coverage. Users are cosmopolitan in their communications requirements, however, and choose a carrier based on nationwide and worldwide coverage, service, plans, pricing, and factors that go well beyond local coverage. (TA 5)

The fate of any feasible coverage enhancement outdoors in Waite Hill, for better or for worse, resides with the carriers we use, predominately Verizon followed by AT&T, T-Mobile, and others. Any practical approach including macro site towers, small cell deployments, or any other approach must ultimately interface these carriers and their licensed networks in one way or another. Importantly, it should not be taken for granted that any carrier will jump to the opportunity to address the difficulties our small Village of 230 households faces. (TA 1)

While every effort is made to provide the resources and facts that the Committee has considered to date and that are relevant to the collective concerns of the audience, the reader is well advised to consider this report as a jumping off point, not a final conclusion. It is intended to provide sufficient information to assist anyone in drawing their own conclusions about topic areas in which they are interested or concerned.

The body of the report including references will be available at <http://waitehilloh.gov>. Questions and comments may be directed to whwc@waitehilloh.gov. Anyone interested in submitting additional information or references is welcome to forward it to the foregoing email address. Please be advised, information that is written and substantiated will be seriously considered by the Committee on a best-effort basis.

About WHWC

In response to broad concerns about cellular problems in the Village, the Mayor appointed a committee to study the relevant issues. The Waite Hill Wireless Committee (WHWC), a citizen advisory committee, is composed of both Village officials and residents. It includes people predisposed with various viewpoints. Some members of the Committee have significant training and experience in the field to be studied; others have a strong understanding of the public safety issues implicated by poor cell coverage. Still others live closest to where a tower might be located and have concerns regarding negative impacts.

WHWC has established its mission: to fulfill the Mayor's assignment to find the best solution to our communication challenges, taking a two-pronged approach to 1) quantify the problem, and 2) evaluate solutions, and reporting Committee findings to the Mayor, Council, and all residents of Waite Hill.

Since inception, WHWC has met three (3) times on 9/15, 10/6, and 10/13/2017. Much collaborative work has transpired by email. Meetings are announced on the Village website and are open to the public. Comments, questions, and other correspondence may be addressed to whwc@waitehilloh.gov.

About this Report

This report is the first in a series from WHWC. Divided into seven (7) Task Areas (TA 1 to TA 7), it represents what has been learned to date and is being provided to the Mayor, Council, and the residents as mandated by the Committee mission: "to fulfill the Mayor's assignment to find the best solution to our communication challenges, taking a two-pronged approach to 1) quantify the problem, and 2) evaluate solutions and reporting Committee findings to the Mayor, Council, and all residents of Waite Hill". This report aims to deliver, at this juncture, on a best-effort basis, practical, factual information useful to the Administration, Council, and residents pertaining to cellular coverage in the Village.

Introduction

The WHWC mission is "to fulfill the Mayor's assignment to find the best solution to our communication challenges, taking a two-pronged approach to 1) quantify the problem, and 2) evaluate solutions and reporting Committee findings to the Mayor, Council, and all residents of Waite Hill". WHWC established a number of task or working areas through which its mission will be effectively accomplished. These include:

1. Canvas service providers (wireless carriers, cable, MVNOs, other)
 - Develop a contact list
 - Contact and collect information and recommendations
 - Is a representative available to speak at a meeting?
 - Preliminary report
2. Research residents' status and experience
 - Survey
 - Preliminary report
3. Harvest the experiences of other Villages and institutions
 - Develop a contact list
 - Contact and collect information and recommendations
 - Is a representative available to speak at a meeting?
 - Preliminary report
4. Measure (objective) in-street coverage
 - Survey
 - Preliminary report
5. Consider public safety related issues
 - First responder issues
 - Public health issues
 - Preliminary report
6. Other

7. Identify, evaluate, and compare coverage enhancement options
 - Develop a rubric to evaluate and compare options (efficacy, cost, reliability, aesthetic impact, regulatory burden, public safety, etc.)
 - Identify and evaluate options available to the individual homeowner
 - Identify and evaluate options available at the discretion of Village government
 - Identify and evaluate options available independently to third parties
8. Final report

This first report conveys findings and work product in each of task areas 1 to 7 and is a precursor to a final report.

Task area 1 - Service Providers and Experts

Verizon

In 2014, Verizon as an anchor tenant proposed a macro site (cell tower) to be located at Village Hall in conjunction with Strategis LLC whom they retained to negotiate the land lease contract with Waite Hill (see Strategis below). At that time, prior to negotiation, Verizon proposed \$1,250/month rent to the Village. Waite Hill chose not to undertake Verizon's proposal at that time.

On 10/6/2017, Mike Newingham, Verizon Solutions Engineer, spoke before the WHWC. The bulk of Mr. Newingham's presentation concerned Verizon's nationwide network and what Verizon is doing to enhance its services nationwide. The emphasis went quickly to 5G rollouts and the capacity increase and quality of service enhancement for **high population density areas**.

Pressed for inputs directed more specifically to the circumstances in **low population density** Waite Hill, Mr. Newingham had the following comments:

Regarding 5g rollout and how it could help, "The opportunities are in the big cities. Obviously we are going to do that first." The date discussed for widespread 5G entrenchment was 2025.

"You do studies to see what it would take to cover the area. Is it one macro site? Is it a couple of micro sites? The mini sites we see on poles, I don't really see that necessarily being the answer out here." When Mr. Newingham says, micro site, he refers to a technology also called a microcell thusly described by Tessco Technologies (see Tessco below):

"Microcell – a single-node, outdoor, short-range radio transceiver deployed to enhance existing Macro cell site coverage. Microcells are installed indoors and outdoors to fill gaps in both capacity and coverage. Their compact size enables them to be mounted on buildings and PROW (public right of way) infrastructure. Carriers use microcells to enhance the user experience in high user density venues or where macro coverage is impeded or impossible (think rush hour in Manhattan). Each microcell can support 200 users – supporting a single

carrier – over two frequencies. With a range of up to two miles, they can quickly fill coverage gaps and capacity issues created by peak usage demand that would outpace the supporting macro cell site. These solutions require trained technicians to install, configure, and maintain optimal performance. A common challenge for all small cells is one of backhaul capacity and availability." [<https://www.tessco.com/knowledge-center/2014/articles/cellular-coverage>]

The microcell maximum range and coverage efficiency depends on position and elevation (as with a macro site tower). The backhaul mentioned is also prohibitive - as Mr. Newingham said in his presentation: "A mini site or two or three that's what you have to figure out and how do I get to those if there's no fiber in the ground."

Mr. Newingham further stated that getting Verizon's real estate and RF engineering people involved is a correct first step, adding they are notoriously hard to reach because they are spread so thin.

Mr. Newingham was **not prepared** with existing Verizon coverage information for Waite Hill. Had his statements been couched in the context of the very poor, existing in-street coverage in Waite Hill, his prognostications would have been more meaningful (see Task area 4 - Objective (measured) In-Street Coverage).

Verizon as well as the other major carriers provide website applications for tower or building site inquiries (see <https://www.verizonwireless.com/biz/real-estate-inquiries/>). Select sites continue to represent valuable assets to the carriers.

Strategis

As mentioned above, acting as an agent for Verizon, Strategis conveyed a cell tower proposal for the Village to consider in 2014 (see Addendum A). Included in that proposal was a justification for WHY a cell tower at the Village Hall location was desired:

"Verizon RF Engineers have determined that there is a coverage and capacity gap in Waite Hill. This data comes from dropped calls, signal strength analysis and customer (your residents and their guests) complaints. With increasing demand for data and with cell phones replacing home phones, Verizon cannot provide the reliable service demanded by its customers without better penetration into the central Waite Hill area. It is estimated that cellular data usage alone will increase at least 5000% over the next five years. Currently, Verizon and all the major carriers are engaging in extensive network upgrades and expansion to meet this growing demand."

The above described situation regarding Verizon cell coverage in Waite Hill has not materially changed since 2014 (see Task area 2 and Task area 4).

Insite Wireless

The Village consulted via phone conference with David Weisman, CEO of Insite Wireless Group, headquartered in Washington D.C., in April of 2017 with the goal to better understand feasible solutions to challenges such as those facing Waite Hill as well as other cellular users nationwide. About Insite:

“InSite Wireless Group, LLC is today one of the largest privately owned tower and wireless infrastructure companies in the United States, as ranked by the wireless industry trade publication RCR Wireless. We operate more than 23 major DAS venues nationwide and more than 1,500 telecommunications towers and sites for wireless carriers across the United States, Puerto Rico, the U.S. Virgin Islands, Australia, and Canada.”

At the Village's request, Mr. Weisman directed his staff to analyze Waite Hill and evaluate various coverage solutions in context. The conclusions include:

Macro-site (tower base station) is the only feasible solution for Waite Hill's circumstance. No tower lighting would be required.

Insite further evaluated stealth tower alternatives and concluded cost and loading limits render stealth prohibitive, for the most part (T.B.D.).

At the Village's request, Insite prepared a contemporary baseline macro site (tower base station) proposal reaffirming that the option remains viable for the Village.

AT&T

AT&T is used by less than 25% of Village cell users (compare Verizon at greater than 60%) who nonetheless generally enjoy better coverage than Verizon users. A meeting with AT&T representatives is being pursued but not yet accomplished.

Charter Communications - Spectrum (Waite Hill cable franchisee)

Charter could be positioned to become an MVNO (Mobile Virtual Network Operator) as has Comcast with its Xfinity Mobile product. Comcast has partnered with Verizon to combine Verizon's nationwide wireless network with Comcast's 16 million WiFi hotspots nationwide. Mobile users have whichever connectivity is best at any location, LTE or WiFi, to conduct voice, text, and data functions.

That said, Clark Secard, a Spectrum Sales Engineer, has said that Spectrum has no projects underway that would result in it offering mobile phone service in Waite Hill. Earlier this year, Verizon's attempt to purchase Charter for \$100 billion was rejected by Charter and now stands abandoned [<https://www.rcrwireless.com/20170602/carriers/verizon-isnt-buying-charter>]. In the same article, the author opined on the issues as follows:

"Verizon is probably too large to be bought by a cable company. Yet it's not large enough to buy one without threatening the value of its core business. For now, Verizon may decide to take a breather and digest its recent acquisitions, giving its earnings time to catch up with its ambitions." RCR wireless also reports talks that Sprint is trying to merge with Charter [<https://www.rcrwireless.com/20170729/carriers/sprint-said-to-be-in-merger-talks-with-charter-tag4>].

