CONNECTICUT SITING COUNCIL

PETITION OF NEW CINGULAR WIRELESS PCS, LLC ("AT&T") TO THE CONNECTICUT SITING COUNCIL FOR A DECLARATORY RULING THAT NO CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AND PUBLIC NEED IS REQUIRED FOR THE PROPOSED INSTALLATION OF A CONCEALED TOWER ON A WATER TANK AND RELATED FACILITIES LOCATED AT A WATER TREATMENT PLANT AT 455 VALLEY RD., GREENWICH, CT	)	**PETITION NO. 1010** **FEBRUARY 15, 2012**

PRE-FILED TESTIMONY OF – DAVID MAXSON, WCP

Q1. Please state your name, profession and position with your employer.

A1. David Maxson, I am co-owner and CEO of Isotrope, LLC, 505 Main Street, Medfield MA 02052.

Q2. What services does Isotrope, LLC provide?

A2. Isotrope, LLC provides consulting services in the field of radio frequency communications.

Q3. What is your professional background?

A3. I am a municipal wireless consultant to numerous municipalities and non-governmental entities. I am experienced in radio propagation modeling, signal test and measurement, radio frequency emissions safety assessment, radio communications facility construction and maintenance, as well as in the processes that regulate wireless facilities. My work is known to the Connecticut Siting Council. Since 1995, I have from time to time testified before the Council

on matters relating to the placement, construction, and modification of personal wireless service facilities in Connecticut. I have appended as Exhibit 1 my *curriculum vitae.*

Q4. What is your involvement in the present proceeding regarding Petition 1010?

A4. As an expert on radio frequency coverage analysis and on the placement, construction and modification of personal wireless service facilities, I was engaged by the neighborhood group consisting of Lee Higgins, *et al* ("Intervenors") to review the facts of Petition 1010 (the "Petition") and provide facts and/or opinions to the public record relating to subject matter involved in the placement of wireless facilities in the locus of the proposed tower installation ("Tower Facility") on the water tank ("Standpipe") by AT&T ("Petitioner") at the Aquarion site at 455 Valley Road, Greenwich, Connecticut ("Site").

Q5. Have you done consulting work in the geographic area of the proposed facility at 455 Valley Road, Greenwich that is the subject of the Petition?

A5. Yes, as consultant to the Town of Greenwich ("Town"), beginning in 2010, I conducted an evaluation and prepared a report for the Town relating to the provision of T-Mobile wireless services in the general area of Greenwich that includes, but is not limited to the vicinity around the Site. In February 2011, I submitted the report to the Town, entitled Assessment of Options for the Placement of a Wireless Facility in the Vicinity of North Mianus in Greenwich, Connecticut ("Town Report"). The Town Report is appended as Exhibit 2.

Q6. Are you affiliated with any professional or industry organizations?

A. Yes, I am a Senior Member of the Institute of Electrical and Electronics Engineers. I also represent my company, Isotrope, LLC, as a member of the PCIA (the wireless infrastructure association) DAS Forum. The DAS Forum is an organization of stakeholders in the distributed antenna system segment of the wireless industry. As a participant on several DAS Forum working committees, I am involved in the DAS Forum's work to reduce regulatory barriers to the use of DAS networks to provide wireless service, particularly in places where one or more new towers may not be the most effective solution.

Q7. Do you hold any licenses or certifications?

A7. Yes, I have earned by examination the only independent certification available for experts in wireless communications engineering and technology – the IEEE Wireless Communications Professional® ("WCP") certification issued by the Communications Society of the International Institute of Electrical and Electronics Engineers. The certification demonstrates my expertise in the seven subject areas of wireless communications engineering technology. I also hold a General (formerly known as First) Class Radiotelephone Operator's License issued by the Federal Communications Commission and a Certified Radio Broadcast Engineer certification issued by the Society of Broadcast Engineers. I am also a licensed construction supervisor in Massachusetts.

Q8. Have you authored any articles on wireless technology in the past year?

A8. Yes, in the December 2011 issue of *Above Ground Level* magazine ("AGL") I published an article explaining the federal State Broadband Initiative ("SBI") in the context of an extensive field survey of wireless data communications I conducted for the State of Utah that was supported by federal broadband funding. AGL is the industry trade journal of wireless infrastructure.

Q9. Please summarize the key conclusions you will testify to in this matter.

A9. Relating to the Petition, I conclude:

a. A new tower mounted on the Standpipe is not necessary, as antennas attached to the same Standpipe without the aid of a tower will be just as effective;

b. The Petitioner has not provided substantial evidence that alternatives of lesser potential impact and/or greater effectiveness have been exhausted (regardless of the Petitioner's claim that the need for the Tower Facility is not subject to review in this matter, despite the Petitioner's submission of coverage analysis).

c. The vegetation near the Standpipe is significantly higher than the proposed antenna height of the Tower Facility. This fact is a material consideration that the Petitioner

has overlooked. Consequently, the Petitioner has overestimated the effectiveness of the proposed Tower Facility to provide improved service to the area.

d. The Petitioner has mis-stated my findings for the Town with respect to the use of DAS near the Site, drawing incorrect conclusions about the potential role of DAS in providing coverage in the area of the Site;

Q10. The Petitioner states, "Of note, the existing water tank is simply too low in height for AT&T to attach antennas to it and provide meaningful service to the area." (Petition, p. 4) Do you agree with this statement?

A10. I disagree. The Petitioner is claiming incorrectly that there would be a significant difference between attaching antennas to the top of the Standpipe, without using a tower and attaching antennas to a tower mounted on the Standpipe.

First, I disagree because the antennas of the proposed Tower Facility are substantially below nearby tree height. This fact is evidenced by the Petitioner's Exhibit C, Visual Analysis Report September 23, 2011, prepared by CHA, in which a simulation of the proposed Tower Facility is presented in View 4, *Proposed View from Valley Road Looking East Towards Site.* Whether using a tower attached to the Standpipe or attaching antennas to the top of the Standpipe, the impact of the surrounding foliage on the radio signals will be significant. In my opinion, based on the information in the Petition and on my experience, there is no appreciable difference in the impact of foliage between the two antenna heights. If the impact of foliage at the proposed height is acceptable to the Petitioner, the impact of foliage at the slightly lesser antenna height without resorting to a tower on the Standpipe would be equally acceptable. I suggest, however, that the impact of foliage at either height is substantial and is good reason not to put a wireless facility on the Standpipe.

Second, I disagree because the actual difference in antenna height (less than a 10 foot difference) between using the proposed attached tower and the alternative of attaching antennas to the Standpipe is inconsequential. The Petitioner's site plans show an antenna centerline of sixty (60) feet above ground (four feet below the proposed overall height of the Tower Facility). The plans show an overall height of the Standpipe of 51 feet (including the four foot tall vent assembly),

which is a reasonable antenna centerline for antennas attached directly to the Standpipe. In my experience, with a difference of antenna height of less than ten feet, the difference in coverage is usually not material.

Third, I disagree because computer modeling of coverage under conditions with surrounding tree cover is burdened by a substantial degree of uncertainty due to the fact that the antennas will be well below the surrounding tree height with either configuration. In my opinion, based on my experience, the Petitioner has not accurately represented the coverage that would be obtained from its proposed Tower facility. The actual coverage will be substantially less than the Petitioner is showing on its computer generated coverage map. (See Exhibit 3)

Q11. Is there a better way to assess the coverage that would be obtained from the proposed Tower Facility and from antennas mounted instead to the top of the Standpipe?

A11. Yes. The most reliable way of addressing the coverage modeling uncertainty in this case is to perform a coverage drive test ("CW Test") with foliage present, using the two prospective antenna heights. Those heights would be with the 60 foot tower-mounted antenna centerline above ground and the 51 foot Standpipe-mounted antenna centerline. The Petitioner has not provided any CW Test information to substantiate its assertions regarding coverage.

Q12. The Petitioner stated in its Supplemental Submission II ("Second Supplement"), paragraph 2.b., "The Town's own consultant came to the conclusion that DAS was not a viable alternative for this part of Greenwich..." Do you agree with this statement?

A12. I disagree with the Petitioner's statement about DAS.

First, I disagree because the Petitioner incorrectly uses the phrase "this part of Greenwich" to equate the part of Greenwich I discussed in the Town Report and the part of Greenwich that would be served by the Petitioner's proposed Tower Facility. My analysis in the Town Report addressed wireless coverage from the then-proposed T-Mobile tower at 328 Palmer Hill Road, whose PCS coverage is different from the coverage from the Petitioner's proposed Tower Facility. There is considerable overlap between the PCS coverage obtained from the Standpipe and from the Palmer Hill Road site, but is incorrect to equate them for the purposes of making the Petitioner's argument.

Second, I disagree with the Petitioner's statement that I concluded "DAS was not a viable alternative," because I never said so in the Town Report. In the Town Report I developed an example DAS network consisting of 18 utility-pole-mounted nodes. I "limited the hypothetical DAS layout to the same coverage area as that of" the then-proposed T-Mobile tower on Palmer Hill Road (Town Report, p.35). I never stated such a DAS network was not a viable alternative. Instead I spoke to the complexities in making a DAS happen, giving the seminal example of Brookline, Massachusetts, which persevered and obtained a DAS in an area of moderate to higher density development not unlike the area around the Mianus River. I also stated that there were concerns about obtaining access to the tops of certain utility poles and explained that new poles could be installed if necessary, and/or antennas could be at lesser antenna heights on existing poles if necessary. I do not regard these concerns as fatal to a DAS solution in the area of the proposed Tower Facility.

Third, I disagree because the petitioner relies heavily on its 850 MHz Cellular Spectrum and is developing services in its new 700 MHz spectrum, neither of which I modeled for the Town Report. It is well understood that these lower frequencies (being less than half the rate of the PCS frequencies used by T-Mobile, around 1900 MHz), are still affected by foliage, but less so than PCS. Consequently, my DAS coverage model does not reflect the coverage that the Petitioner could obtain at its lower frequencies. A separate analysis of DAS coverage at the Petitioner's lower frequencies, in my opinion based on my experience, would show even better DAS coverage than I showed for PCS spectrum in the Town Report (Town Report, Fig. 21). This could result in fewer DAS nodes for the Petitioner than we showed in our example for T-Mobile's PCS service.

Q13. In Table 4 of the Town Report, which was a Comparison of Alternatives to the T-Mobile tower on Palmer Hill Road, you said DAS was "not a high value location for DAS at this time." What did you mean by that?

A13. At the time of the Town Report, I was considering the DAS in light of the coverage that could be obtained from the prime alternatives at either of the two Pinetum sites. The potential for coverage from the Pinetum sites was far greater than the coverage from the originally proposed T-Mobile tower and would have required a larger DAS than that which we modeled for

the Town Report. Because the Town was giving serious consideration to the excellent coverage that could be obtained from the Pinetum sites, the DAS approach for serving the same area was much lower in priority.

Q14. <u>Has your opinion changed since then? If so, how?</u>

A14. Yes, I would rank the DAS option differently now that the townspeople have discounted a new tower at the Pinetum. In my opinion, based on my experience, a DAS in the vicinity of North Mianus and the Valley Road area may well be the best solution for improving coverage to the area.

a. Coverage from a DAS would be more consistent and comprehensive than from a single set of antennas mounted on the Standpipe and surrounded by trees. With its antennas below tree height, the coverage of the proposed Tower Facility will behave much like the coverage from a single DAS node on a utility pole in the same area.

b. Coverage from a DAS could be expanded to areas that coverage from the proposed Tower Facility cannot reach. These are residential areas where there is great sensitivity to new tower facilities, as evidenced by the reaction of the community to the Pinetum tower idea. I said in Table 4 of the Town Report, "Valley Road Water tank…[is] not a substitute [for the T-Mobile tower] – coverage [is] too far north of objective. Would require additional facilities to meet [T-Mobile's] objective." Likewise, based on the Petitioner's existing coverage analysis and on my experience, it is my opinion that if the Petitioner's proposed Tower Facility were to be approved, a substantial area of diminished AT&T service would remain. Consequently, I expect the Petitioner will continue to develop its network piecemeal in the subject area rather than develop a master plan. A DAS could provide the Petitioner with a future proof way to expand services to the entire area, from North Mianus, to Valley Road to the area of the Pinetum. Such expansion can be incremental as the subscriber demand grows.

c. Coverage from a neutral host DAS could be obtained for all the competing carriers, not just the Petitioner. In contrast, at best the proposed Tower Facility might support

two wireless service providers, leaving open the question of how the other providers would improve coverage in the same area.

Q15. Is DAS a different technology than other wireless facilities?

A15. No. The word "technology" is so vague and broad that it is meaningless in this context. Fundamentally, the over-the-air connection to the subscriber's wireless device uses a common set of technologies (such as CDMA, GSM, UMTS, LTE, etc.) regardless of how the wireless facility is constructed. Looking at the individual building blocks of DAS networks and other wireless facilities, we are seeing a convergence of the network elements. The Petitioner's proposed facility includes six "Remote Radio Units" ("RRUs") mounted beside the antennas on the Standpipe. This is like a mini DAS between tower and ground. DAS nodes also consist of antennas attached to RRUs. On sites like the proposed Site, the RRU on the tower is connected to the base station by data link of copper or fiber optic cable instead of coaxial cables. DAS nodes also connect to the base station with fiber or copper links rather than coaxial cables, much like the proposed Standpipe mounted RRUs would. So it is the layout of the elements and not the "technology" that most distinguishes DAS from legacy macro facilities.

Q16. In your experience as a wireless expert and a construction supervisor, what is your reaction to the proposal to mount a tower on the Standpipe?

