May 1, 2002

Mr. William A. DeVasher
Seegel, Lipshutz & Wilchins, P.C.
60 William Street, Suite 200
Wellesley, MA 02481-3803

RE: Report on RF Health Impacts for the AM Radio Antennas, Oak Hill, Newton, MA

Dear Mr. DeVasher:

You requested that Gradient Corporation review health issues with regard to the radiofrequency (RF) waves from AM radio transmitting antennas at 750 Saw Mill Brook Parkway (at its intersection with Spiers Road), in the Oak Hill neighborhood of Newton, MA. Champion Broadcasting has proposed to replace the 2 existing antennas with 5 antennas at a lower height, and to add two additional AM radio stations (WKOX and WRCA) to the current station (WUNR).

Executive Summary:

One task was to measure present-day radio frequency (RF) energy levels in the vicinity of the AM radio towers (WUNR, 1.6 MHz). Gradient Corporation surveyed RF levels on a number of streets during daytime and nighttime hours. Our survey determined that RF levels were low and were many-fold below the Massachusetts Department of Public Health, RF safety standard for public exposure.

Our second task was to review the analysis prepared by the Hatfield & Dawson engineering firm on *"Electromagnetic Field Calculations for Proposed Facilities at the WUNR (AM) Transmitter Site, Newton, MA."* **[Appended to this Report]** The future antenna configuration will include three AM radio stations (WKOX @ 1.2 MHz and 50 kW; WRCA @ 1.33 MHz and 25 kW; WUNR @ 1.6 MHz and 20 kW). From the Hatfield & Dawson analysis, we determined that, when the new antennas are operational, RF levels in the Oak Hill neighborhood will continue to be low and many-fold below the Massachusetts RF safety standard.

1 Introduction

The antenna site is located near a residential area, and some residents have expressed concern as to the possibility of adverse effects on health due to the radio waves. Our evaluations of RF intensity measurements in the nearby area, of future predicted RF levels, and of health concerns are presented in this letter report. My review of this material leads me to the conclusion that no adverse health effects can be expected for people living in the areas adjacent to the present or proposed antennas. In the remainder of this letter, I explain my expertise in the issue of RF health effects, and provide the basis for my conclusions on the health effects of radio waves.

My qualifications and expertise include a Ph.D. degree in physics from Harvard University, an M.S. degree in human physiology, and 20 years of research and teaching as a faculty member of the Harvard School of Public Health (Boston, Massachusetts), in the Department of Environmental Health (full-time faculty for 14 years). I am Senior Health Scientist at Gradient Corporation, an environmental health consulting firm based in Cambridge, Massachusetts. As a public health professional, I have been working for twelve years in the area of human health risk assessment for ionizing radiation and non-ionizing radiation. On a regular basis, I am asked by the National Institutes of Health to review grant proposals for studies on the biological effects of electric and

magnetic fields. I also provide advice and expertise on RF health effects to industries, schools, churches, and municipalities. The International Congress on Radiation Research asked me to organize and chair a symposium on this subject for their annual meeting in the summer of 1999.

On a similar project in 1998, I was asked by the Commissioner of the City of Newton Health Department to help the Newton Board of Aldermen review data, calculations, and scientific literature with regard to a proposed upgrade of a transmitting antenna tower located at 1165 Chestnut Street, in Newton Upper Falls. My tasks, on behalf of the City of Newton, included making measurements of RF levels in the vicinity of the tower and reviewing materials provided by Mr. Donald Haes of Massachusetts Institute of Technology, who was acting as consultant to American Tower Systems, the proponents of the antenna upgrade. I was assisted in my work by Dr. John M. Osepchuk, a radiofrequency engineer. Our 1998 report to the City of Newton found that the existing tower and proposed upgrade produced maximum RF levels that were below about 5% of the public-exposure limits specified by state and federal standards.

In the following enumerated sections, I explain the nature of radio waves and provide the lines of evidence that support my conclusion that the RF levels in the Oak Hill neighborhood cannot be expected to have adverse effects on health.