Here is an important point to keep in mind: Waite Hill wireless users preferentially subscribe to Verizon for a variety of reasons including Verizon's worldwide service, not just its service in Waite Hill locally. At present, any coverage improvement solution must support Verizon customers to be an effective step forward for Waite Hill.

At present, Charter does not offer any solution nor does it project any viable solution for Waite Hill in the future.

Tessco Technologies (<https://www.tessco.com/>)

Tessco is a wireless equipment distributor. It does not build or hold tower real estate. It is expert in the latest wireless technologies in large part because of its relationship with world class manufacturers. One WHWC member has a long standing business relationship with Tessco (over 10 years) and holds its expertise in high esteem. In Tessco's words:

"TESSCO has a long and well established heritage in the wireless industry. We provided key equipment for the second ever cellular network built in the USA, in 1983. And over 30 years later, TESSCO is continuing to set the pace as the leading value-added distributor to the wireless world."

"We have strong relationships with the leading manufacturers that serve the wireless industry - relationships across a broader array of technologies than any other distributor - so that we can offer everything from the tower to the edge."

The author contacted Greg Reich, Senior Sales, in search of resources to better understand how existing and late breaking wireless equipment, systems, and technology might be harnessed to best address Waite Hill's wireless coverage issues. The issues were described in detail to Mr. Reich (based upon resident survey subjective and measured signal strength objective information as well as inputs from other experts) and Mr. Reich in turn asked many questions to better understand Waite Hill's circumstances. Mr. Reich then polled Tessco internal experts as well as experts in the manufacturers' camps to collect inputs and recommendations for Waite Hill. The results can be summarized:

1) Improvements in in-home or in-building coverage can be achieved potentially in many ways depending upon conditions such as outdoor signal strength and Internet connectivity, but each method has some limitations with respect to functions such as emergency calling, power or Internet outages, and other conditions.

2) When it comes to outdoor coverage enhancement, there is little if anything feasible without the carriers' direct involvement. It is illegal to re-broadcast carriers' signals outdoors because of FCC licensing limitations. Further, given Waite Hill's population geography and existing infrastructure resources, the economics of small cell, DAS, or other distributed solutions would be prohibitive.

3) The experts are available should Waite Hill have additional questions or need additional inputs.

4) Tessco's knowledge center and frequent webinars are a good resource as well:

<https://www.tessco.com/knowledge-center/webinars/tessco-webinars>

TowerCo (<http://www.towerco.com>)

TowerCo along with Strategis represented Verizon in negotiations in Willoughby Hills recently. Owing to the two companies close relationship with Verizon in our region, both

TowerCo and Strategis are seen as effective sources of information pertaining to Verizon's plans and aspirations in Waite Hill. At the WHWC request, TowerCo is exploring the current situation with Verizon at this time and information will be utilized as it becomes available in the ongoing work of the WHWC. In TowerCo's words:

"TowerCo was founded in 2004 by industry veterans Richard Byrne, Chief Executive Officer, and Scot Lloyd, Chief Operating Officer, along with Tailwind Capital. They envisioned a pure-play tower company with the straightforward mission of meeting the infrastructure needs of wireless service providers."

TowerCo is based in Cary, NC.

Task area 2 - Residents' Experience

A 34-question survey in five (5) parts was developed to capture the status and cellular experience and satisfaction of Village residents. The survey questions are provided in Addendum B.

Results:

To date, the survey logged 96 full responses from individuals of 79 households. Various results are shown in the Figures.

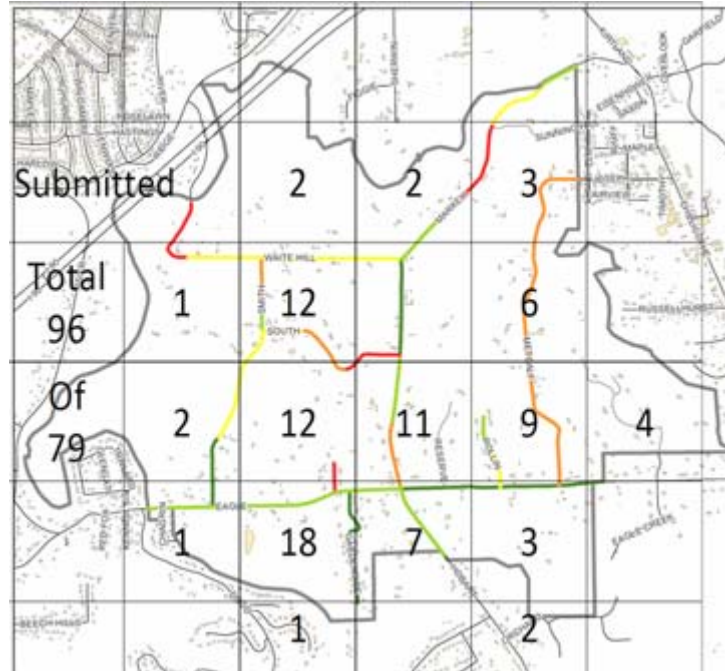


Figure 1 - Geographical distribution of 96 survey respondents residing in 79 households

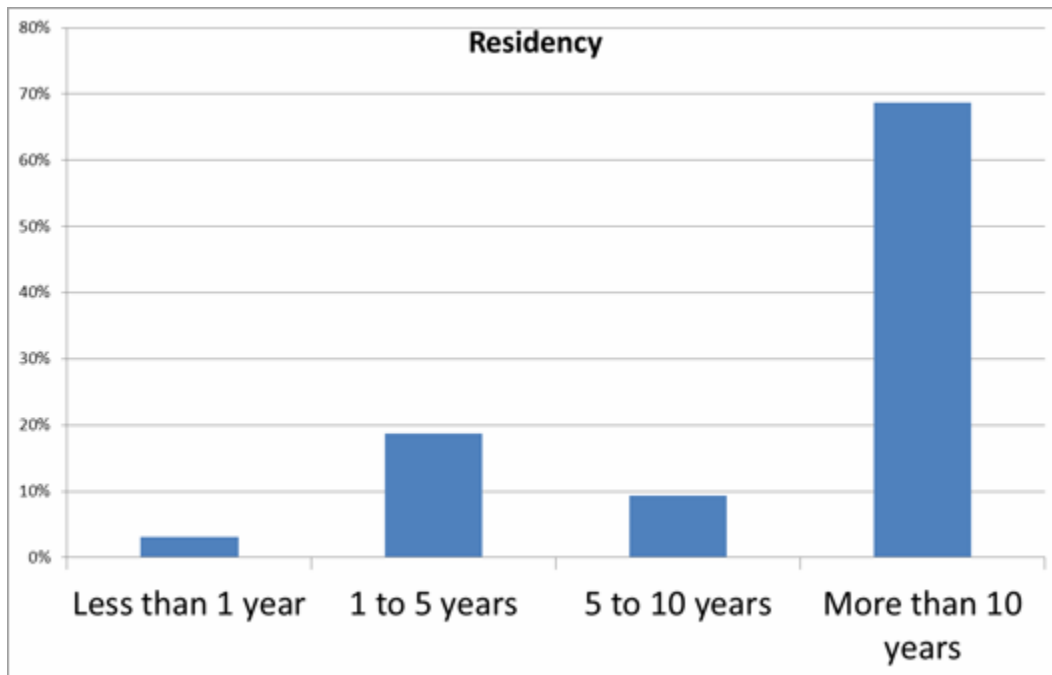


Figure 2 - How long have you lived in Waite Hill? Of 66 residents living here for more than 10 years, 13 have resided for more than 30 years.

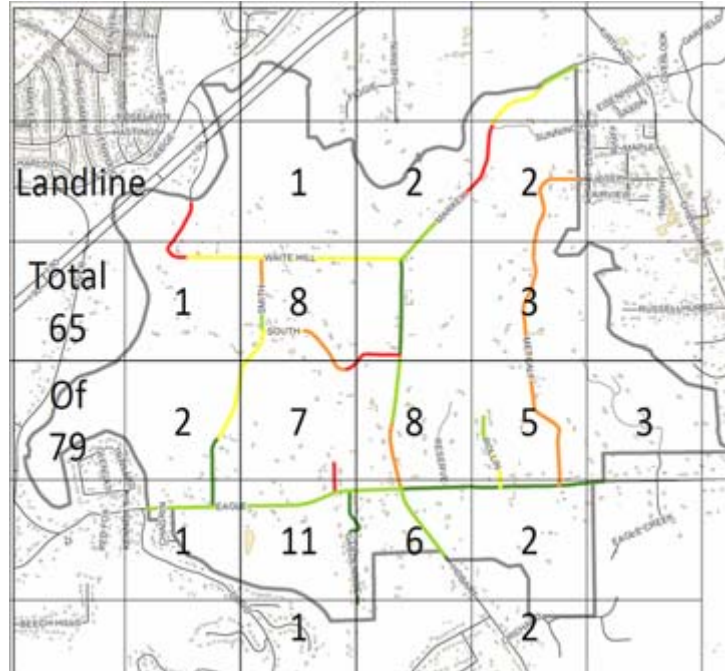


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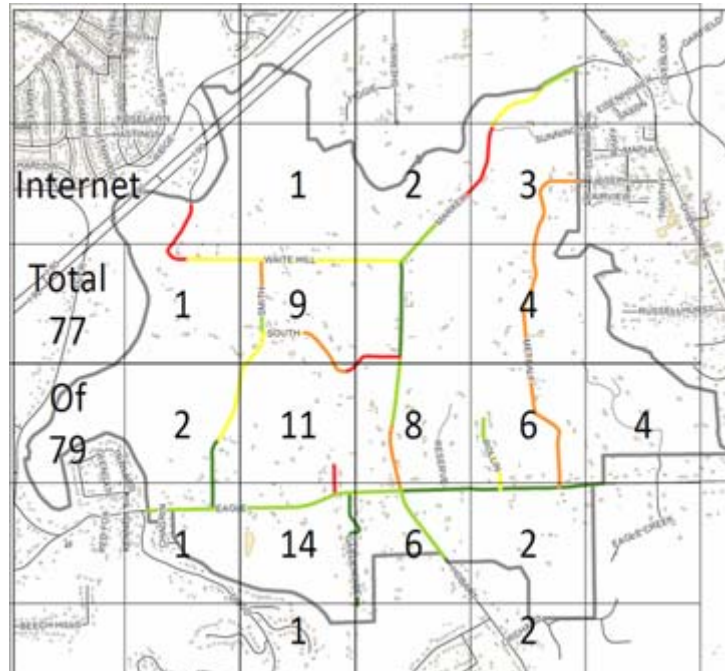