A16. In my opinion, based on my experience, there are serious unanswered questions about the viability of the Standpipe to support the proposed Tower Facility. I was recently involved in the issuance of a Request for Proposals ("RFP") by the town of Weston, MA to invite wireless carriers to place antennas on a 30-foot diameter, 40 foot tall standpipe in Weston, MA (45 feet to the top of the dome). The dimensions and age of the Weston standpipe are nearly identical to those of the Valley Road Standpipe. A successful bidder has indicated that according to its structural engineering, the successful bidder cannot attach a tower above the dome for structural reasons. The Weston bidder was seeking an antenna height of 60 feet above ground, similar to the Petitioner's proposal at the Site.

I was struck by the language in the CHA engineering letter dated September 14, 2011 (the "Structural Report") that CHA evaluated the "overturning moment" of the attachment, but

conditioned the report on the fact that a "plate analysis… was not performed." The Structural Report says the plate analysis would test the adequacy of the tank walls to withstand wind loading forces transmitted by the new tower on top. In my opinion, based on my experience, a reasonable person who is not a structural engineer can understand the distinction between the overturning analysis performed by the structural engineer and the wall plate analysis not performed by the engineer as being the distinction between a) the entire standpipe tipping over in the wind and b) the wall of the standpipe crumpling under the stresses of the wind against the tower attached to it.

I, DAVID MAXSON, duly sworn, hereby verify that this statement was prepared by me or under my direct supervision and is believed to be true and accurate to the best of my knowledge and belief.

David Maxson

2/15/2012
Date

The above signed, DAVID MAXSON, personally appeared before me and verified that the above pre-file testimony for the Connecticut Siting Council is true and accurate and that he adopted it by his free act and deed on this 15th day of February.

Commissioner of Superior Court
Notary Public/
My Commission expires Apr. 9, 2015

LISA HAMEL
NOTARY PUBLIC
COMMONWEALTH OF MASSACHUSETTS
My Commission Expires April 9, 2015

Commonwealth of Massachusetts
Norfolk, ss.

On this 15th day of February, 2012, before me, the undersigned notary public, personally appeared David Maxson, proved to me through satisfactory evidence of identification, which were MA DL, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose.

Notary Public

RESPECTFULLY SUBMITTED BY:

LEE HIGGINS, KAORI HIGGINS,
PETER JANIS, ELIZABETH JANIS,
RICHARD KOSINSKI & SUSAN KOSINSKI

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Their Attorneys

CERTIFICATE OF SERVICE

This is to certify that on the above date a true copy of the foregoing has been sent both electronically and by U.S. Mail, first-class, postage pre-paid, to the following parties of record:

Ms. Linda Roberts, Executive Director, Connecticut Siting Council, 10 Franklin Sq., New Britain, CT 06051 (1 original, 15 copies, plus 1 electronic)
New Cingular Wireless, PCS, LLC (AKA – AT&T), Christopher Fisher, Esq. Cuddy & Feder, LLP, 445 Hamilton Avenue, 14th Fl., White Plains, NY 10601

Mario F. Coppola, Esq.

Exhibit 1 – Curriculum Vitae of David Maxson, WCP

David P. Maxson, WCP®
Curriculum Vitae

Isotrope, LLC, Medfield, Massachusetts, 1982*-present — Founder, CEO

a) Municipal guidance in wireless planning and regulation
b) Evaluation of radio frequency facilities for compliance with technical and regulatory standards
c) Research and development on digital media initiatives
d) Safety planning and evaluation of communications facilities, safety protocol development
e) Communications facility design and construction
f) Radio frequency interference remediation

*Note – The wireless consulting business of the former Broadcast Signal Lab, LLP is now Isotrope, LLC. David has been an owner of the business since co-founding it in 1982. Isotrope was incorporated in 2009.

Charles River Broadcasting Company, Waltham, Massachusetts, 1978-1998.
Vice President, Director of Engineering and Technical Operations

Affiliations and Accomplishments

- Certified by the Institute of Electrical and Electronics Engineers ("IEEE") Communications Society Wireless Communications Engineering Technology program as a Wireless Communications Professional, demonstrating "a thorough understanding of different key technologies in the wireless arena." (ieee-wcet.org)
- Project Reviewer - NTIA Broadband Technology Opportunities Program and USDA Rural Utilities Service Broadband Initiatives Program – American Recovery and Reinvestment Act, 2009.
- Delegate to the National Radio Systems Committee, Digital Audio Broadcasting Subcommittee, 1998-present.
- Member of the PCIA's DAS Forum (the wireless infrastructure association's distributed antenna system group)
- Qualified expert on wireless communications matters before federal and state courts.
- Testimony, US House of Representatives Commerce Committee Telecommunications Subcommittee in the matter of Low Power FM Broadcasting, February 2000.
- Wireless facility evaluation and planning consultant to the Cape Cod Commission as well as to over a hundred municipalities in New England and beyond, 1999 to present.
- Appointed member of Massachusetts Department of Public Health ad hoc committee on revisions to electromagnetic energy safety regulations 105 CMR §122, 1997.
- Senior Member, IEEE; Certified Broadcast Radio Engineer, Society of Broadcast Engineers; FCC General Class Radiotelephone License with Radar Endorsement; Bachelor of Science, Boston University, 1977; Massachusetts Licensed Construction Supervisor #CS073481.

Publications

- Author, *The IBOC Handbook— Understanding HD Radio Technology*, 2007, Focal Press.
- Author, Chapter 2.5, *Managing Workplace and Environmental Hazards*, NAB Engineering Handbook, 10th Edition, 2007.
- Article, *Evaluating Emissions of Your New IBOC Transmitter*, Radio World Engineering Extra, June 2005.
- Article, *Posting Hazard Communications Signs at Your Radio Transmission Plant*, Radio Guide, April 2005.
- Published Paper: *Interference Potential of Hybrid Digital Transmission: An IBOC Occupied Bandwidth Case Study*, Proceedings of the National Association of Broadcasters Broadcast Engineering Conference ("NAB-BEC"), 2004.
- Published Paper: *Integrating ANSI-Compliant RF Signs Into Corporate RF Safety Programs*, NAB-BEC 2004.
- Published Paper, co-author: *Applying the Principles of Data Communications to the Development of an Open and Universal IBOC Data Protocol*, NAB-BEC 2003.

Exhibit 2 – Town Report of Isotrope, LLC

Isotrope WIRELESS

Thinking outside the sphere

ASSESSMENT OF OPTIONS FOR THE PLACEMENT OF A WIRELESS FACILITY IN THE VICINITY OF NORTH MIANUS IN GREENWICH, CONNECTICUT

February 28, 2011

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ASSESSMENT OF OPTIONS FOR THE PLACEMENT OF A WIRELESS FACILITY IN THE VICINITY OF NORTH MIANUS IN GREENWICH, CONNECTICUT

INTRODUCTION

BACKGROUND

Wireless "cellular" communications have been part of our technological landscape since the 1980's. The two original cellular companies in each market area launched competitive services. Policymakers in Washington, DC recognized the tremendous potential of wireless communications and decided to foster a more competitive marketplace. In the late 1990's in addition to the radio spectrum already assigned to cellular services, the Federal Communications Commission put another piece of the radio spectrum up for auction. This was called Personal Communications Service ("PCS"). Billions of dollars were put into the US Treasury by incumbent carriers and by new companies entering the wireless marketplace. This additional spectrum and competition, in conjunction with the newly arrived all-digital wireless technology, turned the heat up on the marketplace.

In 1996, Congress passed the Telecommunications Act of 1996 ("TCA"), an omnibus change to telecommunications regulations nationwide, designed to foster growth and competition both in wireless and in land-line telecommunications. The most salient part of the TCA for the purposes of this report is the fact that the TCA explicitly balances two competing policy objectives. The TCA states clearly that the federal government does not preempt local zoning authority. However, the TCA makes it clear that while local (and state) zoning can regulate the placement, construction and modification of wireless facilities, state and local authorities may not be so restrictive as to "effectively prohibit the provision of personal wireless services." Further, local (and state) zoning may not regulate the placement of wireless facilities on the basis of their radio wave emissions, as long as the facilities comply with federal standards.

The federal policy goal of a robust, competitive marketplace of wireless services available to nearly all people is bearing out. Recent statistics from governmental and industry sources paint a bright picture for wireless communications. Those households with no wireless subscriptions are reported to be less than 20% of all USA households. At the same time, another segment of the marketplace, also about 20% of households, and growing, has no traditional telephone "land line" at home. As of two years ago, there

were 280 million subscribed wireless telephone numbers in the USA. Even allowing for some of those phone numbers to be for business or industrial applications, it is sobering to realize that the population of the USA is around 310 million, a 90% penetration ratio. Further, it is reported that more than 70% of all wireless data traffic comes from inside a building. The FCC reported last year that penetration of wireless phones among teenagers nationwide was about 80%.

Data is the new driver of wireless telecommunications growth. Smart phones are flying off the shelves. New models are announced almost weekly. Subscribers are texting, tweeting, friending, emailing, browsing, playing, streaming, downloading, skyping and searching with their wireless devices. Depending on the source, smartphone penetration is said to be at 30 to 50% of all subscribers in the USA and wireless data traffic is on a steep growth curve, nearly tripling in usage each year.

It is in light of this explosion of consumer use of wireless communications that presents a challenge to municipalities in the coming years. PWS providers are working to provide better coverage to residential areas, schools and businesses for these reasons:

- Better signal quality is needed to reach inside buildings more reliably;
- Residential phone and data use shows continuing steep growth;
- Providers need to keep up with exploding data capacity demands;
- Parents want their children to be able to call home from school or after-school activities;
- Wireless carriers are under a federal mandate to provide phone locations when 911 is dialed.

The Town of Greenwich has embarked on the path of smart-growth planning for the placement of wireless facilities. This report is the result of one of the Town's initiatives to grasp the issues and guide the development of low-to-no impact wireless facilities in Greenwich.

PROJECT

Isotrope, LLC was engaged by the Town of Greenwich, Connecticut ("Town") to provide an assessment of personal wireless service facility siting opportunities in and near North Mianus. Licensed personal wireless service ("PWS") provider, T-Mobile, is preparing to apply to the Connecticut Siting Council to place an 80 foot tall monopole structure for the installation of a PWS facility ("PWSF") on a privately owned parcel at 328 Palmer Hill Road ("328 Palmer Site"). T-Mobile has a lease option with the property owner.

Some residents of the Town have raised objections to the placement of the proposed PWSF at the 328 Palmer Site. The Town conducted a preliminary search for potential alternative locations, and conferred with T-Mobile on the issue. A potential alternative was identified on a Town-owned site ("129 Bible St Site") ¾ mile west-south-west of the 328 Palmer Site. T-Mobile indicated a 160 foot tall tower would be necessary at the 129 Bible St Site to compensate for the ¾ mile distance and the intervening terrain between the 328 Palmer Site and the 129 Bible St Site.

The Town sought independent expert review of the PWS coverage options for the North Mianus area. While there is a focus on the 129 Bible St Site, because there has been dialog with T-Mobile on it, the Town sought expert advice not only on the 328 Palmer Hill and 129 Bible St Sites, but also on other potential ways of placing one or more PWSFs to address T-Mobile's coverage objectives in and around North Mianus with the least adverse impacts possible.

This document reports on the assessment performed by Isotrope, LLC during the month of January 2011. It consists of two major sections: Wireless Coverage and Site Geography. The Wireless Coverage section is first, providing a tutorial on wireless terminology and coverage map reading before delving into the evaluation of existing T-Mobile coverage and new coverage options. The Site Geography section closes the loop. It may be informative to just look at the various coverage options; however, a decision on how to proceed must balance the coverage opportunities with the relative benefits and detriments of the various facility siting options. Site Geography evaluates some of the siting characteristics of each potential site.

The sites considered in both sections of this report are listed in Table 1.

Map Label Name	Site Elevation Ft AMSL	Notes
328 Palmer Site	43	Orange star (Figure 6 - Locations of Sites Considered)
129 Bible St	108	Former vegetation compost area
130 Bible St	109	Site of existing development, land disturbance, and active use
54 Bible Street	30	Ball field, Mianus
Valley Road Water Tank	81	Water treatment plant on Mianus River
1114 East Putnam Avenue (Rt. 1)	74	Across street from existing 1111 East Putnam site
St Catherine	69	A couple of blocks from existing 1111 East Putnam site
Brennan Golf Course	32	Opposite side of ridge, Stamford
DAS Network	N/A	Utilize utility poles to distribute numerous smaller antennas around the area

Table 1 - Sites Considered

WIRELESS COVERAGE

This study concentrates on the area in and around North Mianus. T-Mobile's serious consideration of the 328 Palmer Site for an 80 foot tall PWSF tower instigated the search for alternatives. This Wireless Coverage section assesses potential sites for wireless facilities in terms of their ability to provide wireless coverage to general area of North Mianus.

On a larger scale, the 328 Palmer Site is only one piece of the overall deployment puzzle of the T-Mobile wireless network in Greenwich. In searching for alternatives there are two complementary approaches to consider. First is "substitution" – to look at the locations in Greenwich that the 328 Palmer Site is projected to provide substantially improved coverage to. Then consider ways to place alternative facilities that would substantially substitute for the 328 Palmer Site. The second approach to consider is "reconfiguration" – whether one or more alternative facility placements could provide not only substitution coverage in North Mianus, but also to serve a larger area of Greenwich that T-Mobile will be attempting to improve service to in the future.

The goal of the search for substitution sites is to find the least objectionable way to obtain the improved service in the targeted area. The goal of the reconfiguration search is not only to find the least impactful location for improving service to North Mianus, but also to find the best way to distribute facilities, now and into the future, for overall service to a greater area with the least overall impacts.

TERMINOLOGY

To assist with the common understanding of this report, and wireless issues in general, some definitions will be helpful. At the outset, this report identified two initializations – PWS and PWSF. These terms are the roots of wireless facility siting matters. Under the federal Telecommunications Act of 1996 ("TCA"), a class of services called *personal wireless services* is given some protections in the "placement, construction, and modification" of the *facilities* necessary to provide a robust, competitive and nationwide service.