2 Sources of Electromagnetic Signals in Our Environment

The "electromagnetic spectrum" refers to oscillating (time-varying) electric and magnetic fields; different regions of the spectrum are characterized by the oscillation frequency, as given in units of cycles per second, or "Hertz" (Hz). The spectrum encompasses frequencies from the kilohertz range (1,000's of Hertz) up through microwaves (gigahertz, or billions of Hertz) and on up in frequency into infrared, light, ultraviolet, and X-rays (Figure 1). Visible light is the major source of electromagnetic energy in our environment. The human body, by virtue of being alive and warm, generates heat energy (electromagnetic energy in the infrared portion of the spectrum), which can be seen by a "night-vision" camera, even in complete darkness. The RF portion of the electromagnetic spectrum is at a lower frequency than infrared (heat) radiation, and is many-fold below the "ionizing" portion of the spectrum, which begins at ultraviolet light and continues into the higher frequencies (X-rays). Unlike "non-ionizing" radio waves, photons in the "ionizing" portion of the spectrum can cause molecular damage even at low intensity levels (See Figures 1 and 3).

In the greater Boston area, the predominant RF sources are commercial broadcasting. In the AM, FM, and TV bands, there are between 80 and 90 transmitters in eastern Massachusetts, including 32 AM radio stations, 41 FM radio stations, and 11 television stations. Overall, common sources of radio-wave energy contributing to our personal RF exposure include the following:

Commercial radio (AM & FM) and commercial TV (VHF & UHF & digital)
Marine and aviation radio services, marine and aviation radar, police radar
Public emergency, ambulance, fire, and police dispatch services
Amateur (ham) radio operators, "walkie-talkies," citizens-band transmitters
Cellular telephones, pagers, Personal Communications Systems (PCS)
Microwave ovens, cordless telephones, baby monitors, wireless toys, remote door-openers
Computers, computer monitors, AM/FM radios, TV sets, CD players, computer games
Microwave links for computers, radio & television stations, and telephones
Satellite television / communications, the global positioning system (GPS)
Medical procedures including diathermy, scanning, magnetic resonance imaging

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It is important not to confuse AM radio with cellular telephone technology. As shown in Figure 2, the parameters of the two transmissions are different, and they are clearly distinct from each other.

The amount of power emitted by the various RF sources varies widely, but all transmitters must comply with the RF safety standards. Typical radio and television broadcast stations are licensed to operate at power outputs of 10,000 to 1,000,000 watts; ham radio operators and cell-telephone base antennas have power levels of 100 to 1,000 watts. Baby monitors, phone handsets, and microwave oven leakage produce RF in the range of ½ to 10 watts. An individual's personal RF exposure depends on how close he/she is to the source. For any antenna, the energy emitted is dissipated in all directions, and the RF energy level decreases with distance. [1]

The intensity of electromagnetic energy is expressed as the amount of energy crossing a unit of area. Typical units are "microwatts per square centimeter" or $\mu W/cm^2$. A square centimeter is a square area approximately ½ inch on a side. A microwatt is a millionth of a watt. As a point of comparison, typical home appliances use hundreds of watts of electrical energy, and generally radiate this energy in the visible and infrared portion of the electromagnetic spectrum.

Sunlight at noon bathes us with about 150,000 $\mu W/cm^2$ of electromagnetic energy. For RF energy, the Massachusetts safety standard for public exposure varies with frequency. In the frequency band that includes AM radio (0.3 to 3.0 MHz), the limit for RF power density is 20,000 $\mu W/cm^2$. [2] Measurements and calculations show that present-day and future maximum RF power densities beyond the property line of the Oak Hill AM radio antennas are below 700 $\mu W/cm^2$ (which is 3.5 % of the Massachusetts power density limit). Maximum electric and magnetic fields (which occur on the property line), are below 5% of the Massachusetts field-strength limits.

3 National and International Standards on Safe RF Exposure Levels

Safety standards for RF exposure are based on knowledge accumulated from many years of laboratory work, and from human experience with RF waves (*e.g.,* radio, television, navigation, telemetry, cell telephones, radar). Research findings on potential health effects of RF waves have been assembled and reviewed by numerous independent scientific consensus groups composed of research, engineering, medical, and public health scientists. These groups include:

- American National Standards Institute (ANSI / IEEE, 1992),
- Federal Communications Commission (1996, 2001),
- Health Canada, Royal Society of Canada (1999),
- International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998),
- Massachusetts Department of Public Health (MADPH, 1988),
- National Council on Radiation Protection and Measurements (NCRP, 1986),
- National Radiation Protection Board (NRPB, 1993, 2000),
- Netherlands Health Council (1998, 2001), and
- World Health Organization (WHO, 1993, 2000).

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[1] Strictly true only for an isotropic radiator. AM, FM and TV antennae are typically monopoles that are omni directional in the azimuth, but generally have elliptical vertical patterns. The sector antennae used in cellular / PCS base stations are very directional, and ground-level RF energy can be lower directly under the antenna than at a 500 feet distance. For the AM radio antennas planned for the Oak Hill site, ground level RF decreases with distance.