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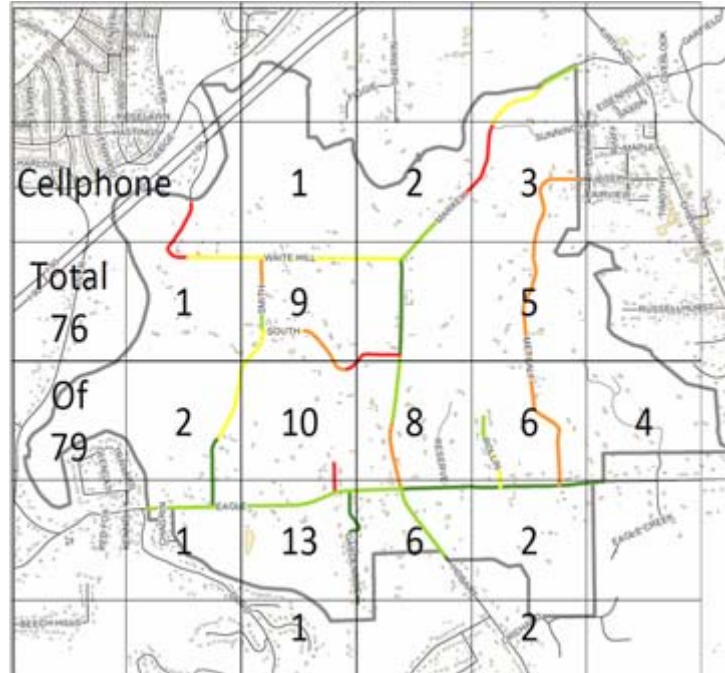


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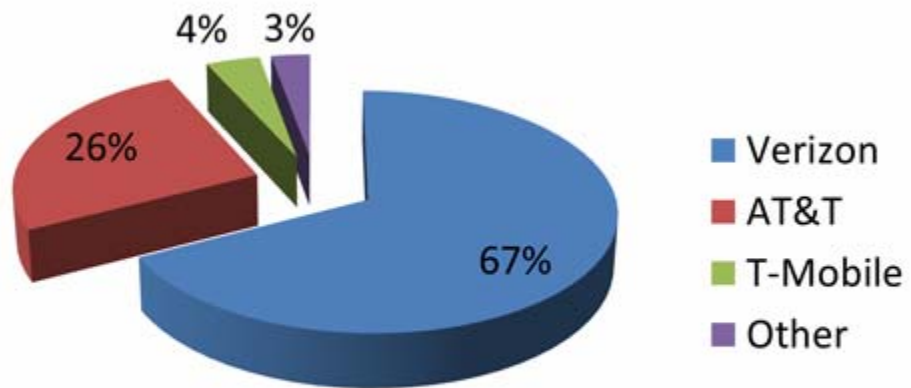


Figure 6 - Which cellular carrier(s) do you use (check all that apply)?

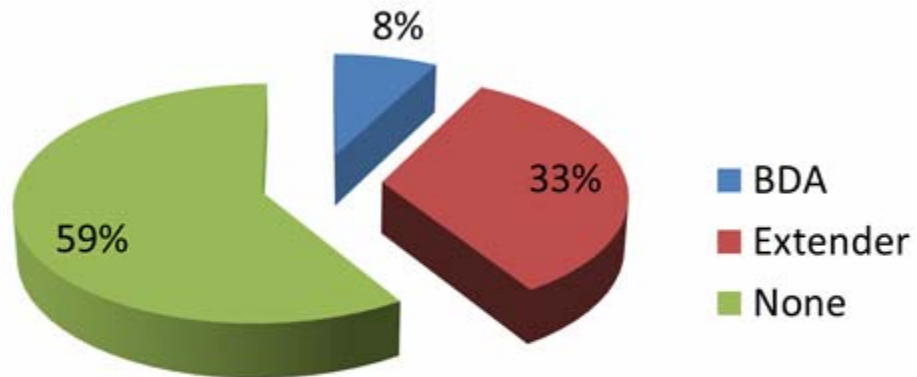


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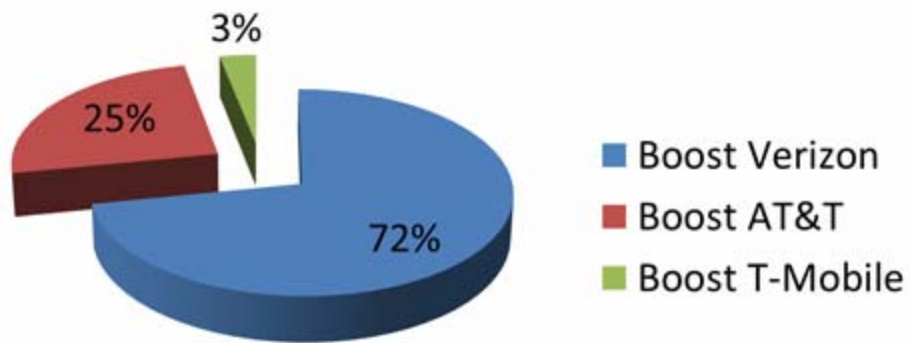


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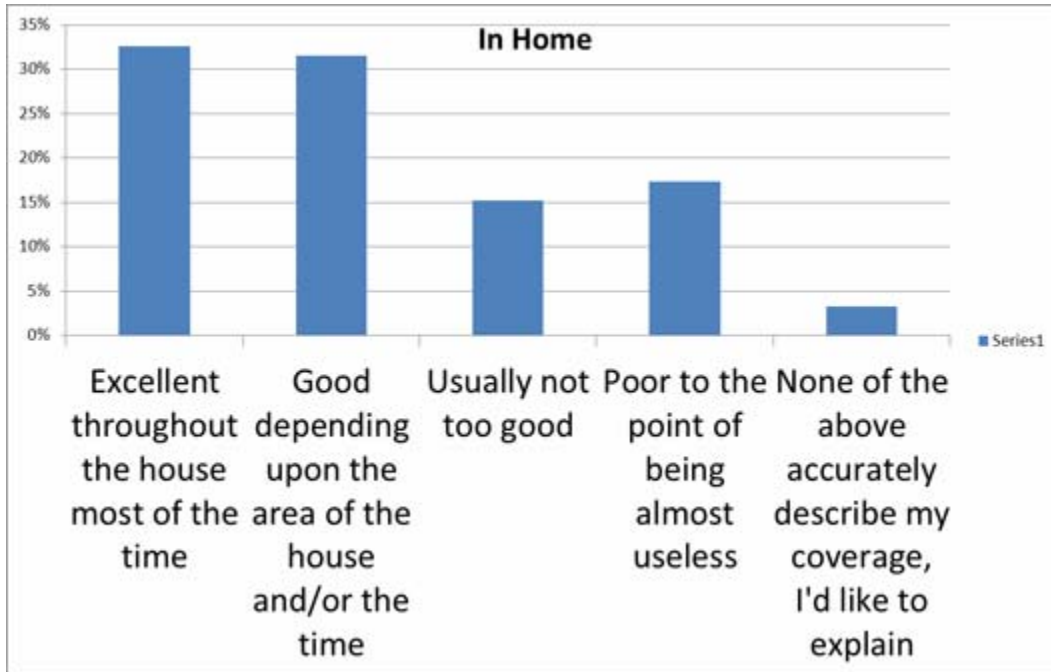


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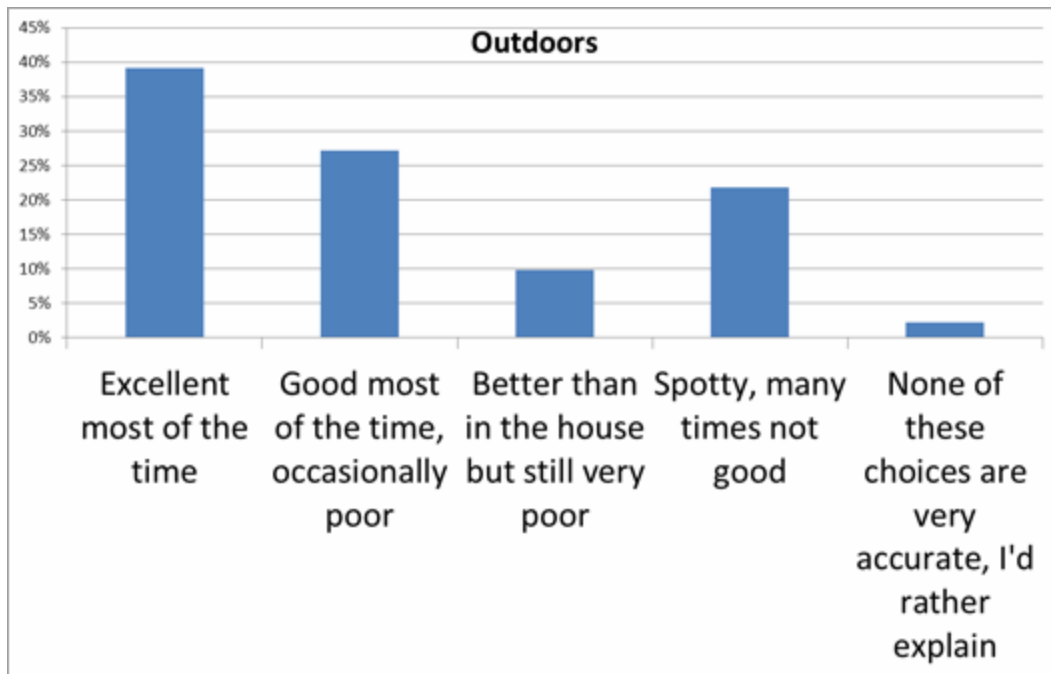


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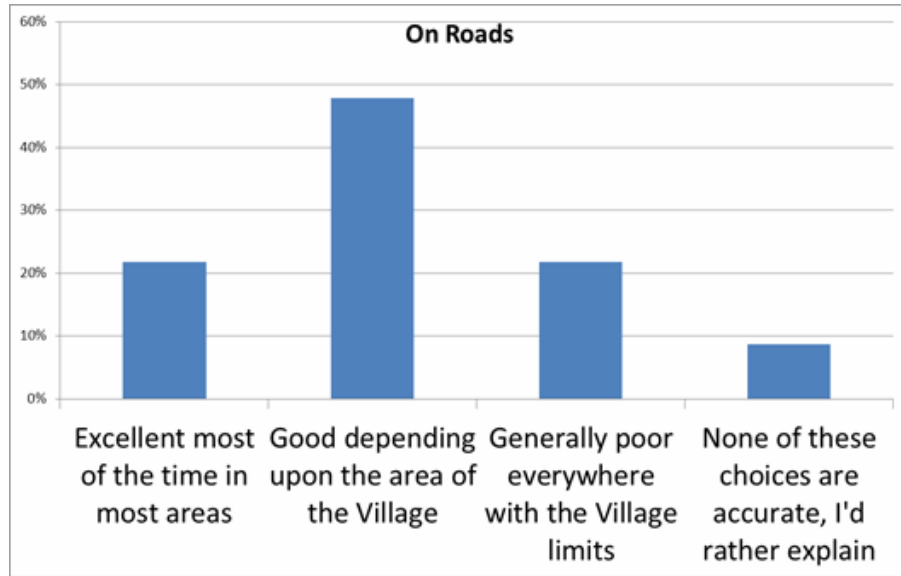


Figure 11 - Traveling on Waite Hill roads - which best describes your cellular coverage experience? The results represent 92 respondents that have one or more cell phone users in the home. Among those citing locations where poor coverage is experienced, the area of Eagle Rd. in the vicinity of the Willoughby Hills border near the Chagrin River was a recurring complaint.