PWS – Personal Wireless Service. The service regulated by the FCC and granted protections to certain license holders for the provision of service. The TCA specifies that states and their municipalities shall not act to prohibit or effectively prohibit the provision of personal wireless services (PWS). T-Mobile is a PWS provider.

PWSF – Personal Wireless Service Facility. In order to provide PWS to the public, PWS providers must build a network of facilities. The TCA says municipalities may regulate the "placement, construction and modification" of personal wireless service facilities (PWSFs) within certain limits. T-Mobile is considering placing a PWSF at the 328 Palmer Site.

The TCA also precludes unreasonable discrimination against providers of functionally equivalent services. The TCA further precludes regulation of the placement, construction and modification of personal wireless services on the basis of their radio emissions, provided those emissions comply with the FCC safety standards. Otherwise, the TCA explicitly aims to protect the rights of zoning authorities to regulate PWSFs.

The Connecticut Siting Council ("CSC") has jurisdiction in Connecticut over new tower placements for PWSFs. The TCA informs and influences the actions of the CSC. The CSC must comply with the TCA. Judging from the new tower approval/denial ratio of the CSC, it appears the CSC has by and large forestalled federal litigation from wireless carriers by approving or approving with conditions nearly all the proposed PWSF towers that come before the CSC. This relatively permissive approach to new PWSF tower siting in Connecticut avoids testing the limits of the federal TCA and the cumbersome litigation that would result.

This brings the discussion to some other common terminology. People often mistakenly use the term "cell tower" to identify any installation of wireless antennas whether on a tower, a rooftop, in a steeple, or other structure. A better way to identify wireless installations is to use the term "wireless facilities", which is an informal term for PWSFs. Generally, each carrier has a PWSF at a building, structure or a tower site. A tower with six carriers' systems installed on it has six PWSFs.

A tower is a tall structure that is not habitable and is designed for supporting something high above the ground (fire tower, water tower, lookout tower and cell tower, for instance). A cell tower is for PWS antennas. Cell towers are usually a "lattice tower" or a "monopole" (Figure 1). Lattice refers to the familiar open frame structure with legs and cross struts. A monopole is a tower made of a tall tubular steel pole. Monopoles with concealed antennas are often called "unipoles" (See Figure 1, also Figure 24). Monopoles with faux tree branches are often called "monopines."

Not all PWSFs utilize towers. In fact, as the wireless industry continues its rapid market growth rate, more and more PWSFs are installed at existing structures. The coverage areas of new PWSFs are often sandwiched between coverage areas of existing facilities. Consequently, the height of a local structure may be sufficient to obtain the desired coverage without resorting to a new tower.

When towers or existing structures are utilized for the placement of one or more PWSFs, the FCC refers to this as "collocation." This definition applies to any existing structure, whether or not there is a PWSF already on site. For example, "that wireless carrier will be the first carrier to collocate on the steeple."

In municipal regulations, a variant of the word is often used with a slightly different meaning: "Co-location" is often defined as the use of a particular structure with 2 or more PWSFs. Each carrier on that structure is said to co-locate on the structure with other carriers.

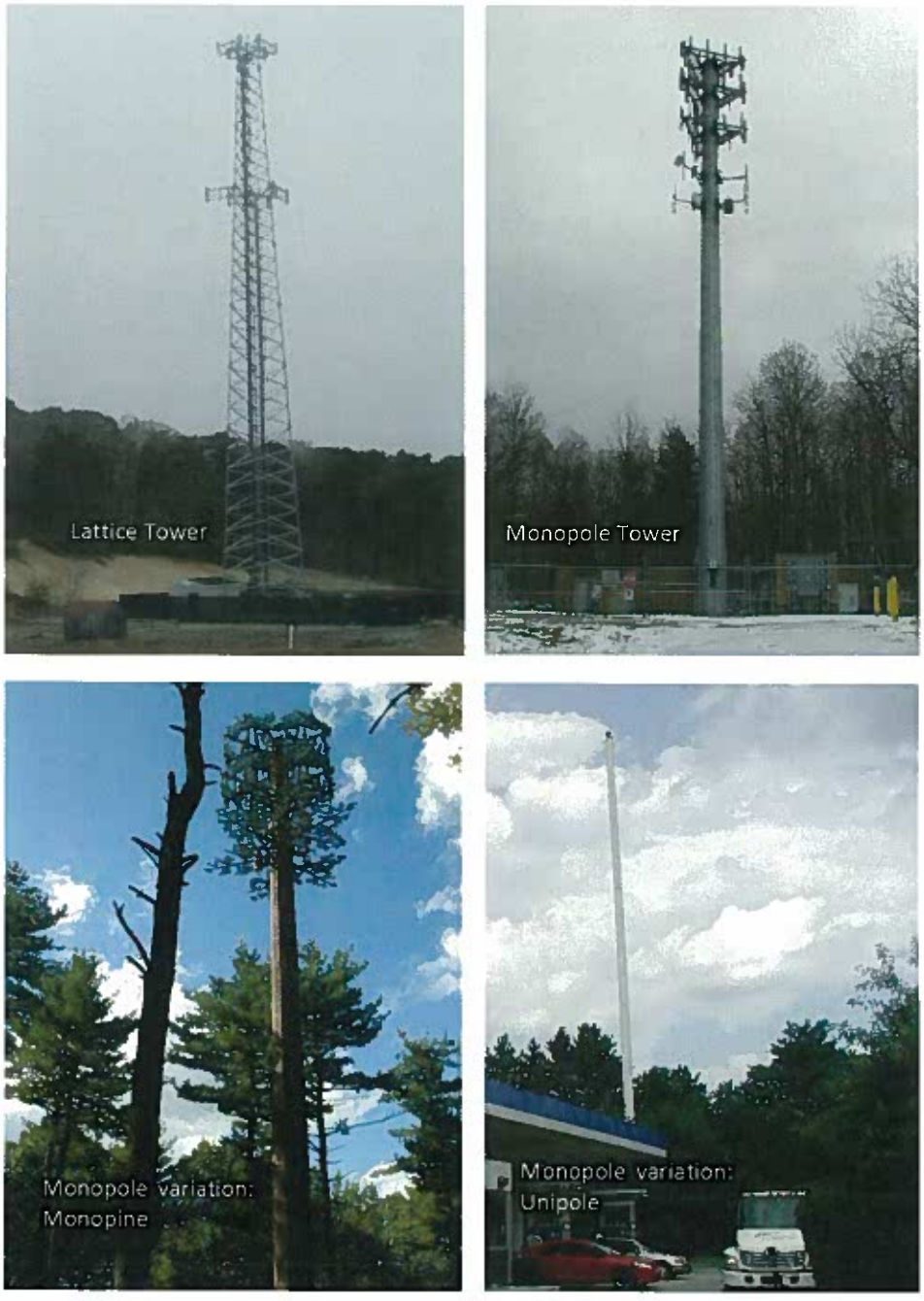

Figure 1 – Common Types of Cell Towers

Because this ambiguity is sometimes confusing in an application processes, Isotrope recommends that the municipal meaning of co-location be retired, and to use a new, self-evident term – "Site-Sharing." For example, "the new wireless carrier proposes to Site-Share on the existing cell tower that already has two carriers."

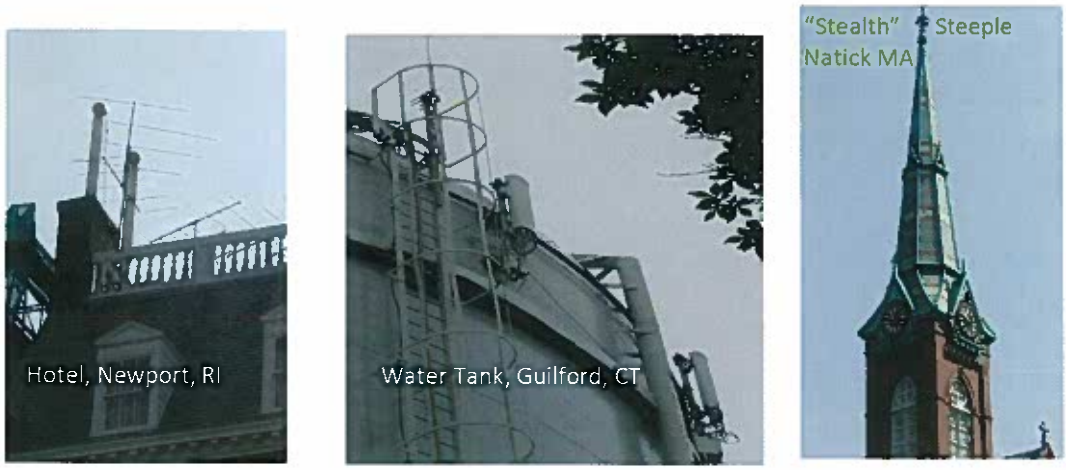

Figure 2 – Examples of PWSF Antenna Collocation

There are two primary factors that affect the provision of services: coverage and capacity.

The capacity of a PWSF is the maximum volume or quantity of services that can be provided simultaneously to all subscribers connected to a given PWSF. Traditionally, capacity issues are most prevalent in locations with a high density of subscribers such as, urban areas, major commuter highways, or stadiums. Primarily, however, it is *coverage*, of one form or another that drives new PWSF development.

"Coverage" is another term that deserves explanation. The TCA focuses on "the provision of personal wireless services" and is silent on "coverage." Coverage is shown on maps. The area(s) on a map where the signal from a PWSF is expected to be above a specified signal level is given a certain color.

Figure 3 is a map of coverage in and around North Mianus. There are existing wireless facilities marked in blue dots on the map. The coverage from those facilities is shown in two shades of green. The dark shade of green represents a stronger signal level than the light shade. Where there is no green (just the background color), the signal levels are expected to be weaker than the thresholds set for the colored areas.

Figure 3 - Example of a Coverage Map

Coverage maps like Figure 3 are generated by a computer. The computer is given a digitized topographical map and another digitized map of the characteristics of the "land cover." The surface features – various kinds of vegetation plus the presence of buildings and water – have an effect on the movement of radio waves ("propagation") in the environment. The computer uses the terrain and land cover data to calculate how well the wireless signals propagate to various points on the map. Computer modeling of coverage is a statistical process; no computer coverage map is an exact representation of the actual coverage at a single spot at a given time. Collectively, all the individually calculated color dots on the map are intended to provide a good sense of the typical or average coverage conditions.

Showing two or more color ranges on a coverage map helps the reader understand how the signal levels degrade as the radio waves propagate away from the cell site. The short arrow on the right in

Figure 3 illustrates how the signal from the cell site can be obstructed by the terrain. The signal follows the path of the short arrow and very quickly degrades from dark green to light green to no color. The transition occurs at a relative high point in the terrain. The area beyond the short arrow is said to be "in shadow" because the hill is blocking the signal to the northeast. (Other factors are also involved, but in this case the terrain is the dominant factor). If the antennas at site "180" were higher, the coverage past the hill might improve.

The leftmost and longest arrow on Figure 3 depicts a more complicated path. The signal reaches to Florence Road well, until the terrain drops on the opposite side of Florence Road, and the signal is in shadow approaching the Mianus River. Then as the terrain rises on the opposite side of the river, the signal is picked up again because the terrain is no longer blocking it. This additional coverage across the river is a coverage patch that stands alone or nearly so from the coverage of other facilities.

Continuing out across the coverage patch, the signal level drops to a relatively wide light green area at the far edge, before it drops to no color. Remote patches of coverage can be helpful in the absence of a nearby facility. However, they create a situation where connections can drop when the subscriber exits the area of the of the coverage patch.

The colors on the coverage map are often chosen to indicate threshold signal levels. For instance, T-Mobile typically uses a signal level of -76 dBm to depict "reliable in-building coverage." That means if the signal level outdoors is at or above -76 dBm, then –as we understand it– T-Mobile is satisfied it will have excellent coverage inside residences. Signals lose strength passing through building surfaces. This is the dark green in Figure 3.

The light green spans out to include signal levels to -84 dBm. Because these are negative numbers, -84 dBm is a weaker signal than -76. T-Mobile typically uses -84 dBm as their threshold for "reliable in-vehicle coverage." A signal level outdoors of -84 dBm or greater is regarded by T-mobile as excellent in-vehicle coverage. On the average, signals lose less strength passing into cars than they do passing into houses. This means that both the dark green and the light green areas are desirable to T-Mobile for providing service to subscribers in vehicles.

Finally, the meaning of the areas with no color must be understood. It is not the case that there is "no coverage" in the uncolored areas. It is just that the computer model has been set to show "coverage" only if the predicted signal strength is better than -84 dBm. There is signal strength in the uncolored areas past the light green. The signal strength would be less than -84 dBm, but by how much one cannot be certain. Signal levels less than -84 dBm can provide coverage into vehicles and residences, just with less reliability than at the thresholds selected by T-Mobile. It is only when the signal levels drop to substantially lower levels that the service becomes very unreliable.

EXISTING COVERAGE

The current carrier of interest is T-Mobile. Isotrope gathered public records to identify the existing T-Mobile PWSFs in and around North Mianus. The CSC website makes available two key characteristics: tower location and antenna height. Isotrope contacted T-Mobile to obtain additional information about T-Mobile's antenna types, orientations and power levels. T-Mobile indicated a willingness to provide the data. However, the short time frame within which this assessment was conducted did not synchronize with the amount of time T-Mobile required to provide the information.

Lacking specific antenna characteristics, Isotrope used transmitted power levels that are typical of the T-Mobile and other PCS services in the northeast. Consequently, the Isotrope maps are generally indicative of the coverage that *could* be obtained from T-Mobile's cell sites, and they are not representations of T-Mobile's actual coverage. For the purposes of the present analysis, these approximations will be sufficient to examine the effects of terrain, distance and vegetation on T-Mobile coverage from various existing and potential sites.