[2] The Massachusetts Limits for Public Exposure are for three separate RF field parameters, and an RF facility must be in compliance with all three. In the 0.3 to 3.0 MHz band, which includes AM radio, these limits are 80,000 $(V/m)^2$ for mean squared electric field strength, 0.5 $(A/m)^2$ for mean squared magnetic field strength, and 20 mW/cm^2 for equivalent plane wave free space power density.

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The setting of standards and regulations is a rigorous procedure that involves basic elements of quality control. The reports of the public health groups are written by doctors, biologists, engineers, and toxicologists, and are thorough and even-handed. The review group begins by examining the vast body of relevant medical and scientific literature, utilizing scientists whose training and experience make them familiar with the research (typically, university scientists, physicians at medical schools, public health research workers, and environmental regulators). The standard-setting process incorporates periodic review, and standards are updated as scientific knowledge improves and new information becomes available. The final result is a health-protective standard designed to protect the population, even sensitive groups, against adverse health effects the exposures under consideration.

The blue-ribbon panels have determined that the current guidelines for RF exposure (with minor variations) protect the health of the public. For example, the Massachusetts Department of Public Health (MADPH) has adopted RF exposure regulations, which have the force of law in Massachusetts [105 CMR 122.000 (Code of Massachusetts Regulations)]. The allowable RF exposure levels vary with the frequency of the radio waves, and are generally expressed as a certain amount of energy per unit area, *e.g.,* $\mu W/cm^2$ (See Footnote 2).

Appendices A, B, and C to this report provide more information for people who may want to read at greater length on RF safety issues. Appendix A identifies standard-setting documents, Appendix B provides Internet addresses for public-health review groups, and Appendix C lists some recent publications on RF health effects. The list of public-health groups (Appendix B) also includes a brief summary finding for the blue-ribbon panel. The safety standards are overall similar, but cover a range of values. For example, the RF safety guideline for 1.6 MHz, which is the highest frequency in question (WUNR), ranges from 20,000 $\mu W/cm^2$ (Massachusetts) to 70,000 $\mu W/cm^2$ (FCC, United States) to 24,000 $\mu W/cm^2$ (Health Canada), and to 3,140 $\mu W/cm^2$ (International Commission on Non-Ionizing Radiation Protection).[3] In this document, we will use the Massachusetts RF standards. It should be remembered that the standards are not designed to be a boundary line between safety and hazard, but rather, incorporate safety factors such that exceeding the standard is still in a region of RF intensity not known to have health effects.

4 Nature of Scientific Evidence of Health Effects

Understanding the potential toxicity in humans of any type of exposure is an integrative process that looks for coherence among several lines of evidence. At the most fundamental level, scientists believe that the operation of living organisms, although not completely understood, is bounded within the context of accepted principles of physics, chemistry, and biology. Thus, the first line of analysis identifies the levels of RF exposure, which, on a physical, chemical, and biological basis, have the ability to modify the operation of life processes (Figure 3).

Second, cellular and animal experiments are used to test the outcome of RF exposure under controlled conditions. However, the very complexity of living systems requires careful attention to the possibility of artifacts. That is, health differences between the exposed and control animals may result from factors that are not due to the exposure in question. Consequently, laboratory experiments need to be examined for validity from a number of viewpoints, *e.g.,* physics of electric and magnetic fields, radio wave dosimetry, cell biology / molecular biology methodology, animal toxicology / physiology / pathology, and statistical analysis.

[3] The safety guidelines at the AM radio frequencies are often given in terms of mean squared electric (V/m) or magnetic (A/m) field strengths rather than "plane-wave power density," and this partly contributes to the range in values, when expressed as power density ($\mu W/cm^2$).

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Third, data from human studies (volunteers, clinical studies, epidemiology) are important, because extrapolation from animal species or from *in vitro* systems is not required. Studies of workers in RF occupations have been utilized in establishing RF safety levels. However, the diverse nature of human lifestyles, job descriptions, and personal histories makes controlling bias, confounding, and exposure misclassification difficult, and complicates the interpretation of human studies. Although very helpful, epidemiology associations, in isolation, are seldom sufficient to make a causal connection between exposure and outcome.