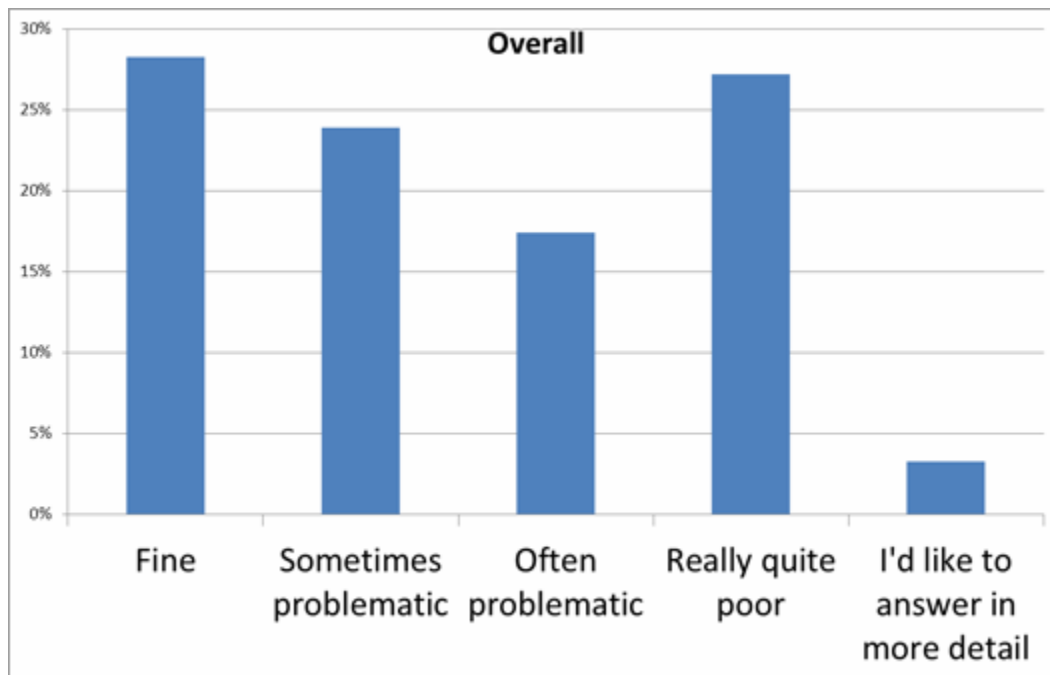


Figure 12 - Overall, how do you rate the cellular coverage in Waite Hill? The results represent 92 respondents that have one or more cell phone users in the home.

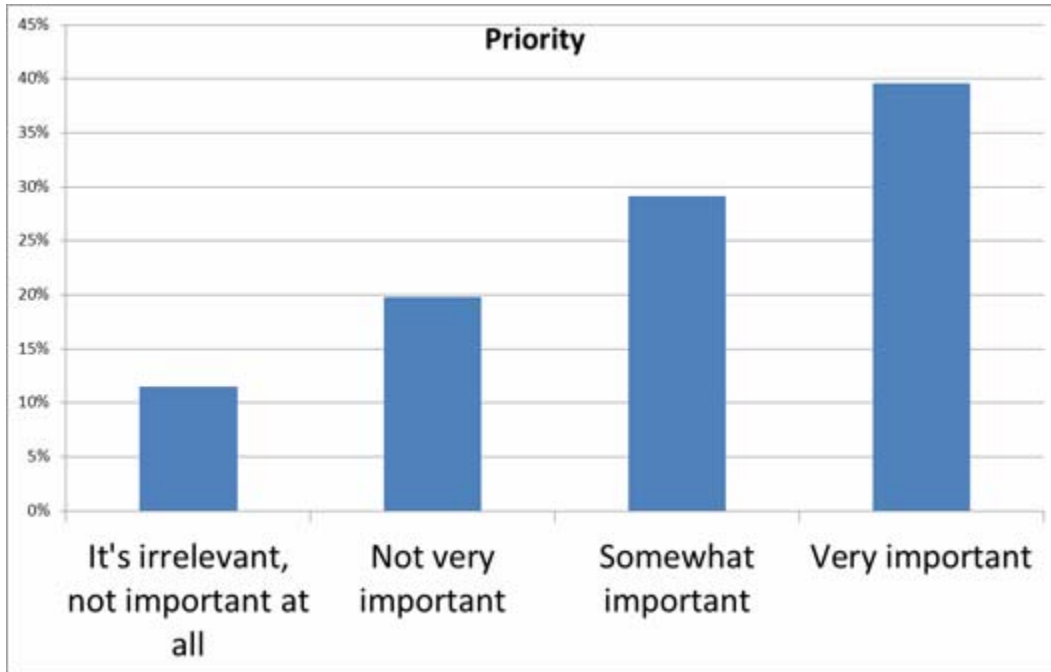


Figure 13 - How important is improving cellular coverage in the Village? Of 96 respondents. Some who do not use cell phones themselves host guests that do.

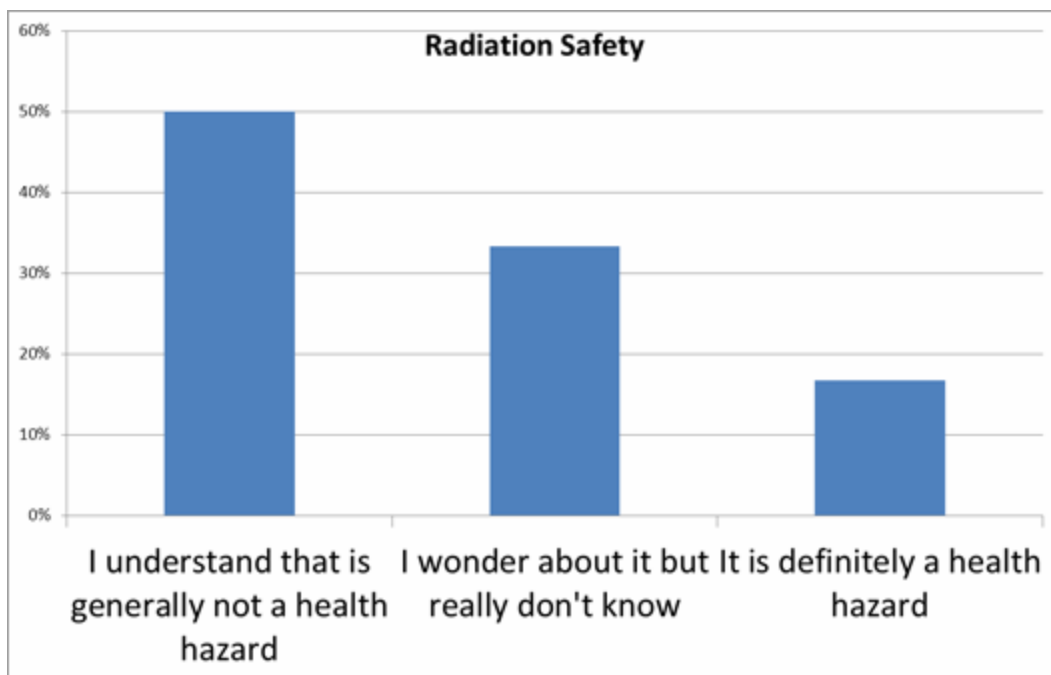


Figure 14 - Do you believe electromagnetic radiation in the environment presents a health hazard? 16 who responded that it is definitely a hazard were given the opportunity to select sources of radiation they believed were harmful. 12 included cell phone radiation in their selections.

Because measured coverage results (see Task area 4 - Objective In-Street Coverage) show severe coverage deficits on roads along the Waite Hill - Willoughby Hills border, WHWC intends to extend this survey to Willoughby Hills residents living in those areas.

Task area 3 - Experience of Other Villages. Organizations

Kirtland School District

One (1) tower established 2011 located at Kirtland School. Annual land lease revenue with American Tower was \$1,500 per month. After 1-1/2 year negotiations, it has been converted to a perpetual lease for a one time payment of \$300,000. Carrier tenants are only AT&T. Verizon has shown some level of interest in locating on this tower over the past 6 months, but nothing is precipitating. Land lease agreement is available in Addendum C1.

Gates Mills

One (1) tower established 1997 located just southwest of the intersection of Mayfield and Chagrin River Rd. Another tower underway at Gilmore Academy (approved by Gates Mills). Annual revenue from the single tower is \$74,650. Initial carrier tenant was Verizon with AT&T, Nextel, and T-Mobile all joining by 2002. Land lease agreement is available in Addendum C2. See the comment below for Hunting Valley.

Hunting Valley

Four (4) cell towers established from 1998 on. Two at Village Hall, two more at South Woodland east of Som Center Rd. Annual revenue is \$126,919. Carrier tenants include AT&T, Sprint, and Verizon. Land lease agreements are available in Addendum C3.

Comment: Because of the Hunting Valley and Gates Mills towers, Verizon coverage is predominately good to excellent all along scenic Chagrin River Rd. from south of South Woodland to north of Mayfield Rd. The level never falls below -100 dBm (see Task area 4 - Objective (measured) In-Street Coverage).

Kirtland Hills

One (1) tower located at Village Hall. 2016 Annual revenue is \$9,810. Land lease agreement is available in Addendum C4.

Willoughby Hills

Willoughby Hills has recently gone through deliberations ultimately rejecting a proposal to build a tower at the municipal Grange location at the corner of Maplegrove and Chagrin River Rd. Public records pertaining to the deliberations are available in Addendum D.