Figure 3 is a detail view of Isotrope's map of the coverage available from existing T-Mobile cell sites. Note how the area surrounding the lower elevations of Palmer Hill Road and the nearby section of the Mianus River appears to be in a "pocket" of coverage that is less than T-Mobile's threshold. In other words, this area is substantially without T-Mobile's desired green levels of coverage.

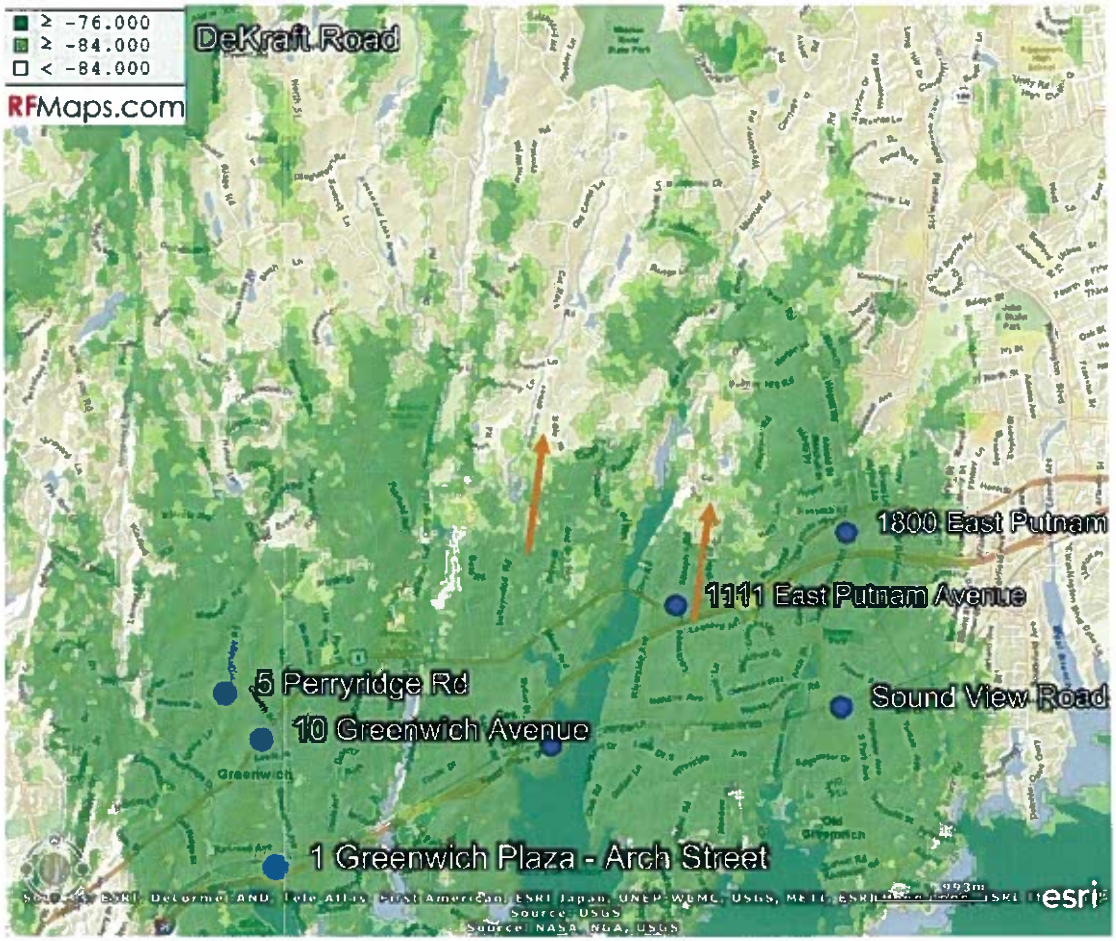

Figure 4 - Coverage Available from Existing T-Mobile Cell sites

Figure 4 shows the coverage available from the existing T-Mobile facilities over a wider area than Figure 3. In addition to the North Mianus pocket north of 1111 East Putnam Avenue (right arrow), notice how the lack of additional facilities to the north of Route 1 leaves more developed area with signal levels below T-Mobile's thresholds (left arrow). These two areas are more detailed in Figure 3..

Figure 5 is a third representation of the same general area of the proposed 80 foot unipole at the 328 Palmer Site. This format will be used to compare alternatives in the rest of this report. Note that in addition to the relief map layer and the coverage layer, there is an additional parcel layer. This layer helps illustrate the location and density of development on the map. The arrows in Figure 4 are reproduced in Figure 5 to maintain a reference to the two general areas of below-threshold coverage.

Figure 5 - Coverage Available from Existing T-Mobile Facilities, with Parcel Overlay

The remaining coverage maps in this report maintain the scale of Figure 5 for easy comparison.

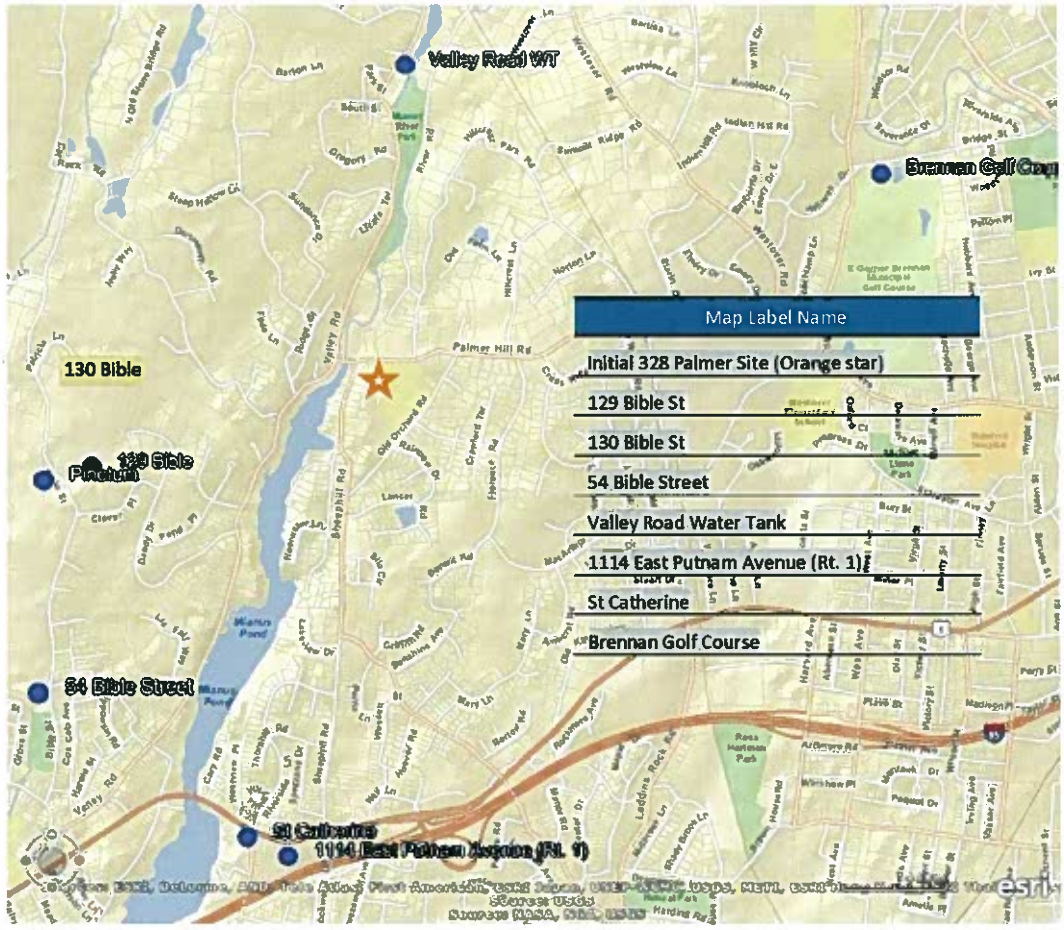

Figure 6 - Locations of Sites Considered

328 PALMER HILL COVERAGE (AT 80 FEET)

The 80 foot unipole that T-Mobile is considering placing at the 328 Palmer Site (Figure 7) provides coverage to T-Mobile's thresholds in the Mianus River valley. Presently, T-Mobile's coverage in this area is predominantly below T-Mobile's preferred thresholds (Figure 5). The east face of the ridge that Palmer Hill Road climbs is more densely developed than its surroundings (particularly to the west). The 328 Palmer Site is central to this developed area. Easterly, its coverage is limited by the ridge and extends

about 6/10 mile to the east. As seen above, coverage from 1800 East Putnam Avenue rides the spine of the ridge, allowing the coverage from the 328 Palmer Site below to connect well with the 1800 East Putnam Avenue coverage above.

The coverage from the 328 Palmer Site also reaches west across the Mianus River. The extent of its westerly coverage is limited by the terrain to a distance of 7/10 mile, reaching Clover Place and not reaching most of the Pinetum lands. Since there is no PWSF to the west or northwest of the 328 Palmer Site, a considerable area of Greenwich would remain unserved with T-Mobile's desired signal levels. This includes areas around Bible Street, Cat Rock Road, Stanwich Road, Dublin Hill Road, and Montgomery Lane. These locations, which are in the Westerly, northerly and southwesterly areas marked on the maps, will be reconsidered in some of the following site analyses.

Figure 7 - Coverage Available from Existing T-Mobile Facilities plus the 328 Palmer Site at 80 Feet above Ground.

To the south, toward Route 1, the coverage is sufficient to overlap with coverage from the 1111 East Putnam Avenue PWSF. To the north, the coverage reaches about 6/10 mile to the Gregory Road area. Because there are no nearby facilities to the north, the 328 Palmer Site facility does not provide a smooth

connection to another PWSF in that direction. A future facility can be anticipated to the north to provide more of the desired signal level to that portion of Greenwich.

The remaining maps in this report have the six arrow markers with labels shown in Figure 7. These arrows provide points of reference for the written discussion, and to give the eye these reference marks for visual comparison of the maps.

ALTERNATIVE – 328 PALMER SITE WITH ANTENNAS IN A HYPOTHETICAL CUPOLA (AT 35 FEET ABOVE GROUND LEVEL)

Figure 8 - Coverage Available from Existing T-Mobile Facilities plus the 328 Palmer Site at 35 Feet above Ground.

Because the 328 Palmer Site is, first, on high ground beside the river, and second, in a valley, a lesser antenna height might still be effective there. We use our "salad bowl" analogy to explain this phenomenon. To illuminate a large salad bowl's inside surface, one could place a lamp at the rim of the

bowl and shine it out and down. This is like using a tower on a ridge to illuminate a valley with wireless coverage. Another way to illuminate that bowl is to put the light at the bottom of the bowl and shine it out and up. In the right circumstances, this method is an effective way to reduce the visual impact of a tower by avoiding a hill top and installing in the lowland by relying on the salad bowl effect. The 328 Palmer Site has this characteristic. Isotrope hypothesized the salad bowl effect would be successful at this site. Since the antenna is "shining" uphill for the most part, the height of the facility may not be so important.

If antennas were concealed within a new cupola placed on the roof of the residence at the 328 Palmer Site, it is assumed they would be about 35 feet above ground. The coverage from this alternative height is shown in Figure 8.

The reduced height of the 35 foot high antennas causes the horizon to be a little closer to the source, as compared to the 80 foot height. This causes some pockets in the terrain to fall below the threshold signal level. One such pocket is at a point along Cat Rock Road west of the 328 Palmer Site. Depending on the degree to which the signal levels are depressed in the pocket, and on the actual size of the pocket (determined by a field test of coverage), the pocket may not be consequential to the overall service to the area.

If the visual impact of the proposed 80-foot tower at the 328 Palmer Site were objectionable to the community, the cupola (or chimney) approach would fully conceal the PWSF from public view. It would also not require the participation of the CSC.

129 BIBLE ST SITE (160 FEET ABOVE GROUND)

The most actively considered alternative location for a T-Mobile PWSF is the 129 Bible Street 129 Bible St Site. Town officials are in dialog with T-Mobile on the possibility of utilizing the 129 Bible St Site instead of the 328 Palmer Site. A height of 160 feet above ground has been suggested as the height required to achieve T-Mobile's coverage objectives in North Mianus. The 129 Bible St Site is approximately ¾ mile from the 328 Palmer Site.

A first impression of the coverage available from the 160 foot height (Figure 9) is that it appears to satisfy T-Mobile's stated objectives in the North Mianus area. There are some very minor depressions in signal level below the T-Mobile thresholds. These are so small that it is highly likely that they are inconsequential. Further, they are so small that the variance in this computer model (or any other) may render these small depressions on the map meaningless in the field.

A second impression of this coverage is that it serves a significantly larger area of Greenwich than the 328 Palmer Site facility would. The 129 Bible St Site PWSF at 160 feet would serve additional areas that are below the T-Mobile coverage threshold – in the vicinity of Bible Street, northwestern Cat Rock Road, Stanwich Street, Montgomery Lane and Dublin Hill Road.

These areas served from the 129 Bible St Site at 160 feet extend some 1¼ miles west, southwest, and northwest of the 328 Palmer Site. A substantially greater land mass and residential development is reached from the 129 Bible St Site at 160 feet than from the 328 Palmer Site at 80 feet. Rough estimates indicate the 129 Bible St Site could provide a 50 to 75% increase in residences served with improved coverage, compared to the proposed 328 Palmer Site.

Continuity of coverage from the 129 Bible St Site at 160 feet is obtained to the south and the west of the 328 Palmer Site, the same as from the 328 Palmer Site. This allows communications to be handed off as subscribers move between 1111 East Putnam Avenue and North Mianus. Unlike the 328 Palmer Site, the 129 Bible St Site also provides new coverage continuity along Bible Street and Orchard Street as these streets approach existing coverage near Route 1.

Figure 9 - Coverage Available from Existing T-Mobile Facilities plus the 129 Bible St Site at 160 Feet above Ground.