A voluminous scientific and medical literature (1000's of articles) exists of studies regarding possible health effects from RF. A complete picture cannot be presented by focusing only on selected studies or anecdotal stories. The scientific credibility and interpretation of each study needs to be weighed in the context of other knowledge and by scientists having the qualifications and training to interpret the study's strengths and weaknesses. Publication of a report is the beginning, not the end, of the scientific review process. It is this sort of thorough scientific review that forms the basis of the conclusions of public-health and standard-setting panels.

Sometimes, organizations propose RF guidelines that are not based on scientific evidence, but rather are based some other principle, such as "as low as reasonably achievable" (ALARA). Likewise, scientific panels on any topic invariably conclude that "more research is needed," and this is as true of RF as it is of drinking-water safety, automotive emissions safety, food safety, and almost any human activity. Because knowledge is never complete, some groups suggest guidelines on a "precautionary basis," recognizing that even though no valid health effect has been identified, perhaps a lower level is technologically feasible as a hedge against possible future findings of adverse effects. The utility of such guidelines is limited by the fact that reducing levels below the existing standards have not been shown to yield public health benefits. That is, careful review of available scientific data has not found human health effects from RF exposure at levels below the safety standards.

5 RF Levels in the Vicinity of Saw Mill Brook Parkway and Spiers Road, Newton

RF levels were surveyed on a number of streets during the daytime hours on September 22, 2000, and during the nighttime hours on November 28, 2000. The streets included Antonellis Circle, Caulfield Circle, McCarthy Street, Saw Mill Brook Parkway, Spiers Road, Van Roosen Road, Walsh Road, and Wiswall Road. Our measurements were sensitive to the whole spectrum of RF sources, including AM radio (where the Massachusetts standard is 20,000 $\mu W/cm^2$). We found that the largest RF readings on public streets were below 0.25 % of the AM-radio power density limit, that is, below 50 $\mu W/cm^2$.

Our monitoring used the Narda Model 8718 survey meter, in combination with the Narda Electric Field Probe 8760D (Frequency Range: 0.30 MHz to 3,000 MHz). The probe-instrument combination gives RF levels in total energy flux per unit area, or $\mu W/cm^2$. The accuracy and calibration of the probe-instrument combination are checked yearly against NTIS standards by the manufacturer to assure that the accuracy is within ±5%. The response of the probe is designed to be "flat" over its frequency range, *i.e.*, it reads the sum total RF energy, independent of frequency. The lower limit of the probe's sensitivity is about $\pm 0.02\ \mu W/cm^2$.

Measurements were made over a height of about 3 to 6 feet above the ground level, and peak RF levels were noted (in $\mu W/cm^2$). The maximum RF levels that were determined for a number of the nearby public streets are shown on Table 1. The vast majority of the readings were lower than what is shown in the table, but the highest ones tended to be at the point where the streets made their closest approach to the existing AM radio transmission towers.

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Table 1. Maximum Measured, Present-Day RF Levels

Street	Daytime RF Level	Nighttime RF Level
Antonellis Circle	21 $\mu W/cm^2$	18 $\mu W/cm^2$
Caulfield Circle	13 $\mu W/cm^2$	9 $\mu W/cm^2$
McCarthy Street	1.5 $\mu W/cm^2$	1.8 $\mu W/cm^2$
Saw Mill Brook Pkwy.	42 $\mu W/cm^2$	41 $\mu W/cm^2$
Spiers Road	32 $\mu W/cm^2$	30 $\mu W/cm^2$
Van Roosen Road	10 $\mu W/cm^2$	8 $\mu W/cm^2$
Walsh Road	2.2 $\mu W/cm^2$	1.9 $\mu W/cm^2$
Wiswall Road	2.0 $\mu W/cm^2$	2.2 $\mu W/cm^2$
Overall Average During Survey Period [4]	6.4 $\mu W/cm^2$	3.8 $\mu W/cm^2$

To assess the RF impact of the proposed antennas, we derived RF power level values from information in the Hatfield & Dawson report. The H&D report calculated RF field intensity values for residences on the closest streets, because RF levels were lower for all more distant streets. The values for the residence with the maximum RF level for that street is shown in Table 2, and these maxima were generally for the residence that was closest to the radio towers. Of course, for the longer streets, *e.g.*, Saw Mill Brook Parkway and Spiers Road, the RF level calculated as an average over the whole length of the street would be much lower that the maximum level shown in Table 2.