Task area 4 - Objective (measured) In-Street Coverage

Owing to the predominance of Verizon amongst Village cellular subscribers, measurements were made assessing the downlink signal strength of the Verizon LTE network in the 746 MHz

to 756 MHz band (band 13) over most areas of Village and adjacent streets. Two late model handsets (Samsung Galaxy S7 Edge and HTC One M9) in field measurement mode and an Anritsu 2711D spectrum analyzer were employed to measure Reference Signal Receive Power - RSRP and Received Signal Strength - RSS respectively. RSRP is specified as one of two significant reception level measures by the 3GPP in its technical specification TS 36.133 V8.9.0 (2010-03) available at (www.3gpp.org/Specs/36133-890.pdf). A Honda minivan was utilized for transport with all windows and moonroof open. The spectrum analyzer antenna was outside, roof-mounted. Detailed numerical data is presented in Addendum E.

RSRP measurements collected may be graded into five (5) regions:

>-80 dBm	Excellent	● Green
-80 to -90 dBm	Good	● Yellow
-90 to -100 dBm	Poor	● Orange
<-100 dBm	Very poor	● Red
No LTE		● Blue

Table 1 - Grading for LTE reception based upon RSRP power level.

The grading scheme is shown diagrammatically in Figure 15

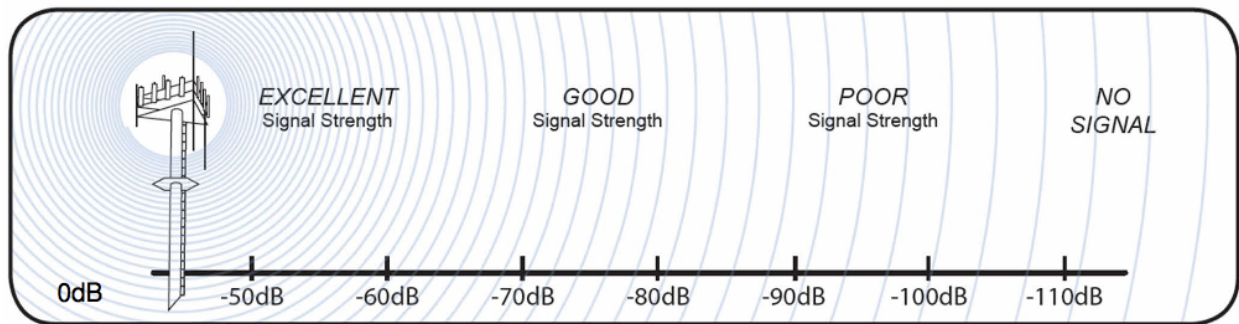


Figure 15 - Coverage conditions as a function of RSRP signal strength in 4G LTE.

At each location, the respective handset measurements were averaged in the log (dBm) domain. Of 70 measurement locations, 56 averaged RSRP below -100 (very poor). 14 locations measured in the range of -100 to -90, poor. There were no locations in the good signal strength category. Of the 56 locations below -100 dBm, five (5) had no measurable LTE signal whatsoever. The map of Figure 16 conveys average LTE RSRP signal strength at locations color coded as in Table 1 above. There are no green (excellent) or yellow (good) locations.

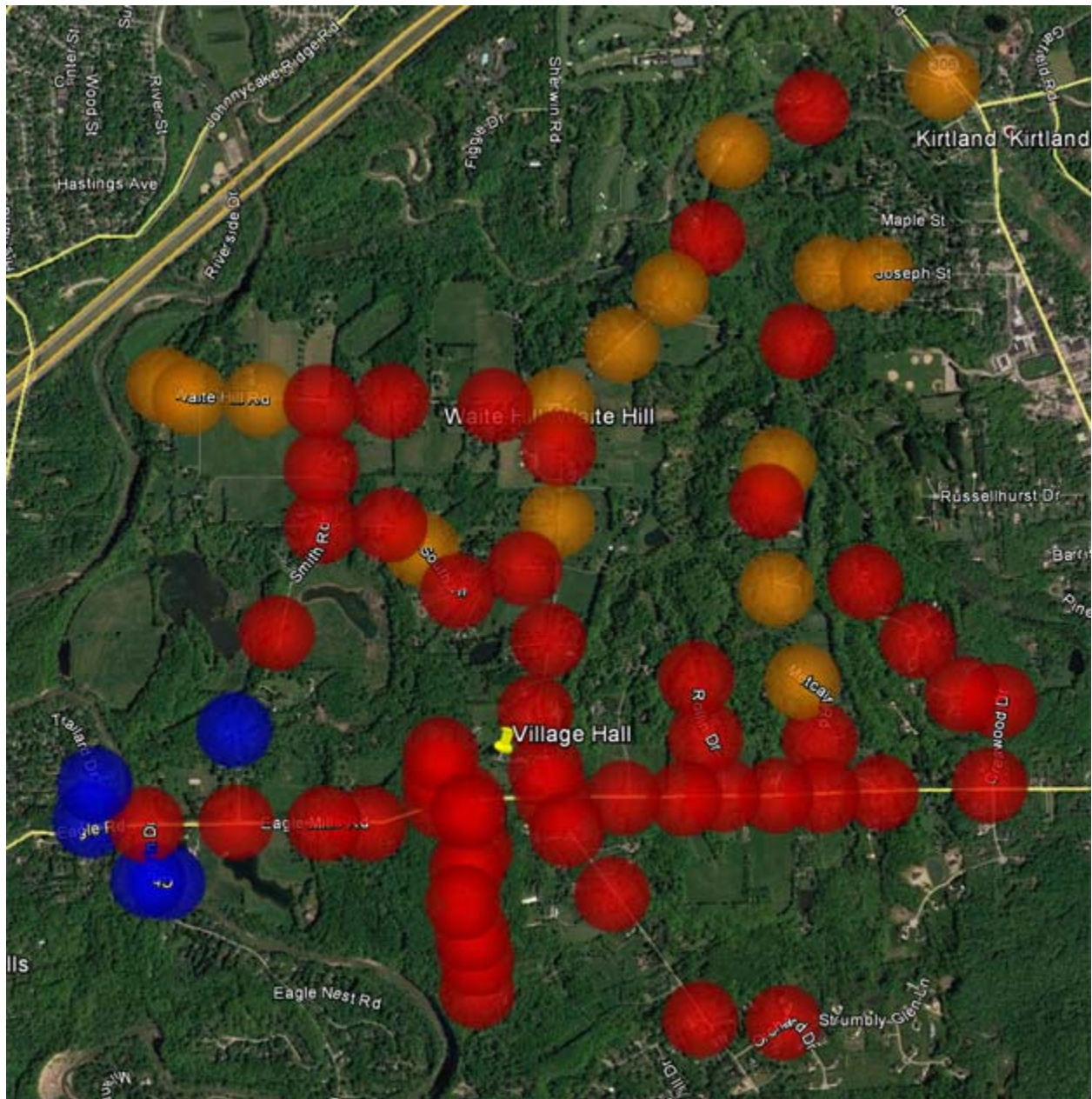


Figure 16 - Verizon RSRP in Waite Hill Village

Note: The LTE protocol includes adaptive handset (called User Equipment - UE in the specification) uplink transmit power control (see: http://www.etsi.org/deliver/etsi_ts/136200_136299/136213/08.08.00_60/ts_136213v080800p.pdf) It turns out that poor cell coverage exacerbates the RF exposure because handsets must operate at higher power levels to connect. See Task area 5 - Public Safety for the details.

Task area 5 - Public Safety

Three (3) sub-areas related to public safety have been identified:

- i) First responder issues (law enforcement, fire, EMS, etc.)
- ii) Human exposure to RF (Radio Frequency) radiation, health impact issues
- iii) Environmental issues

First Responder Issues

First responders as well as municipal service workers rely upon good mobile phone coverage to effectively execute their work on the public's behalf. In the case of fire, law enforcement, and EMS responders, it is well known and broadly documented that in situations where their public safety radio system is inoperative (often due to dead zones in buildings or other structures) or inappropriate, these individuals rely on mobile phones to communicate, often in circumstances where life and livelihood are at stake. Waite Hill public servants share this reliance on the mobile phones they use.

Data as well as voice communications is also key to the first responder's mission. Internet access is mandated for access to law enforcement databases used in daily operations and will become increasingly important for intra and interdepartmental information sharing as well. Today in Waite Hill as in the majority of venues nationwide, mobile broadband access is relied upon for Mobile Data Terminals (MDTs) to access the Internet on a mobile basis from departmental vehicles. When in-street coverage is lacking, an interruption to data communications may result. In vehicle enhancement measures including high gain external antennas may help in areas where coverage is marginal but will not be sufficient in areas where coverage is so poor that the antenna gain coupled with the existing in street signal power remains below an acceptable performance level for LTE communications. There are many areas in Waite Hill where this is the case (see Task area 4 - Objective In-Street Signal Strength).

The FIRSTNET (<https://www.firstnet.gov/>) program, now under development and deployment, is an LTE-based (cell phone) public safety communications network that is targeted to both augment and eventually replace many of the functions provided by today's public safety radio systems. The requirement for LTE coverage will increase as FIRSTNET becomes a reality.

Emergency Calling (911 and E911)

In home cellular signal enhancers variously called "network extenders" or "microcells" rely upon utility power and Internet connectivity to operate. Bidirectional amplifiers (BDA) variously called "signal boosters" or "repeaters" require utility power to operate and also a sufficiently high quality signal from a cell macro site (tower) available to a rooftop or outdoor "donor" antenna. WiFi calling requires utility power and Internet connectivity to operate. None of these devices may be legally used to improve outdoor signal strength (in fact BDAs rely on sufficient outdoor signal strength). All are subject to failure in conditions of Internet or power outages. This is one important caveat for those that rely upon such mechanisms to achieve in-home cellular coverage in the absence of macro site signal strength.

Another area of caution is the location information utilized ubiquitously by Public Safety Answering Points (PSAPs) when processing 911 emergency calls. In particular, calling 911 over

a WiFi connection relies upon the caller to either have programmed his location into his phone or to relay his location verbally to the 911 operator. Conversely, normal mobile calling utilizes the phones GPS system to automatically relay location information to the PSAP.

All of this can become particularly daunting when guests are visiting a household. In the presence of an emergency, when Internet and/or power may be unavailable, a guest trying to reach 911 (or reach others) on his mobile phone may find it to be an impossible task. Depending upon circumstances, it is even possible that imprecise information about an emergency caller's location may be forwarded to the PSAP further frustrating an effective emergency response effort.