ALTERNATIVE – 129 BIBLE ST SITE AT 100 FEET

In our preliminary visibility analysis, we determined that a height in the vicinity of 105 feet above ground would be below treeline from certain street views. To assess the coverage viability of a lesser height, Isotrope prepared a coverage map from 100 feet above ground at the 129 Bible St Site (Figure 10).

Figure 10 - Coverage Available from Existing T-Mobile Facilities plus the 129 Bible St Site at 100 Feet above Ground

The predicted coverage from 100 feet above ground is visibly reduced compared to the 160 foot coverage. However, closer inspection suggests that both coverage plots have only minor depressions below the T-Mobile preferred threshold. The most apparent difference with coverage from the 160 foot height is an increase in below-threshold coverage in the neighborhood around Coachlamp Lane and lower Ridge Road. It appears the 100 foot height would be viable if the height were necessary to satisfy visual impact concerns.

This is also an opportunity to note the natural tension among tower heights, numbers of towers to be developed, and the local impacts of the towers. On the one hand, it is often a policy to maximize the

heights of towers for tower sharing among carriers, which may result in minimizing the number of towers in Greenwich. On the other hand, matching the height of a tower to the context of the site often results in more palatable facilities, even though less height means fewer Site-Sharing carriers. The proposed 328 Palmer Hill Unipole, at 80 feet height, is an example of an attempt to match the scale of a tower to its surroundings, at the cost of limiting the Site-Sharing capacity of the tower.

If the 129 Bible St Site remains an active alternative, it would be appropriate to perform a more comprehensive visual impact analysis. This analysis would further inform decision making about the optimal height between 100 and 160 feet that best mitigates adverse visual impacts, if any, while it enables improved coverage and allows some Site-Sharing.

ALTERNATIVE – 129 BIBLE ST SITE AT 80 FEET

Pushing toward the lower limit on tower height, Isotrope modeled coverage from 80 feet above ground at the 129 Bible St Site. The deciduous trees in the area are estimated to be in the 55 to 65 foot height range at their peaks. It is likely that coverage from antennas mounted below 70 to 75 feet height would be compromised by the tree cover, especially in foliage months.

Considering its height, an 80 foot tower and PWSF at the 129 Bible St Site still provides impressive coverage to North Mianus (Figure 11). It is sufficient to not only substitute for the tower proposed at the 328 Palmer Site, but also extends coverage farther west of the Mianus River to locations west of the Pinetum land. The depression in T-Mobile's desired coverage from the 129 Bible St Site to Coachlamp Lane increases substantially compared to the 100 foot height tower. Since the 328 Palmer Site's desired coverage barely reaches the Pinetum, and does not affect the Coachlamp Lane area, the coverage from the 129 Bible St Site at 80 feet remains more substantial than the coverage proposed from the 328 Palmer Site.

There is a moderate increase in a depression of below-threshold coverage on a terrain-shadowed portion of Valley Road. It still appears to be small enough that there is no significant impairment in coverage along Valley Road.

When considering final height selections at a candidate site and when also trying to be careful to mitigate potential adverse visual impacts, it is helpful to perform a "drive test" of the coverage obtained from several heights at a selected site. This kind of test of a potential site's coverage is called a "CW" test (named for the informationless Continuous Wave signal used to conduct the test). A crane is placed at a candidate site. With an antenna attached to the crane, the crane is hoisted to selected heights. The CW signal from the antenna is received by measurement equipment in a vehicle driven around the subject area. Drive test information is very helpful in fine tuning antenna heights because coverage mapping models may not be precise enough to identify small but critical differences in coverage from various heights.

With a tower of 80 feet height at the 129 Bible St Site, there may be no possibility of a second carrier Site-Sharing the tower with the first carrier. Conversely, with a 100 foot tower, it is likely that up to three wireless carriers will find the 129 Bible St site useful.

Figure 11 - Coverage Available from Existing T-Mobile Facilities plus the 129 Bible St Site at 80 Feet above Ground

ALTERNATIVE – 130 BIBLE ST SITE

The 130 Bible St Site is about 600 feet westerly of the 129 Bible St Site (Figure 25). Its ground elevation is about 5-10 feet higher than the 129 Bible St Site. Coverage analyses from 160, 100 and 80 feet above ground are shown in the following figures.

At 160 feet, the 130 Bible St Site coverage (Figure 12) is very similar to that of the 129 Bible St Site coverage (Figure 9). The 130 Bible St Site coverage shows a minor depression at the Mianus West Bank.

As the height drops to 100 feet, the extra 600 feet to the river makes a small difference in coverage (Figure 13). The coverage depression at the Mianus West Bank area is increased. In comparison, the 100 foot 129 Bible St coverage (Figure 10) leaves a depression on the Mianus West Bank that remains unremarkable. Overall, these small depressions in signal level are minor differences compared to the amount of coverage obtained from either 129 or 130 Bible St.

Going to 80 feet, the depressions appearing in the 130 Bible St (Figure 14) and 129 Bible St (Figure 11) Site coverage maps are enlarged compared to the 100 foot heights. The Mianus West Bank depression would benefit from a CW drive test to determine the extent and depth of the depression below T-Mobile's preferred threshold, if any.

Coverage to the north and west steadily becomes more perforated as the antenna heights lessen. This is true for both the 129 Bible St and 130 Bible St Sites. In any event, the total coverage from all three heights at the 130 Bible St Site is substantially greater in area and number of residences served than from the proposed 328 Palmer Site.

Figure 12- Coverage Available from Existing T-Mobile Facilities plus 130 Bible St Site at 160 Feet above Ground

Figure 13- Coverage Available from Existing T-Mobile Facilities plus 130 Bible St Site at 100 Feet above Ground

Figure 14- Coverage Available from Existing T-Mobile Facilities plus 130 Bible St Site at 80 Feet above Ground

ALTERNATIVE – 54 BIBLE STREET AT 100 FEET

Another site that came up in discussions with Representative Town Meeting Land Use Committee and Pinetum Coalition representatives was a parcel consisting of two ball fields, tennis courts, playscape, parking and an outbuilding (Figure 15). It is designated 54 Bible Street. The parcel is relatively large, 6.8 acres, and is surrounded by a dense development of residences on 0.1± acre parcels (~5000 sq ft). The location is 1000 to 2000 feet from Route 1. Being this close to Route 1, the general area of 54 Bible Street has patchy coverage from facilities along Route 1, which varies above and below the T-Mobile coverage thresholds.

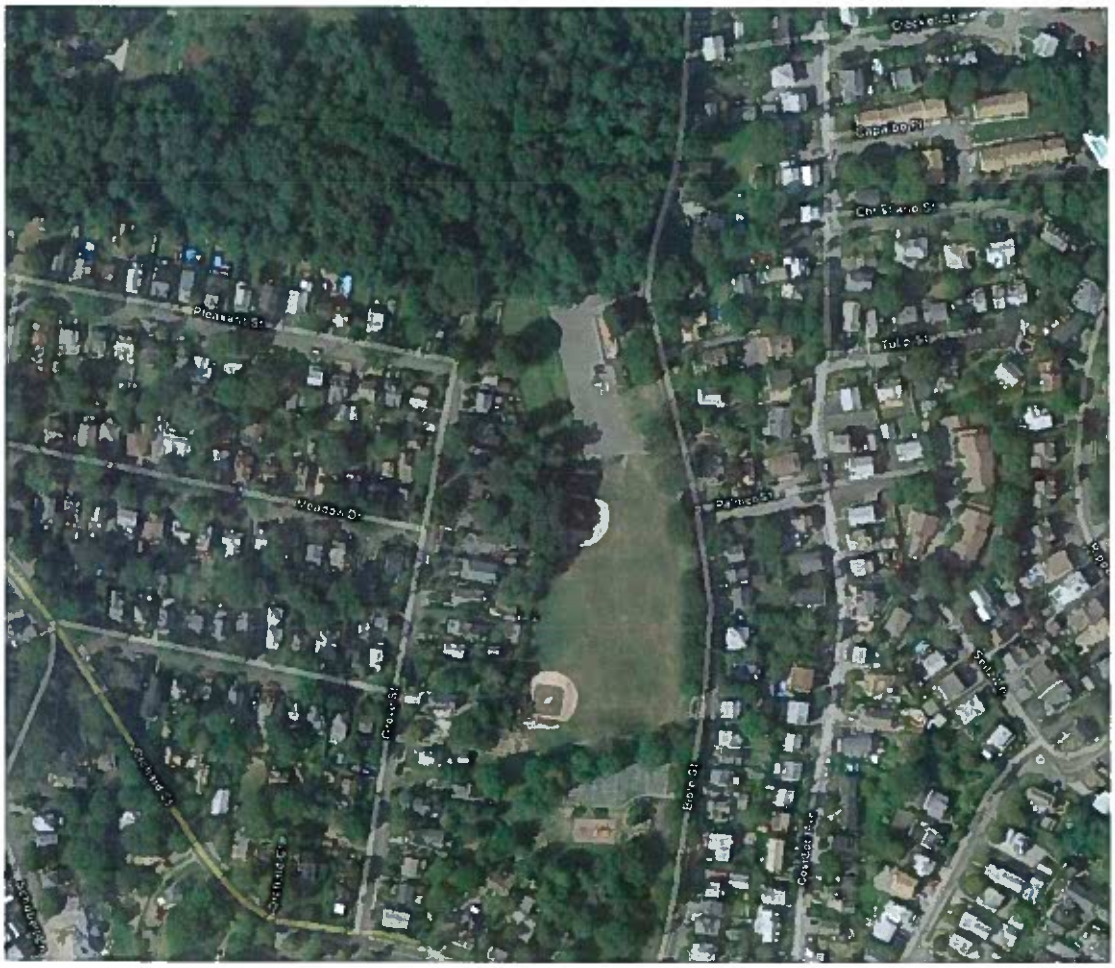

Figure 15 - Aerial View of Southerly Bible Street, with #54 at Center

Figure 16 illustrates the available coverage from 54 Bible Street. Note how the coverage extends northerly as far as Clover Place beside the 129 Bible St Site; easterly to the Mianus River (Pond); and westerly to the Orchard Street, Stanwich Road, Central Middle School area. Only on the wedge of land between the Mianus River and Clover Place is there coverage in common between coverage from the 328 Palmer Site and the 54 Bible Street site. On the North Mianus side of the river, the 54 Bible Street facility would have no impact on coverage at the T-Mobile thresholds. Coverage to the south of 54 Bible Street already exists, which means much of the coverage that would be obtained from 54 Bible Street would be redundant. Perhaps, in the future, a carrier will need to increase capacity to the densely developed residential area around 54 Bible Street. Then it would be more productive to consider putting PWSFs at 54 Bible Street. Presently, 54 Bible Street appears to be insufficient to address, or contribute to addressing, the current coverage objective.

Figure 16 - Coverage Available from Existing T-Mobile Facilities plus 54 Bible Street at 100 Feet above Ground

ALTERNATIVE – VALLEY ROAD WATER TANK

The Valley Road water treatment facility on the Mianus River, 2/3 mile north of the Palmer Hill Road crossing, is a narrow parcel almost fully developed with a treatment plant (Figure 17). The site includes a water tank on the north end of the parcel, which Isotrope estimates to be 40 feet tall. Isotrope modeled coverage at 50 feet above ground, assuming that 50 feet is enough height to clear the tree heights (no certainty).

Figure 17 - Aerial View of Valley Road Water Treatment Facility, with Water Tank

Figure 18 - Coverage Available from Existing T-Mobile Facilities plus Water Tank 50 Feet above Ground

Figure 18 illustrates the potential coverage from the water tank. Despite its height, and its position at river level in the valley, the 50 foot height does provide patchy coverage to the North Mianus area. This is due to the salad bowl effect discussed above. The desired level of coverage does not reach the west side of the Mianus River in the area south of the Palmer Road crossing. The water tank site is not nearly as effective in reaching the North Mianus area with coverage as the Pinetum sites are.

ALTERNATIVES – 1114 EAST PUTNAM AVENUE & ST CATHERINE

The two final locations suggested to Isotrope in discussions with Representative Town Meeting Land Use Committee and Pinetum Coalition representatives are along Route 1 in the locus of 1111 East Putnam Avenue. Because these locations are duplicative of the existing T-Mobile PWSF at 1111 East Putnam Avenue, there is no value in analyzing them further.

ALTERNATIVE – UTILILTY INFRASTRUCTURE

The alternatives discussed above rely on new towers or existing structures for mounting wireless antennas. Another means of providing coverage is the use of utility infrastructure in the public way for mounting antennas. There are various ways PWS providers employ this infrastructure. In locations where a single facility is sufficient to patch a hole in otherwise sufficient coverage, a *microcell* might be sufficient. A microcell is in effect a miniature cell site; it consists of base station equipment and antennas configured to provide a reduced number of wireless channels to an area of restricted size. Figure 19 shows the microcells of three different wireless services mounted on utility poles.

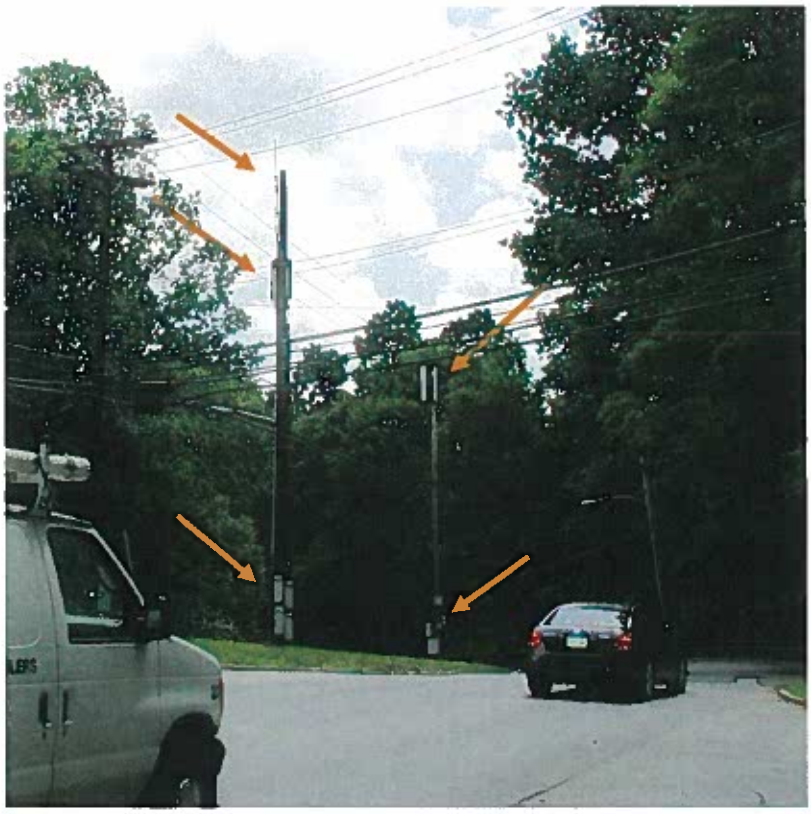

Figure 19 - Microcells (3) at busy residential intersection, Lower Merion, PA

Another architecture for providing wireless services using utility infrastructure is the Distributed Antenna System ("DAS"). DAS installations rely on the same building blocks as microcells and full cell sites, including base station equipment, interconnections of equipment using fiber optic cables or microwave radio links, a centralized connection back to the national communications network ("backhaul"), antennas and antenna cables. The difference with DAS is that rather than place a microcell base station at each antenna installation, a more compact radio transceiver is placed at the antenna sites ("nodes") where

antennas are attached to utility poles (Figure 20). The remainder of the base station's equipment is at a centralized location ("hub" or "hotel") where it serves antenna installations on numerous utility poles. Cabling (usually fiber optic) on the utility poles connects the hub with the antenna nodes.

Figure 20 - DAS Node in Brookline, Massachusetts

Just as there is a tower industry supporting the placement of wireless facilities on towers, there is a DAS industry that is presently experiencing explosive growth enabling wireless services on utility infrastructure. As one would expect, the industry growth is first occurring where DAS networks are

needed most. The earliest and easiest opportunities for outdoor DAS facilities occur in areas with high use density (such as urban areas and densely developed suburban areas) and in locations where towers and rooftop antenna facilities are impossible or impracticable to achieve (such as scenic locations Nantucket Island, Massachusetts and Hilton Head Plantation, North Carolina – two early examples).

Tower and rooftop facilities are developed essentially one at a time. When a new need presents itself, a PWS provider typically budgets for a new base station facility and looks for a solution. Existing structures are typically sought first, followed by a search for "raw land" on which to place a tower. There is little in the way of long range planning (5 years or more) on wireless network layout.

DAS installations are inherently extendable in a way that individual PWSFs are not – Additional nodes can be added to the area served by existing "backbone" cables on utility poles; also, the backbone can be expanded to a larger area when needed. Consequently, the benefits of DAS architecture are apparent when considering a long range view of the provision of PWS in a particular area. In the short view, PWS providers tend to rely on the traditional approach, continuing network expansion one tower (or rooftop) at time.

The exception to this generalization is occurring mostly in the densely developed areas. New York City, Yonkers, Mount Vernon, Boston, Providence, and numerous other urban areas in the northeast already have significant DAS network penetration.

Isotrope developed a DAS network layout in the area of the 328 Palmer Site (Figure 21). The goal was to provide coverage from a DAS network that would be equivalent to the coverage that the 80 foot unipole is expected to achieve. The example shown in Figure 21 employs 18 separate DAS nodes on utility poles. Isotrope's modeling is configured conservatively to anticipate the often significant impact of foliage on the wireless signals. The DAS nodes in this model are set at 40 feet above ground. The present state of utility and DAS regulation in Connecticut is bleak with respect to the ability of a DAS developer to mount an antenna above certain utility poles to achieve the desired coverage. New utility poles could be necessary at many of the DAS node locations depicted, in order to obtain a 40 foot height. Alternatively, DAS antennas may have to be demoted to a height of about 25 feet. This can substantially diminish the coverage of a DAS node. A more detailed analysis is necessary to develop a validated working model of a DAS in the subject area.

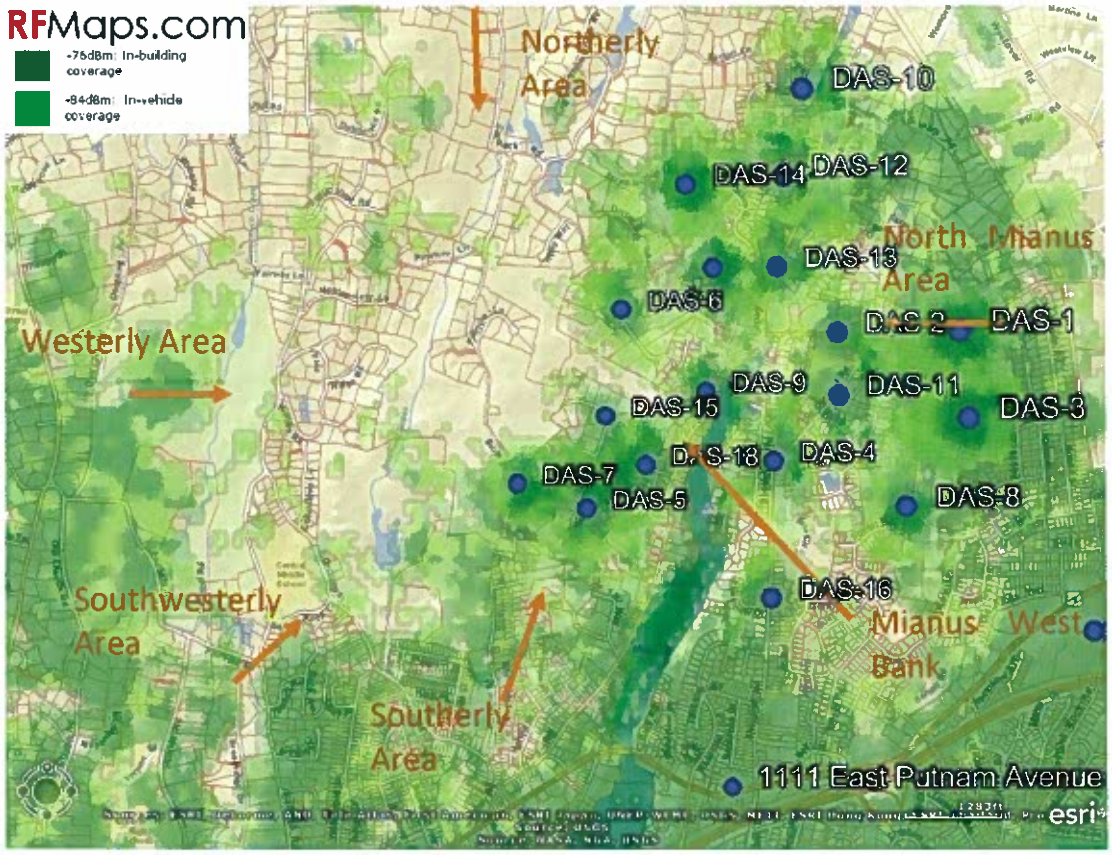

Figure 21 - Hypothetical DAS Configuration

Figure 21 shows that the 18 node DAS is not intended to reach west, north and south of the Pinetum area. Numerous additional nodes would be necessary to do so. Because the primary objective of this study is to provide alternatives to the facility that T-Mobile contemplates at 328 Palmer Hill Road, Isotrope limited the hypothetical DAS layout to the same coverage area as that of the 80 foot unipole.

Generally, in Isotrope's experience, the area depicted by the hypothetical DAS is not a high-priority location for a DAS for PWS providers. This is due in part to the only moderate density of the development in the area, as well as due to a perception that there may be locations for a new tower that the PWS provider may feel will be acceptable to the CSC. In a very rough approximation, Isotrope found there would be an average of 170 persons per node in Figure 21.

If there is a strong DAS interest on the part of the community, it would require a concerted effort to encourage DAS developers to compete for the opportunity to set up a DAS. In Brookline, Massachusetts this was done when the town issued a request for proposals for a DAS developer to lease municipal land to build the DAS hub facility. This built momentum for the development of a DAS in a moderately densely developed area of Brookline. It took several years for various reasons. Alternatively, the Town could fund and install its own DAS backbone and make it available to PWS providers.

SITE GEOGRAPHY

This section of the report discusses the geographical characteristics of the most effective potential sites. Consideration is given to the topography, land use, land cover and location of each site.

328 PALMER SITE

The property at 328 Palmer Hill Road ("328 Palmer Site") is in predominantly residential use and is at the summit of a small hill with a relatively steep drop to the Mianus River basin, which is approximately 350 feet west of the 328 Palmer Site. The ground elevation of the 328 Palmer Site is roughly 43-47 feet above mean Sea level ("AMSL"), which is approximately 35 feet higher than the Mianus River. The North Mianus School occupies the abutting parcel to the east, which is about ten feet lower in elevation (typical) than the 328 Palmer Site.

Three quarters of a mile east-north-east of the 328 Palmer Site stands the summit of Palmer Hill, located at Starin Drive, Stamford. The summit of Palmer Hill is approximately 180 feet higher in elevation than the 328 Palmer Site.

The locus of the 328 Palmer Site is well developed with mixed residential and commercial use. See Figure 22. The proposed PWSF at the 328 Palmer Site would be designed as a concealed-antenna monopole, most often referred to as a "unipole." No antennas or appurtenances would be visible because they are concealed beneath the tapered tubular surface of the unipole. See Figure 24 for an example.

Figure 22 - Aerial View of Subject Area

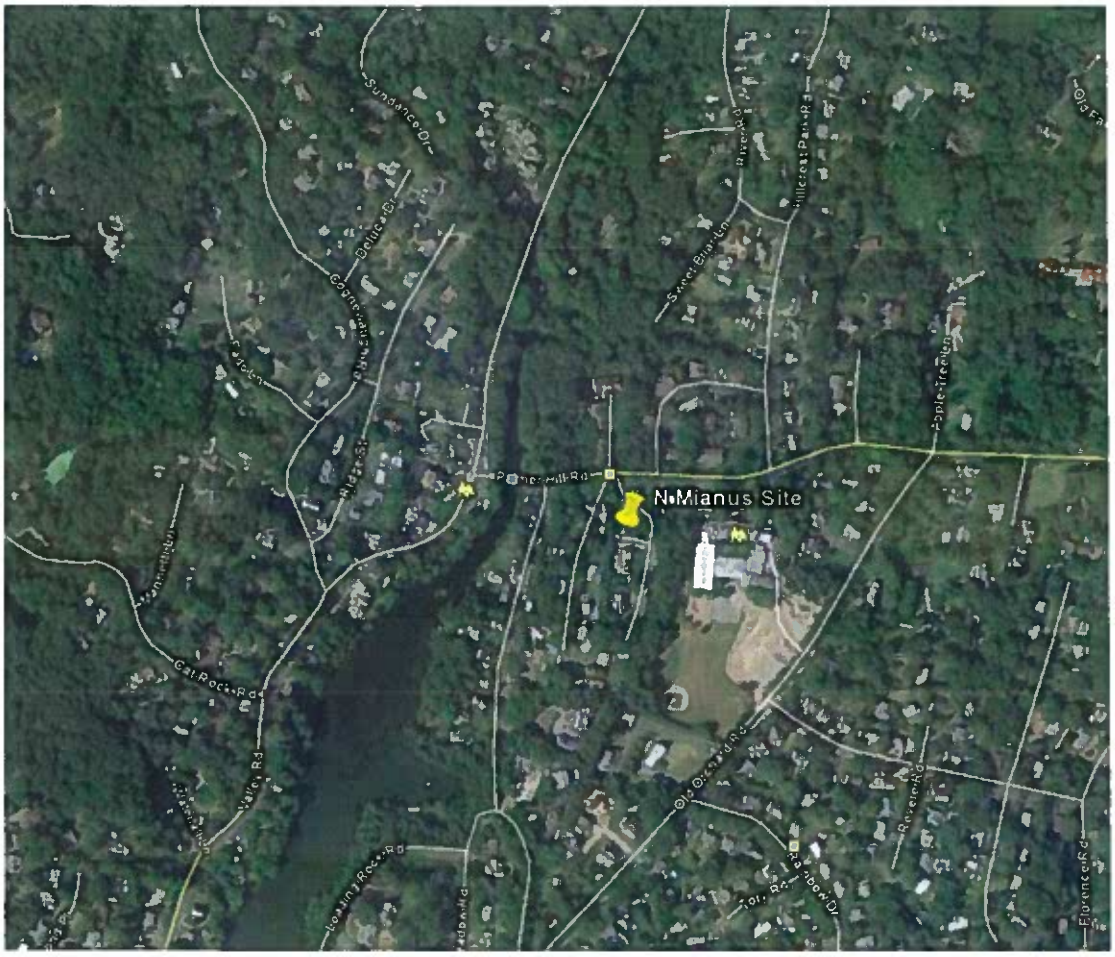

Figure 23 - Aerial View of North Mianus Including 328 Palmer Site

Figure 23 shows the locus of the 328 Palmer Site. The degree of development is apparent with numerous buildings placed fairly close together.

The proposed design of the 328 Palmer Hill PWSF reflects an attempt by T-Mobile to adopt a simple uncluttered look. The intensity of development for the 328 Palmer Hill PWSF is relatively low, for several reasons:

1. The tower height and design limit the intensity, visually. The visual mass of the proposed unipole is the minimum practicable, for a tower – a relatively slender pole, ~2 feet diameter at the top (Figure 24, for example), and nearly as short as they come.
2. The limited height, in turn, limits the number of carriers sharing the site and building ground facilities. There is potentially room for one, or at most two, *additional* PWS carriers on the 80 foot tall unipole. The corresponding area required to develop the subject parcel for PWSFs would be limited to that which two or three carriers would occupy – perhaps 750 square feet at

most. The resulting bulk of structures, cabinets and fencing, as well as noise potentially generated by the PWSFs, has an inherent limit that is substantially less intensive than a tall cell tower development with four to seven carriers.