The FCC works to alleviate the challenges of 911 and E911 services with mobile devices. Background information can be found at <https://www.fcc.gov/consumers/guides/911-wireless-services>, <https://www.fcc.gov/general/9-1-1-and-e9-1-1-services>, and <https://www.fcc.gov/consumers/guides/emergency-communications>.

Human exposure to RF

Perils of Poor Coverage

Poor cellular coverage represents a greater radiation exposure risk to cell phone users.

Those espousing human health considerations pertaining to RF energy associated with cell phone systems unanimously identify energy from handheld devices to be of significantly greater concern than RF energy from base stations (cell towers). The LTE protocol includes adaptive handset uplink transmit power control. For example, conventional LTE power control is used in attempt to maintain a constant Signal to Interference plus Noise Ratio (SINR is a measure of quality of reception) at the receiver. UE (user equipment, *i.e.*, your handset) increases its transmit power to fully compensate any increase in path loss [see 3gpp technical specification ETSI TS 136 213 V8.8.0 (2009-10)]. Path loss is related to the distance from the tower. The further away, the greater the path loss. It turns out that poor cell coverage exacerbates the RF exposure because handsets must operate at higher power levels to connect. Unfortunately, distant towers wind up requiring substantially higher (perhaps maximum) handset transmit power to maintain adequate signal quality. The maximum level is regulated by the FCC in the U.S. and is on the order of 3 watt (30 dBm - remember this number as we will compare it to the power level the user sees from the tower for comparison). This means, perhaps unexpectedly, that having poor cell coverage actually maximizes the radiation the user receives from the most significant source of RF energy, the cell phone itself. The implication is that better coverage is safer from an overall RF energy exposure perspective for cell phone users.

A vast array of government agencies, non-government agencies and organizations, and individuals espouse information and concerns related to human RF safety in general and cell phone RF safety in particular. Pertaining to cell phone RF safety, one fact emerges unanimously: radiation from the cell phone itself represents the highest concern regarding human safety. Some sources of information are:

Harvard Campus Services - Environmental Health and Safety

A memorandum from Harvard University pertaining to human safety and cellular telephony is cited because it summarizes many of the issues succinctly. The entire memorandum is available in Addendum F. It is excerpted here:

"It is generally accepted that damage to DNA molecules in living cells is necessary to initiate the carcinogenic process. For example, we know that ionizing radiation such as gamma ray and x-ray exposure, by virtue of its high energy, can cause initiation of cancers through unrepaired mutations of genes or disruption of chromosomal structure. This process may be mediated by the production of reactive oxygen species. The frequencies of RF fields are over 100,000 times lower than electromagnetic wave frequencies capable of breaking chemical bonds. Thus, RF energy is called "non-ionizing". It has not been found to cause cancer in animals or to enhance the cancer-causing effects of known chemical carcinogens in animals. For these reasons, the overwhelming majority of consensus documents from various health agencies worldwide agree that cell phones and base-station antennas are unlikely to cause cancer."

"As stated above, epidemiological research on potential long-term health risks from radiofrequency exposure has focused on brain tumor risk and mobile phone use. For the most part, this literature has not uncovered a positive association between RF (mostly from cell phones) and brain cancer, although there are several exceptions. Since most cancers have a latency period of between 10 and 40 years and mobile phones were not widely used until the early 1990s, epidemiological studies can only assess cancers with shorter latency periods."

"Studies have shown that environmental levels of RF fields (produced by cellphone base stations, radio and TV broadcasting, GPS) routinely encountered by the general public are typically far below the FCC limits. From 30 to 300 MHz the FCC MPE (Maximum Permissible Exposure) for the general public is 0.2 milliwatts per square centimeter (mW/cm²) increasing to 1 mW/cm² at 1,500 MHz. Across radio, TV and cellular bands the highest fields the public might typically experience are between 0.1% to 0.5% of the FCC limit, translating to an absolute value of about 1 microwatt per square centimeter (μ W/cm²)."

"Do more cell phone towers mean higher RF exposure levels?"

"Not really. Cellphone user's RF exposures come from two sources. One is cellphone towers, which send signals to cellphones through RF waves. The RF fields, created by cellular base stations, in typical public areas may be equal to or less than a few microwatts per square centimeter (10-6 Watts/cm²). The cellphone itself sends signals to base station antennas with the power of thousands of microwatts (10-3 Watts). Because a cell phone is typically held against the side of the head when in use, much of the RF energy is delivered to very small volumes of the user's body. The greatest RF exposures are from cellphones, not from base stations."

"Cell phone communication is two-way. RF signals from a base station decay with distance. All things being equal, the greater the distance between a cell phone and a base station then the weaker the signal. However, a cell phone needs to operate at greater power for its signal to reach base stations further away. This leads to more RF exposure to the cell-phone users when base stations are widely spaced. When phone users are close to towers, the cell phone will emit

signals at lower power, which means less RF exposure to a user, ***so more towers generally reduce a user's RF exposure.*** [emphasis added]"

Once again, the entire memorandum including references appear in Addendum F.

EMFscientist.org

<http://EMFscientist.org> (contributed by WHWC member Rebecca Platz). The organization solicits signatories to an International Appeal that states:

"We are scientists engaged in the study of biological and health effects of non-ionizing electromagnetic fields (EMF). Based upon peer-reviewed, published research, we have serious concerns regarding the ubiquitous and increasing exposure to EMF generated by electric and wireless devices. These include—but are not limited to—radiofrequency radiation (RFR) emitting devices, such as cellular and cordless phones and their base stations, Wi-Fi, broadcast antennas, smart meters, and baby monitors as well as electric devices and infra-structures used in the delivery of electricity that generate extremely-low frequency electromagnetic field (ELF EMF)."

With respect to cell phone safety in particular, the EMFscientist homepage references the ongoing National Toxicology Program (NTP) studies under the National Institute of Health (NIH) which will be reviewed briefly next.

NIH, NTP (National Institute of Health, National Toxicology Program)

NTP asserts:

"Cell phones are now being used by 91 percent of American adults, according to a 2013 survey. Given this large number of users, if adverse health effects are shown to be associated with cell phone use, this could potentially be a widespread public health concern."

Further:

"The nomination for the National Toxicology Program (NTP) to study cell phone radiofrequency radiation was made by the U.S. Food and Drug Administration (FDA) because of the following:

Widespread human exposure.

Current exposure guidelines are based largely on protection from acute injury from thermal effects.

Little is known about potential health effects of long-term exposure to radiofrequency radiation.

Data from human studies are inconsistent. Additional studies are being conducted.

Many people are concerned that cell phone radiation will cause cancer or other serious health effects."

"While current scientific evidence has not conclusively linked cell phones with any health problems, NTP and other scientific organizations recognize that additional data are needed."

"Therefore, NTP is conducting studies to help clarify any potential health hazards, including cancer risk, from exposure to cell phone radiation, and to pave the way to better protection for public health."

The long term study in rats and mice is of 2-year duration and is scheduled for completion by the end of 2017. Note, the dosage levels being used in the study are based on pilot study results and are selected by NTP for SAR (Specific Absorption Rate) exposures of 0, 3, 6, 9 W/kg in rats and 0, 5, 10, and 15 W/kg in mice. Note, while one must be careful in estimating SAR levels for a variety of reasons, it is very safe to say that the SAR levels (other than 0) being utilized in the NTP study are high compared to those allowed by current cell device rules and are ***thousands of times greater than the RFR levels from cell towers of modest height at any distance on the ground.*** Details of the NTP study parameters can be found at https://ntp.niehs.nih.gov/ntp/research/areas/cellphone/slides_bioem_wyde.pdf. As stated above, current scientific evidence has not conclusively linked cell phones with any health problems, but, given the ubiquitous use of cell phones, even a small increase in health problems associated with RFR from phones is important to understand. One good piece of advice from the FCC if one is concerned with one's phone radiation:

"ALL cell phones must meet the FCC's RF exposure standard, which is set at a level well below that at which laboratory testing indicates, and medical and biological experts generally agree, adverse health effects could occur. For users who are concerned with the adequacy of this standard or who otherwise wish to further reduce their exposure, the most effective means to reduce exposure are to hold the cell phone away from the head or body and to use a speakerphone or hands-free accessory. These measures will generally have much more impact on RF energy absorption than the small difference in SAR between individual cell phones, which, in any event, is an unreliable comparison of RF exposure to consumers, given the variables of individual use."

FCC (Federal Communications Commission www.fcc.gov)

Owing to concerns such as those of NIH and the NTP, the FCC has recently revisited its rules pertaining to RF safety. The FCC (Federal Communications Commission) publishes the following webpage:

<https://www.fcc.gov/general/radio-frequency-safety-0>

A link to a subsidiary page "FCC Policy on Human Exposure" is:

<https://www.fcc.gov/general/fcc-policy-human-exposure>

There is a substantial amount of information associated with the above links.

For those thirsting for a deeper dive, ET Docket 13-84 is an FCC inquiry proceeding to further consider limits to human RF exposure in light of more recent developments. A large cross-section of individuals, companies, and organizations respond to the inquiry. One can survey Docket 13-84 at:

[https://www.fcc.gov/ecfs/search/filings?proceedings_name=13-84&q=\(proceedings.name:\(\(13-84*\)\)%20OR%20proceedings.description:\(\(13-84*\)\)\)&sort=date_disseminated,DESC](https://www.fcc.gov/ecfs/search/filings?proceedings_name=13-84&q=(proceedings.name:((13-84*))%20OR%20proceedings.description:((13-84*)))&sort=date_disseminated,DESC)

This proceeding does not represent government dogma per se but rather is a broad spectrum collection of opinions from around the world about the FCC rules and guidelines in particular and human RF safety in general. It is both very interesting and voluminous.

The FCC also publishes an informative consumer guide pertaining to cellular coverage: <https://www.fcc.gov/consumers/guides/understanding-wireless-telephone-coverage-areas>

WHO (World Health Organization www.who.int)

WHO publishes extensively on human health effects of non-ionizing RF radiation. The proceedings of the WHO International Workshop on Base Stations [cell tower] and Wireless Networks: Exposures and Health Consequences, Geneva, Switzerland, 2007, are of particular relevance to this report.

The scope and objectives of the workshop included answering the following questions:

What are the current and future wireless technologies?

What RF exposures do people receive from these technologies?

Is there evidence of health effects from long-term, low-level RF exposures?

What further research is needed, if any?

What international standards exist or are being developed?

What have national authorities done in response to this issue?

How can we provide effective communication to all stakeholders on this issue?

What policy options can be recommended for national authorities?