3. The Site and the area around it are already developed with residence, business and school uses. The existing development may contribute to lessening the relative impact of the proposed development. The eye of the beholder is already accustomed to the structures, utilities and ways around the Site. In some circumstances, such a location may have little detrimental impact on the community. Isotrope takes no position on the issue, and only suggests that this is one factor in considering the proposed 328 Palmer Site.

Figure 24 - Unipole behind Lincoln, Massachusetts Public Safety Building

In the experience of Isotrope, it is quite common for communities to look for alternative ways to lessen the number of people adversely impacted by a proposed PWSF and to seek to lessen the degree of adversity of the impact. Design, intensity and location are the primary opportunities for controlling adverse visual impacts. Sites that are larger and more remote from residential uses are often sought. In addition, existing structures are often sought out to minimize new tower construction and new tower heights.

129 BIBLE ST SITE

The 129 Bible St Site is located at 129 Bible Street. The Montgomery Pinetum is 102 acres and owned by the Town. It consists primarily of open space, although there is an area of disturbance at which the Pinetum's operations are sited. Across Bible Street from these facilities is additional Pinetum land where the 129 Bible St Site is located.

The 129 Bible St Site was considered as an alternative location for placing PWSFs for several reasons. One very common reason for having PWSFs on municipal property is in support of the common good.

Figure 25 - Disturbed Areas of the Montgomery Pinetum

People also naturally look for locations that are not residentially developed, are on large parcels, or are surrounded by wooded areas. Each of these conditions substantially increases the likelihood that PWSFs will not be particularly visible or seen to loom over neighboring parcels. The Montgomery Pinetum has all three characteristics.

The Montgomery Pinetum is largely open space. Isotrope takes no position in favor or against the use of the property for PWSFs.

The initial location of interest provided to Isotrope was 129 Bible St, which is marked on Figure 25. This was an area where vegetative debris had been discarded in the past. Consequently, it is an open area requiring the removal of no trees to construct a PWSF. It has an access driveway from Bible Street.

Isotrope visited the 129 Bible St Site in January. There are two essential concerns about PWSFs and their towers with respect to visibility – horizontal view to ground level of the PWSF and elevated view to a tall tower that pierces or disturbs the skyline. Many residents in many communities are displeased by the prospect of having to look at an industrial looking telecommunications facility from their treasured residential parcels. If the 129 Bible St Site were ideal, it would be invisible at three elevations of view. We will call these "understory," "defoliated trees" and "skyline" visibility. Rarely is such a facility near a residential area completely invisible to residential uses on all three levels.

Figure 26 - South Understory View from 129 Bible St Site

Isotrope took photographs of the residences and outbuildings visible from 129 Bible St. Of course, in January there is no foliage, so there was maximum visibility for the photography. Figure 26 is a southerly view toward the rear of the parcels on Clover Place.

Figure 27 - Right Hand Structure in Figure 4, 3.75:1 zoom 105 mm equivalent

Figure 28 - Center Structure in Figure 4; 3.75:1 zoom 105 mm equivalent

Figure 29 - Left Hand Structure in Figure 4; 3.75:1 zoom 105 mm equivalent

Figures 5-7 are detail views of Figure 26 and are listed in Table 2. Figure 30 is oriented more southeasterly from the 129 Bible St Site. Figure 31 is a detail view of the only remaining residential structure that is visible from 129 Bible St.

Detail View	Estimated Address	Distance to a Laser-Readable Surface on or Near Structure
Figure 27	#23 Clover Place	166 yd/498 ft
Figure 28	#15 Clover Place	162 yd/486 ft
Figure 29	#13 Clover Place	180 yd/540 ft
Figure 31	#5 Clover Place	174 yd/522 ft

Table 2 - Table of Detail Photographs, Addresses & Distances from 129 Bible St Site

Figure 30 - Southeast Understory View toward Clover Place from 129 Bible St Site

Figure 31 - Detail View of Structure in Figure 8; 3.75:1 zoom 105 mm equivalent

The above series of photographs provides a good sense of the distances and the amount of understory screening that exists between the nearest residences and the 129 Bible St site. This helps visualize the degree of visual impact in the horizontal understory field of view.

To illustrate a skyline view, Isotrope took a photograph from Clover Place at the driveway of #23. Figure 32 is oriented in the general direction of the 129 Bible St Site. Using a laser rangefinder, the distances to various targets captured in Figure 32 were measured. From this data, the approximate height and location of a prospective tower at 129 Bible St Site were triangulated.

On Figure 32 there is a gray "T" shaped marking behind the corner of the house at #23 Clover Place. Isotrope placed this figure on Figure 32 to indicate an estimated height of 160 feet at the 129 Bible St Site. Its thickness approximates the expected thickness of a monopole at that distance. The width of the cross bar at the top approximates the breadth of an antenna platform, if the tower were to use the customary exposed antenna mounts.

Laterally, the proposed tower may not turn out to be exactly in the position shown, depending on the exact position of a new tower in the vegetation disposal area. It may be a little bit left or right of the position shown. However, Isotrope is reasonably certain that from the camera's viewpoint a portion of the 160 foot tower would be clearly visible above the treeline in the background of Figure 32.

Figure 33 shows a simulation of a 105 foot tower at the same position on the 129 Bible St Site. It is partially concealed by the residence. Accounting for potential errors, Isotrope is reasonably certain that a 105 foot tower would not extend above the tree line in the background from the camera's point of view. If the 129 Bible St Site remains a candidate, Isotrope recommends that a more thorough visibility study be performed. While it is often impossible to completely conceal a tower from residential or street views, a study can help determine the severity of the overall visual impact of the facility, help identify the best mitigation methods, and provide a point of comparison with visual impacts of other alternative locations.

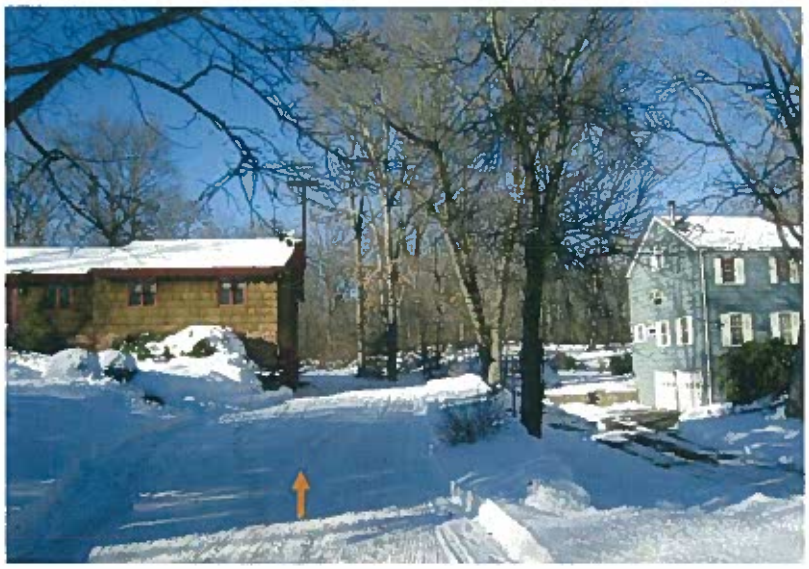

Figure 32 – Defoliated Trees & Skyline View (#23 (left) & #19 Clover Pl) – 160 ft Simulated Tower

Figure 33 - Defoliated Trees and Skyline View - 105 ft

130 BIBLE ST SITE

Based on Isotrope's experience with searching for alternatives, Isotrope presents the 130 Bible St Site for consideration, for reasons explained herein.

As a point of comparison, let us first review the considerations for the 129 Bible St Site. Among potential locations on the Montgomery Pinetum land that might be suitable technically and aesthetically for a PWS tower, the 129 Bible St Site was attractive for several reasons. Among the reasons for considering the 129 Bible St Site:

- ✓ The 129 Bible St Site was previously used and the land disturbed for vegetation compost;
- ✓ There is existing access to Bible Street;
- ✓ No trees would have to be cleared;
- ✓ There is a 500-foot tree and vegetative understory buffer to the nearest residences that
  - Obstructs ground level views of the tower from the residences.
  - Reduces the scale of the tower, to minimize a shadowing or looming effect
  - Allows the trees behind the residences to obscure, in summer, much of the tower from the clearest view points, and the entire tower from many more vantage points. (In winter, the defoliation increases visibility.)

In comparison, possible reasons for considering the 130 Bible St Site are:

- ✓ The 130 Bible St Site is disturbed and developed as the central facilities for Pinetum operations;
- ✓ There is existing access to Bible Street;
- ✓ It might be possible to construct the facility with no or one tree to be removed or cut back;
- ✓ There is a 550-foot tree and vegetative understory buffer, as well as a 10-foot hill, adjacent to the nearest residence that
  - Obstructs ground level views of the tower from the residences.
  - Reduces the scale of the tower, if visible, to minimize a shadowing or looming effect to residences.

The main "campus" of the Montgomery Pinetum is across Bible Street from the 129 Bible St Site. The campus consists of a horticultural building, greenhouses, driveways and parking areas (an estimated 30,000 square feet of pavement), and a 70x70-foot maintenance equipment building. The campus of the Montgomery Pinetum is the primary area of disturbance on the Pinetum lands.

Many municipalities and planners encourage the use of disturbed land, and particularly developed land, for the placement of new wireless facilities. While the 129 Bible St Site is disturbed land, the 130 Bible St Site is developed with the usual elements of a public gathering place and place of directed activity. Isotrope identified a hypothetical location at the "working end" of the Pinetum campus where the maintenance equipment building is located. The approximate location is marked by the 130 Bible St arrow on Figure 25.

A tower at either location (129 Bible St or 130 Bible St) will be visible to visitors at the Pinetum facilities.

Skyline Views

From the Pinetum upper parking area, a 130 Bible St tower behind the maintenance building will be in full view. In comparison, from that parking area, a 160 foot tower at the 129 Bible St Site would be visible above the treeline.

Based on a preliminary visual assessment, there is a very low likelihood that a tower at the 130 Bible St Site would be visible above the treeline from residential areas within at least 1500 feet of the tower. Contrast this with the expected visibility above the treeline of a 160 foot tower, from some points along Clover Place.

Figure 34 - Westerly View from 129 Bible St Site to Pinetum Maintenance Building, Showing the Degree of Screening through Understory and Defoliated Trees Views

Defoliated Trees Views

From the Pinetum upper parking area, a defoliated view through the tree branches to the 129 Bible St Site would also occur. Note the reverse view (from 129 Bible St Site to the Pinetum Maintenance Building) in

Figure 34. It shows that the defoliated tree view has sky as a backdrop. The same occurs in the opposite view, from the Pinetum parking area to the 129 Bible St Site.

With respect to the residential views to the 130 Bible St Site, based on a preliminary visual assessment, it is uncertain whether there would be visibility from residences through defoliated trees to a 130 Bible St tower. Contrast this with the evident visibility to a 129 Bible St tower through defoliated trees from locations on Clover Place (see Figure 32).

Understory Views

From the parking area of the Pinetum, there is no understory to screen a tower behind the maintenance building. Therefore, a tower at the 130 Bible St Site will be more visible to the grounds around the facilities than will one at the 129 Bible St Site, 600± away.

In contrast, it is expected that there will be no understory view from the nearest residences to the 130 Bible St Site. In contrast there is winter understory visibility, albeit very limited, from several residences to the 129 Bible St Site 500 feet away (for example, see Figure 26).

Figure 35 - Detail View of Maintenance Building from 129 Bible St Site; 3.75:1 zoom 105 mm equiv.

Point of View	Elevation of Viewline	129 Bible St Tower in Vegetation Disposal Area	130 Bible St Tower Behind Maintenance Building
From Residences	Skyline	160 ft yes, 105 ft no	Possibly not
	Defoliated Trees	Yes	Possibly not
	Understory	Winter, very limited	Possibly not
From Pinetum Parking Lot	Skyline	160 ft yes	Any height yes
	Defoliated Trees	Yes	Any height yes
	Understory	Winter, very limited	Any height yes

Table 3 Comparison of Visibility of Towers at 129 Bible St & 2 Sites to Residences and Pinetum Parking Area

Table 3 summarizes the visibility characteristics of each potential tower location – 129 Bible St and 130 Bible St. Visibility is considered from residences, and from the parking area of the Pinetum facilities. The 130 Bible St Site appears to have substantially less visibility to residences in the area, but requires further analysis to verify. The 129 Bible St Site has increased visibility to residences, and a similar visibility to the Pinetum parking area.

It may be more palatable to have the tower appear on developed land at 130 Bible St, in full view of the parking area, if it results in a significant improvement in residential visual impacts. These are local judgments that are best informed with a thorough visibility analysis.

At the 129 Bible St Site and the 130 Bible St Site, a unipole similar to that depicted in Figure 24 might be more palatable than a more conventional tower. Wireless coverage is addressed in the next major section of this report.

OTHER LOCATIONS CONSIDERED

During the fact-gathering phase of this project, Isotrope entertained suggestions for alternative locations received from residents. Isotrope also toured the area of interest and studied geographic information sources to identify possible alternatives. Table 1 - Sites Considered, lists the various locations that were evaluated for their potential to provide meaningful improvement to wireless coverage in the subject area. Some of those sites were not addressed in this Geography section: St Catherine, 1114 East Putnam Avenue, 54 Bible Street, Valley Road water tank, and Brennan golf course did not provide sufficient coverage to consider them further.

FINAL COMENTARY

This report describes the analysis of Personal Wireless Service Facility siting options in response to T-Mobile's expression of interest in placing a PWSF on a new tower in North Mianus. The tower would be 80 feet tall. Coverage from the tower would serve the hillside area east of the Mianus River, in the vicinity of the river crossing of Palmer Hill Road. The Town of Greenwich sought to evaluate possible alternatives that might be equally as effective in addressing T-Mobile's desire to improve coverage in North Mianus while also addressing community concerns about PWSF placement.

Several locations were identified for consideration. Isotrope toured the area, examined public records, obtained input from town officials and residents, and performed analysis on its geographic information system and wireless coverage analysis system. Table 4 outlines the alternatives discussed in this report and provides a short synopsis of their coverage performance.

The most effective alternative, from a coverage perspective is with a tower at the 129 Bible Street 129 Bible St Site (the former location of a vegetation compost area). The optimum tradeoff between tower height and visibility to residential uses will require more detailed visual analysis and coverage analysis.

The most effective alternative, from the perspective of visibility to residential uses, is with a tower at the maintenance facility of the Montgomery Pinetum – the 130 Bible St Site – on the opposite side of Bible Street from the 129 Bible St Site. On initial observation at the site and using GIS tools, a tower at the 130 Bible St Site may succeed in not being visible at all to residential uses within 1500 feet or more of the facility. The optimum tradeoff between tower height and visibility to residential uses will require more detailed visual analysis and coverage analysis.

The remaining alternatives considered are at worst, fully redundant with existing wireless facilities, and at best simply fail to come close to addressing the T-Mobile objective.

While the proposed T-Mobile facility at the 328 Palmer Hill Road 328 Palmer Site would serve within a certain radius of the site, the proposed facility by no means addresses all the remaining area of Greenwich that is shown as having T-Mobile service below T-Mobile's preferred thresholds.

The use of the Pinetum for placing a PWSF is an opportunity not only to supply improved coverage to the North Mianus community, but also to serve a larger area of Greenwich that is below the T-Mobile coverage threshold. By allowing wireless carriers to utilize a new tower at the Pinetum, the town forestalls future demand for one or more facilities to improve service in the vicinity of Stanwich Road, western Cat Rock Road, Montgomery Lane and Dublin Hill Road.

A cooperative effort with T-Mobile is recommended to test one or more of the most viable alternatives for the effectiveness of their coverage and the degree of possible visual impact. Both are best done with a crane test. A similar field analysis of the proposed 328 Palmer Site would complete the process and give the Town an opportunity to consider the benefits and detriments of the options available.

Table 4 summarizes key findings about each alternative site and tower height considered.

Map Label Name	Tower Height - Ft	Notes
Proposed 328 Palmer Site 328 Palmer Hill Road	80	Defines basic T-Mobile coverage objective. Does not address all areas with below-threshold coverage. Estimated 1000 residences and 2800 population reached with >-84 dBm coverage
129 Bible St	160	Replaces and expands on 328 Palmer Site coverage. Includes new areas south, west and north of the Pinetum. Estimated 1600 residences and 4500 population reached with new >-84 dBm coverage
129 Bible St	100	Replaces and expands on 328 Palmer Site Coverage. Includes new areas south, west and north of the Pinetum, with a minor depression near Coachlamp Lane
129 Bible St	80	Replaces and expands on 328 Palmer Site Coverage. Includes new areas south, west and north of the Pinetum, with a moderate depression near Coachlamp Lane and Mianus West Bank
130 Bible St	160	Coverage is comparable to that of 129 Bible St at same height
130 Bible St	100	Coverage that is comparable to, and very slightly less effective than the 129 Bible St Site at the same height
130 Bible St	80	Coverage that is comparable to, and slightly less effective than the 129 Bible St Site at the same height
54 Bible Street	100	Reaches some of the area targeted by the 328 Palmer Site facility. Has substantial overlap with coverage from PWSFs along Route 1.
Valley Road Water Tank	81	Not a substitute – coverage too far north of objective. Would require additional facilities to complete objective.
St Catherine	N/A	Fully redundant with existing 1111 East Putnam Avenue T-Mobile PWSF.
1114 East Putnam Avenue (Rt. 1)	N/A	Fully redundant with existing 1111 East Putnam Avenue T-Mobile PWSF.
Brennan Golf Course	N/A	Ridge between golf course and North Mianus blocks all signals.
DAS Network	Util. Poles	Not a high-value location for DAS at this time. Local action necessary to foster DAS over time.

Table 4 - Comparison of Alternatives Considered in this Report

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Isotrope WIRELESS

Thinking outside the sphere

CSC Petition 1010

Prefiled Testimony of David Maxson, WCP

Exhibit 3 – Comparison of Coverage from Two Antenna Heights

This exhibit contains two coverage maps modeled at the Cellular frequency band of 850 MHz. The location of the source of the signal in both maps is the 455 Valley Road Standpipe. One is modeled with an antenna centerline of 60 feet above ground level, which is proposed by the Petitioner. The other model is from a 51 foot antenna centerline, which is the height of the top of the vent of the Standpipe and four feet above the highest point of the dome on the Standpipe.

As outlined in the Prefiled Testimony of David Maxson, WCP, the Petitioner's evidence demonstrates that both antenna heights (60 and 51 feet) are well below the height of the surrounding trees. Our computer modeling accounts for the generalized tree cover, but we have made no adjustment for the fact that the signals start off below tree height. Based on understanding of the Petitioner's practices, and upon inspection of its coverage map, we have no reason to believe that the Petitioner has made any allowances for the below-tree-height position of the antennas. We do expect that the Petitioner's coverage maps, like ours, do account for the generalized effect of vegetation, but not for the specific effect of the immediately surrounding tree cover. The Petitioner's and Isotrope's coverage maps therefore substantially overstate the coverage that would be obtained from the Standpipe.

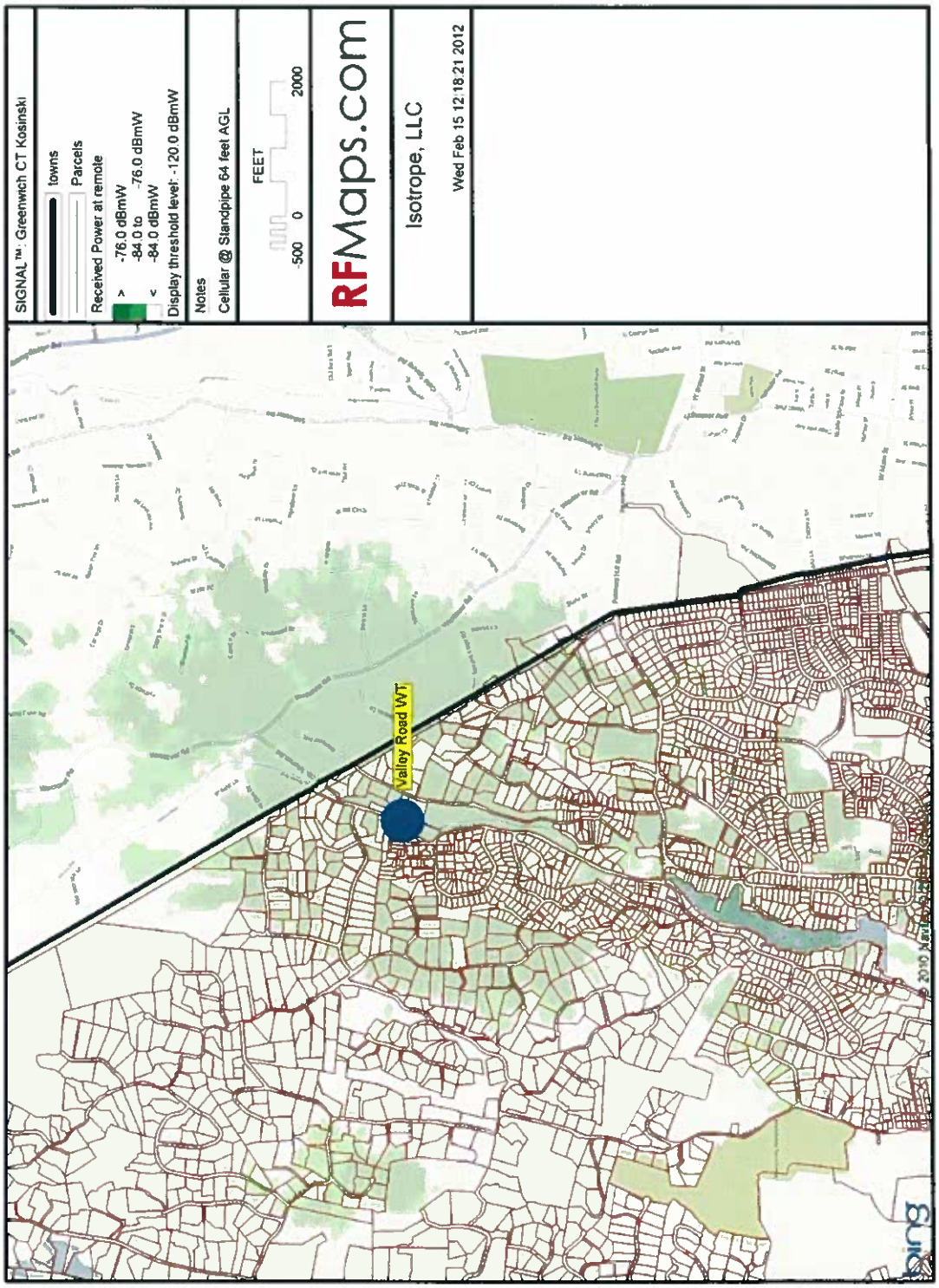
Independent of the fact that coverage is overstated, one can still compare the differences coverage between the two antenna heights. In the following maps, one can see the general effect of the terrain on the coverage. The valley forms a bowl-like environment that is nearly

equally illuminated by the antennas at the two heights. There is a slight reduction in coverage at the fringes, but the signals from both antenna heights drop off rapidly in most directions due to the terrain.

Based on these coverage maps, it is evident that there is no convincing technical reason to place the antennas at the 60 foot centerline height by installing a tower on the Standpipe rather than attaching antennas directly above the Standpipe.

David Maxson, WCP

February 15, 2012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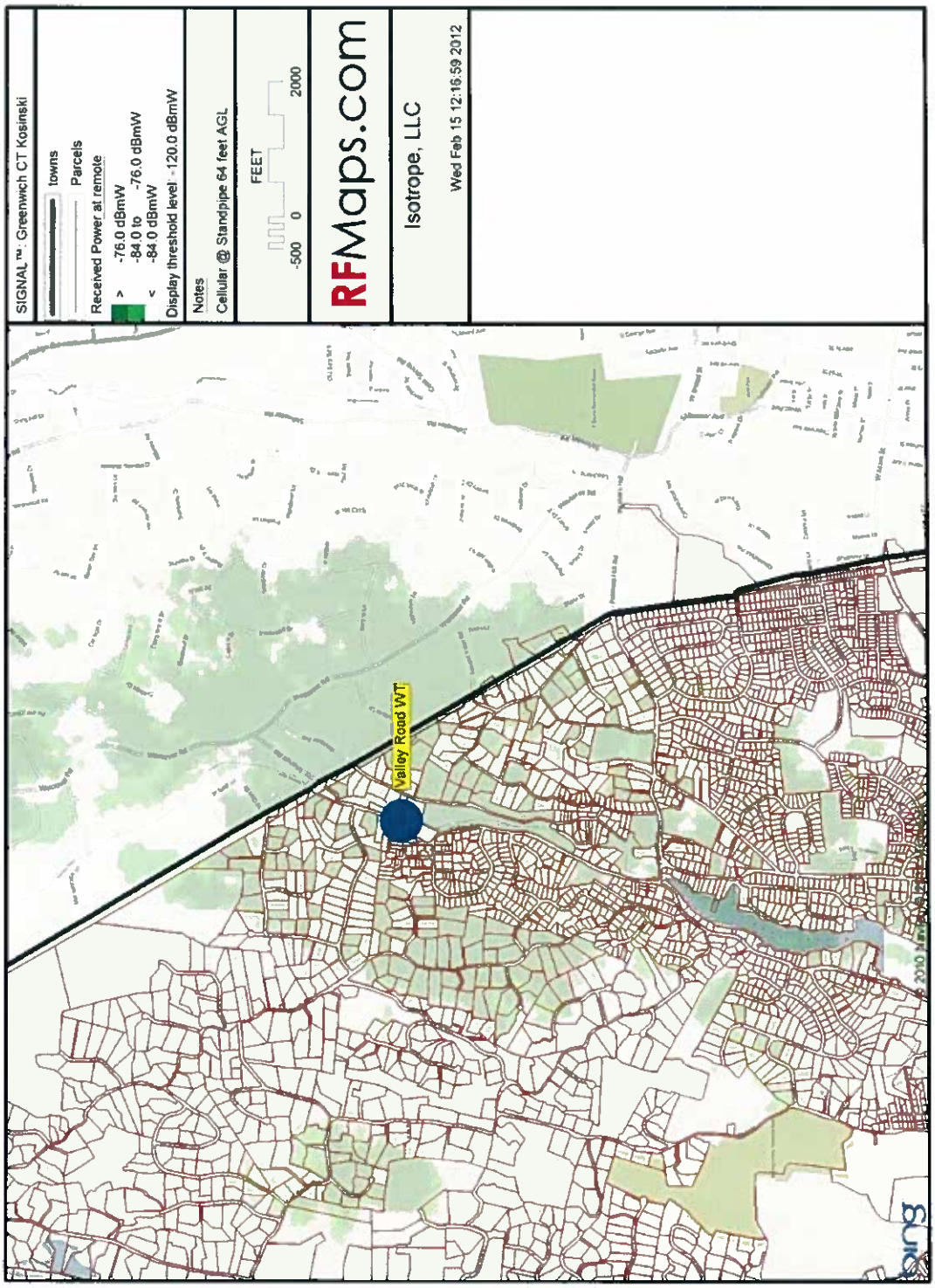
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