Workshop contributor Peter A. Valberg reminds us in his presentation "Modulated RF Energy: Mechanistic Viewpoint on the Health Implications" as follows:

"Mechanistic considerations are crucial because living organisms rely upon the same laws that govern all systems. As shown in Fig. 1 below, physics forms the basis of chemistry, which forms the basis of biology, which forms the basis of medicine. Hence, even though there is an increase in complexity as you move up this progression, each successive layer must obey the fundamental laws found to be valid for the layer below. At the most fundamental level are the laws of physics, which have been exhaustively validated by experiment and through internal consistency. The principles behind radiofrequency waves, namely Maxwell's laws of electromagnetism, are accepted to be invariant in time and space, and their accuracy in describing the interactions between electromagnetic fields and matter underlies the functioning of virtually all technology. No exceptions have been found, in spite of constant challenges. Likewise, physics has been found to be valid in complex systems, encompassing chemistry, biology, technology, and medicine. Simple conservation laws (e.g., energy, motion, charge, momentum) are universally applicable, and biology is no exception."

From Valberg:

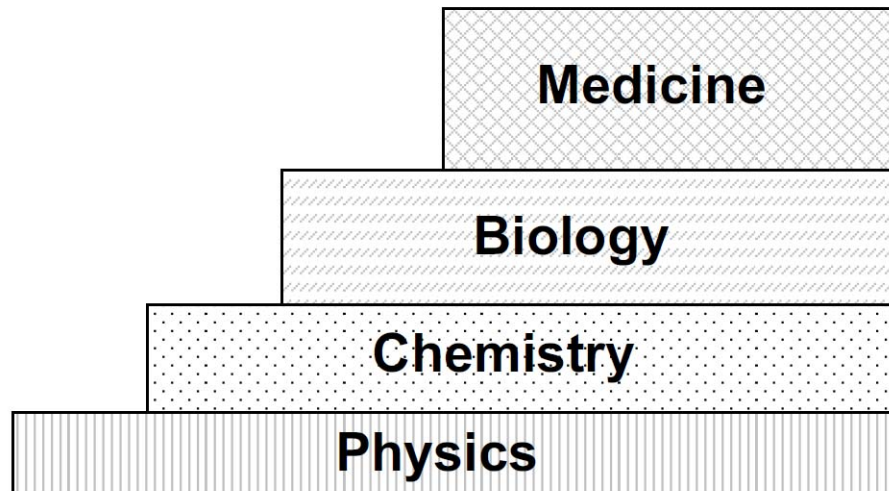


Figure 1: *Each scientific discipline rests on the underlying laws of a more basic discipline*

Figure 17 - Valberg's hierarchy of scientific disciplines

Valberg examines quantum (photon) effects, thermal effects, and the effects of forces generated by RF fields on organisms. He concludes:

"My review and other similar reviews support the conclusion that, mechanistically, the RF energy associated with cellular telephone technology is not sufficient to cause modulation-dependent health hazards of RF fields, because there appears to be no biophysical basis on which such hazards would be expected (Challis, 2005; Foster and Repacholi, 2004; NCRP, 2003; NRPB, 2004)."

Contributor Bernard Veyret *et. al.* reviews the non-thermal health effects from radio frequency fields relevant to base station (tower) exposure. The abstract summarizes:

"The aim of this review is to gather data from laboratory studies on biological and health effects of "low-level" RF exposure relevant to base station exposure. Results related to whole-body exposure of humans and animals are considered along with exposure of cell culture models. Most of the studies were done using mobile telephony signals, but other sources were also taken into consideration. Overall, there is no evidence of deleterious biological effects that could be associated with health hazards."

Interestingly, Veyret *et. al.* point out:

"The paucity of data related to mobile telephony base stations and other similar sources is thus explained by the fact that the health concerns revolve more around hand-held phones which expose the head, with an SAR level close to the local exposure limit, than base stations which are located far from the body – with a corresponding whole-body SAR several orders of magnitude lower than exposure guidelines."

Once again, the virtually unanimous viewpoint that cell phones themselves are a far greater concern to the researchers and practitioners studying health effects than are the cellular base stations (towers) as RF radiation sources.

The balance of relevant work undertaken by WHO centers on cell phone exposure hazards and RF hypersensitivity.

The Residents of Waite Hill

The results in Task area 2 - Residents' Experience show that, of 96 respondents to the cellular survey, 50% responded that they understand that radiation associated with cell phones is generally not a health hazard, 33% wonder but really don't know, and 17% believe electromagnetic radiation is definitely a hazard. Given a choice of radiation sources, 12 of the 16 responding that electromagnetic radiation is definitely a hazard specifically cited cell phone transmissions as a source while 4 cited only other sources not including cell phones.

Environmental Issues

From Thomas Schwengler, Chapter 6, Practical Aspects of Wireless Systems, (<http://morse.colorado.edu/~tlen5510/text/classwebch6.html>)

"The telecommunication industry and overall Information and Communication Technologies (ICT) seem to have a beneficial impact on the environment, generally encouraging eco-friendly transfer of information rather than transport of paper, goods, or people. Still the sector is growing rapidly, and is increasingly sensitive to green initiative, both in increasing efficient use of ICT, and in lowering energy use in manufacturing and operations. These efforts are increasingly important for service providers as general public environmental awareness increases; and are also important in energy cost savings for telecom operators. Starting in 2008, for instance, China Mobile cited environmental reasons as a major selection criteria for equipment selection, and attributed major contracts to Nokia-Siemens for that reason; the public relationship aspect was of course important, especially with Olympic spotlight on Beijing, but China Mobile also cited power consumption as a major source of operational savings."

About Thomas Schwengler:

Lecturer

Thomas.Schwengler@Colorado.EDU

Dr. Schwengler is principal architect and chief wireless architect at CenturyLink, where he researches and analyses a broad range of wireless systems and services. He held positions as director of RF engineering at Qwest wireless, senior staff engineer at U S WEST Advanced Technologies, and research engineer at France Telecom R&D. His areas of work are RF engineering applied to wireless voice and broadband communications. Current areas of interest include propagation and performance modeling and measurements, lab and field trials, especially focus on Wi-Fi and LTE.

Mobile Apps in Medical Applications

The FDA (federal Food and Drug Administration) addresses mobile applications that may be considered to be "medical devices". For example, see:

<https://www.fda.gov/MedicalDevices/DigitalHealth/MobileMedicalApplications/ucm368744.htm>

"The Food and Drug Administration (FDA) recognizes the extensive variety of actual and potential functions of mobile apps, the rapid pace of innovation in mobile apps, and the potential benefits and risks to public health represented by these apps."

More from the FDA:

... examples of mobile apps that MAY meet the definition of medical device but for which FDA intends to exercise enforcement discretion. These mobile apps may be intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease. Even though these mobile apps MAY meet the definition of medical device, FDA intends to exercise enforcement discretion for these mobile apps because they pose lower risk to the public.

The FDA understands that there may be other unique and innovative mobile apps that may not be covered in this list that may also constitute healthcare related mobile apps. This list is not exhaustive; it is only intended to provide clarity and assistance in identifying the mobile apps that will not be subject to regulatory requirements at this time.

Appendix B in the guidance includes examples of mobile apps for which the FDA intends to exercise enforcement discretion at the time the guidance was finalized. As part of FDA's ongoing effort to provide clarity to mobile app manufacturers this page includes all examples in Appendix B as well as updates with additional examples.

Mobile apps that help patients with diagnosed psychiatric conditions (e.g., post-traumatic stress disorder (PTSD), depression, anxiety, obsessive compulsive disorder) maintain their behavioral coping skills by providing a "Skill of the Day" behavioral technique or audio messages that the user can access when experiencing increased anxiety;

Mobile apps that provide periodic educational information, reminders, or motivational guidance to smokers trying to quit, patients recovering from addiction, or pregnant women;

Mobile apps that use GPS location information to alert asthmatics of environmental conditions that may cause asthma symptoms or alert an addiction patient (substance abusers) when near a pre-identified, high-risk location;

Mobile apps that use video and video games to motivate patients to do their physical therapy exercises at home;

Mobile apps that prompt a user to enter which herb and drug they would like to take concurrently and provide information about whether interactions have been seen in the literature and a summary of what type of interaction was reported;

Mobile apps that help asthmatics track inhaler usage, asthma episodes experienced, location of user at the time of an attack, or environmental triggers of asthma attacks;

Mobile apps that prompt the user to manually enter symptomatic, behavioral or environmental information, the specifics of which are pre-defined by a health care provider, and store the information for later review;

Mobile apps that use patient characteristics such as age, sex, and behavioral risk factors to provide patient-specific screening, counseling and preventive recommendations from well-known and established authorities;

Mobile apps that use a checklist of common signs and symptoms to provide a list of possible medical conditions and advice on when to consult a health care provider;

Mobile apps that guide a user through a questionnaire of signs and symptoms to provide a recommendation for the type of health care facility most appropriate to their needs;

Mobile apps that record the clinical conversation a clinician has with a patient and sends it (or a link) to the patient to access after the visit;

Mobile apps that are intended to allow a user to initiate a pre-specified nurse call or emergency call using broadband or cellular phone technology;

Mobile apps that enable a patient or caregiver to create and send an alert or general emergency notification to first responders;

Mobile apps that keep track of medications and provide user-configured reminders for improved medication adherence;

Mobile apps that provide patients a portal into their own health information, such as access to information captured during a previous clinical visit or historical trending and comparison of vital signs (e.g., body temperature, heart rate, blood pressure, or respiratory rate);

Mobile apps that aggregate and display trends in personal health incidents (e.g., hospitalization rates or alert notification rates);

Mobile apps that allow a user to collect (electronically or manually entered) blood pressure data and share this data through e-mail, track and trend it, or upload it to a personal or electronic health record;

Mobile apps that provide oral health reminders or tracking tools for users with gum disease;

Mobile apps that provide prediabetes patients with guidance or tools to help them develop better eating habits or increase physical activity;

Mobile apps that display, at opportune times, images or other messages for a substance abuser who wants to stop addictive behavior;

Mobile apps that are intended for individuals to log, record, track, evaluate, or make decisions or behavioral suggestions related to developing or maintaining general fitness, health or wellness, such as those that:

Provide tools to promote or encourage healthy eating, exercise, weight loss or other activities generally related to a healthy lifestyle or wellness;

Provide dietary logs, calorie counters or make dietary suggestions;

Provide meal planners and recipes;

Track general daily activities or make exercise or posture suggestions;

Track a normal baby's sleeping and feeding habits;

Actively monitor and trend exercise activity;

Help healthy people track the quantity or quality of their normal sleep patterns;

Provide and track scores from mind-challenging games or generic "brain age" tests;

Provide daily motivational tips (e.g., via text or other types of messaging) to reduce stress and promote a positive mental outlook;

Use social gaming to encourage healthy lifestyle habits;

Calculate calories burned in a workout.

Mobile apps for providers that help track or manage patient immunizations by assessing the need for immunization, consent form, and immunization lot number [Added March 12, 2014];

Mobile apps that provide drug-drug interactions and relevant safety information (side effects, drug interactions, active ingredient) as a report based on demographic data (age, gender), clinical information (current diagnosis), and current medications [Added March 12, 2014];

Mobile apps that enable, during an encounter, a health care provider to access their patient's personal health record (health information) that is either hosted on a web-based or other platform [Added March 12, 2014];

Mobile apps that are not intended for diagnostic image review (and include a persistent on-screen notice, such as "for informational purposes only and not intended for diagnostic use") are medical image communications device under 21 CFR 892.2020, product code LMB. Non-diagnostic uses could include: image display for multidisciplinary patient management meetings (e.g., rounds) or patient consultation. Medical image communications devices are Class I and do not require FDA 510(k) premarket notification. Possible product code LMD (21 CFR 892.2020) [Added March 12, 2014];

Mobile apps that allows a user to collect, log, track and trend data such as blood glucose, blood pressure, heart rate, weight or other data from a device to eventually share with a health care provider, or upload it to an online (cloud) database, personal or electronic health record [Added June 11, 2014];

Mobile apps that provide the surgeon with a list of recommended intraocular lens powers and recommended axis of implantation based on information inputted by the surgeon (e.g., anticipated surgically induced astigmatism, patient's axial length and preoperative corneal astigmatism, etc.) [Added August 1, 2016]

The proliferation of medical applications that rely on mobile broadband connectivity is a compelling reason to continue to weigh the benefits and costs of mobile coverage in society in general and Waite Hill in particular.

Task area 6 - Other

Real Estate Values

The statement is often made that a cell tower in a neighborhood has a deleterious effect on property sales and prices. Negative, neutral, and positive impacts on sales and prices can be found in reports in the public domain. More often than not, perceived radiation hazards associated with cell towers are cited as the cause of negative impacts. Worldwide efforts continue to elucidate the real health impacts, and as the results continue to arrive, the impact of tower proximity will undoubtedly be affected (please see Task area 5 - Public Safety on Human Exposure to RF to learn about current work and findings). Here we review some reference material related to the subject as it currently stands.

Poor cellular coverage is also known to have a negative impact on real estate.

The Appraisal Journal (thanks to the National Association of Realtors)

Sandy Bond, Ph.D. and Ko-Kang Wang, "The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods", *The Appraisal Journal*, Summer 2005, conveys information pertaining to studies conducted by the authors in New Zealand. The entire paper is available in Addendum G. The authors find a negative impact on property values in 3 of 4 neighborhoods studied with a positive (upward) impact on prices in one (1). The trends appear to be predominately media driven as it effects homebuyers' perceptions. From Bond et. al.:

"a positive impact on price being recorded in one neighborhood, possibly due to the CPBS [Cell phone base station = tower] being built in that suburb ***before any adverse media publicity*** [emphasis added] about CPBSs appeared in the local Christchurch press."

The authors further conclude:

"The comments of survey participants indicate the ongoing concerns that residents have about CPBSs. There is the need to increase the public's understanding of how radio frequency transmitting facilities operate and the strict exposure-limit standards imposed on the telecommunication industry. As more information is discovered that refutes concerns regarding adverse health effects from CPBSs, and as information about the NZ safety standards are made more publicly available, the perception of risk may gradually change, eliminating the discounts for neighboring properties."

From Probate and Property (American Bar Association)

Forsten, Richard A., et. al., "Cell Phone Towers - Do they Effect Property Values", *Probate and Property*, May/June 2016, Vol. 30 No. 3, discusses a Sussex County Delaware case where litigation regarding a proposed cell tower transpired concurrently with the erection of a temporary tower over a timeframe when neighboring homes sales occurred and could be documented. The entire article is available in Addendum H. From the authors' conclusion:

"Studies have long shown that cell towers have no appreciable effect on property values, but opponents of towers, and some boards that consider these applications, refuse to believe these studies. Nevertheless, the results are supported by empirical data, and although it may seem counterintuitive, the results ultimately make sense. As one appraiser in the AT&T case observed, "a cell tower pole, a single monopole, really is an expected thing in today's world. . . . people have been making purchase decisions for many years in the presence of those lines and the other uses like gas pumps and the convenience store, and we just didn't see any evidence of this one particular structure [having] a unique influence on property value." The AT&T case is especially interesting and uniquely helpful because it allowed the cell tower applicant to demonstrate that there would be no effect on value for the very location at issue. Property values in the vicinity of the temporary tower moved in the same way as property values in the larger market. Not only is this conclusion consistent with the general literature and studies in this area, but AT&T was actually able to demonstrate that its proposed tower in its proposed location would not affect property values in the immediate area."

Small Cells

Tessco Technologies

Small cell technology, generally a practice of utilizing small radio transceivers that can be variously deployed on structures such as utility poles, small towers, buildings and other "typically smaller than macro site cell tower" structures, is touted as a solution to a variety of challenges facing the mobile communications industry and their subscribers. Scott Gregory of Tessco Technologies (see Task area 1 above) has an informative overview of small cell technology and deployment issues posted at the knowledge center:

https://www.tessco.com/yts/knowledge_center/article/2014-feb-mar/capacity-coverage-small-cells-its-time.html. Another superb overview from Tessco is at <https://www.tessco.com/knowledge-center/2014/articles/cellular-coverage>.

As a distributor, Tessco interfaces the manufacturers of small cell equipment and components and sells to network developers and installers worldwide.

Small Cell Forum (www.smallcellforum.org)

The small cell forum (SCF) is a valuable resource for understanding the applications, promises and challenges of small cell technologies in principle.

SCF states their mission as: "to drive the wide-scale adoption of small cells and accelerate the delivery of integrated HetNets."

"This implies two main areas of focus:

1. Standardization, regulation & interoperability

We work to ensure the adoption of industry wide standards, a positive regulatory environment, common architectures and interoperability.

2. Marketing, promotion & business case

We promote the value & potential of small cells across the industry and to journalists, analysts, regulators, special interest groups and standards bodies."

SCF drives their mission through a document release program:

Our mission is The Small Cell Forum Release Program has now established business cases and market drivers for use cases including recent series of practical working guides to make densification using small cells a commercial reality, both for today's 4G and for future 5G networks.

"While 5G standards are still being defined, it is clear that network densification is fundamental to meeting the cardinal requirements of high capacity, low latency and 100% coverage. These new outputs outline SCF's activities in addressing technical, practical and commercial barriers to densification."

"As well as identifying and expanding upon the key role densification will play in driving future networks, these publications detail what it takes for operators and the enterprise to commercially deploy a hyperdense network today; including comprehensive explanations of regulatory, logistical and operational considerations."

Google FI (www.fi.google.com)

Google Fi is another Mobile Virtual Network Operator (MVNO). At present, carriers partnered with Google Fi do not include Verizon or AT&T. When WiFi connection is not available, calling is limited to T-Mobile, Sprint, and recently added U.S. Cellular networks. Google publishes a 911 and E911 location and connectivity warning label (see suggested warning label and article) that highlights the problems associated with WiFi based emergency calling.

Comcast Xfinity Mobile (www.xfinity.com/mobile)

An MVNO, Comcast is partnered with Verizon to provide a combination LTE and WiFi based virtual mobile network. This service is not available in Waite Hill.

Task area 7 - Coverage Enhancement Options

Macro Site

Also called "cell tower site" and "base transceiver station". Details to be provided.

Small Cells

There is confusing terminology when it comes to various communications nodes known as a group as "small cells".

Microcell

Don't confuse this with the AT&T's "MicroCell" network extender (it's is really a femtocell or tiny cell device).

From Wikipedia:

A microcell is a cell in a mobile phone network served by a low power cellular base station (tower), covering a limited area such as a mall, a hotel, or a transportation hub. A microcell is usually larger than a picocell, though the distinction is not always clear. A microcell uses power control to limit the radius of its coverage area.

Typically the range of a microcell is less than two kilometers wide, whereas standard base stations may have ranges of up to 35 kilometres (22 mi). A picocell, on the other hand, is 200 meters or less, and a femtocell is on the order of 10 meters,[1] although AT&T calls its femtocell that has a range of 40 feet (12 m), a "microcell".[2] AT&T uses "AT&T 3G MicroCell" as a trade mark and not necessarily the "microcell" technology, however.

A microcellular network is a radio network composed of microcells.

Like picocells, microcells are usually used to add network capacity in areas with very dense phone usage, such as train stations. Microcells are often deployed temporarily during sporting events and other occasions in which extra capacity is known to be needed at a specific location in advance.

Cell size flexibility is a feature of 2G (and later) networks and is a significant part of how such networks have been able to improve capacity. Power controls implemented on digital networks make it easier to prevent interference from nearby cells using the same frequencies. By subdividing cells, and creating more cells to help serve high density areas, a cellular network operator can optimize the use of spectrum and ensure capacity can grow. By comparison, older analog systems have fixed limits beyond which attempts to subdivide cells simply would result in an unacceptable level of interference.

Important issues when considering a small cell project:

Handoff (or more accurately hand-in) issues with outdoor small cells

Operator deployed is only sensible scenario (CAPEX, OPEX, including maintenance)

Use case

Economic drivers

Radio access technologies (LTE at least)

Site issues (planning and zoning, access power, form factor)

Backhaul

Available assets (spectrum, fixed networks, etc.)

Economics

Metro cell

Important issues are similar to microcell above.

Femto Cells and Pico Cells

These are typically indoor coverage approaches and may be implemented under the prevue of a building owner/operator or a homeowner. Important consideration related to emergency calling (911) are considered in Task area 5.

Please email whwc_report_information@waitehilloh.gov to request information about this report including the following:

Addendum A - 2014 Strategis-Verizon Proposal

Addendum B - Waite Hill Cell Phone Survey

Addendum C - Cell Tower Lease Agreements and Related Information

Addendum C1 - Kirtland Local School District

Addendum C2 - Gates Mills

Addendum C3 - Hunting Valley

Addendum C4 - Kirtland Hills

Addendum D - Willoughby Hills Cell Tower Deliberations

Addendum E - In-Street (Drive Test) Data

Addendum F - Harvard Memorandum on Environmental Health and Safety

Addendum G - The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods

Addendum H - Cell Phone Towers - Do they Effect Property Values

Note: In your email request, please be specific about the information you are interested in obtaining.