Figure 4 illustrates information parallel to that shown in Table 2, except that now the comparison is given as a percentages of the Massachusetts magnetic-field-strength standard, which is more restrictive in this case than the electric-field-strength standard. Figure 5 also shows a helpful comparison of the transmitting power of the future Oak Hill antennas to the transmitting power that currently exists (and is projected for) the Newton Upper Falls area, where a number of FM radio and television transmitting antennas are located adjacent to residential neighborhoods.

[4] The overall average in the last row of Table 1 is not the average of the numbers above it in the column, but is the average of all readings collected during the RF monitoring period, the majority of which were, by definition, lower than the maximum measured. The nighttime survey included the more distant sections of Saw Mill Brook Parkway and Wiswall Road, which have lower levels of RF than streets near to the antenna site.

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Table 2: Maximum Predicted RF Power Density Levels, Future Operating Conditions [5]

Street	Daytime RF Level	Nighttime RF Level
Antonellis Circle	400 $\mu W/cm^2$	420 $\mu W/cm^2$
Saw Mill Brook Pkwy.	160 $\mu W/cm^2$	160 $\mu W/cm^2$
Spiers Road	420 $\mu W/cm^2$	530 $\mu W/cm^2$
Property-line Max. [6]	520 $\mu W/cm^2$	680 $\mu W/cm^2$

6 Summary

AM radio waves and RF communication have been used in the United States for many decades. During this period of time, the effects of RF have been studied extensively both in laboratory experiments and in exposed human populations. Although some of the studies have been used to fuel public anxiety about health concerns, careful review of the whole body of literature for validity, coherence, reproducibility, and relevance have not identified legitimate reasons to believe that the current RF safety standards are not protective of public health. Regulatory and scientific consensus groups remain unanimous in concluding that operation of facilities within RF safety standards will not contribute to increases in any disease statistic. At the same time, research and analysis continue to provide insight on how all portions of the RF spectrum can be used in such a way as to improve communication, human health, and well-being.

Our analysis of the present-day and proposed antenna facilities in the Oak Hill neighborhood of Newton showed that, beyond the antenna property, the RF levels are low and will remain well within the applicable RF safety standards after the proposed antenna upgrade. In the AM radio band, the Massachusetts standard for RF power density is equivalent to 20,000 $\mu W/cm^2$. Present-day and future maximum RF power densities in the Oak Hill neighborhood are below 700 $\mu W/cm^2$ (which is 3.5 % of the Massachusetts power density limit). Maximum electric and magnetic fields (which occur on the property line), are below 5% of the Massachusetts field-strength limits. [7]

Sincerely yours,
GRADIENT CORPORATION
Peter A. Valberg, Ph.D.

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[5] Representative calculations are taken from the Jan. 31, 2002, report of Hatfield & Dawson, Consulting Electrical Engineers, Seattle, WA: *"Electromagnetic Field Calculations for Proposed Facilities at the WUNR (AM) Transmitter Site, Newton, MA."* The Hatfield & Dawson report provided calculations at the nearest residences, and for this table, the street value given is what was calculated for the residence with the maximum RF level. RF levels on more distant streets are lower. The Hatfield & Dawson report gives electric and magnetic field values instead of power density levels. The RF power density level is by definition the product of electric and magnetic field levels.

[6] The property-line maximum in the Hatfield & Dawson report occurs on that part of Northeast property boundary that is closest to the "NE" transmitter tower. The Northeast boundary of the property parallels Spiers Road.

[7] The Hatfield and Dawson calculations showed that the maximum squared electric field strength on nearby streets ranges from 0.7% to 2.1% of the Massachusetts standard. Likewise, the maximum squared magnetic field strength on nearby streets ranges from 0.9% to 3.3% of the Massachusetts standard. The maximum values on the property line are 2.6% of the electric-field-strength standard, 4.6% of the magnetic field strength standard, and 3.4% of the power-density standard.

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Appendix A: Standard-Setting and Public-Health Organizations Reviewing RF Guidelines

Standards or guidelines for human exposure to RF energy have been developed by several professional organizations and government agencies in the United States and elsewhere. These standards and guidelines have been developed to exclude all identified hazards of RF energy exposure, with large safety factors. The list below gives both the major standard-setting organizations, and public-health organizations that have commented on RF standards.

The scientific measure of radio-wave absorbed dose is the Specific Absorption Rate (SAR), which is the rate of energy absorption in tissue, in units of watts per kilogram of tissue (W/kg). For example, the RF safety standard specifies a maximum whole-body SAR limit for the general public as 0.08 W/kg. In addition, a limitation is put on the energy absorbed by any small portion of the body. That is, the maximum SAR (averaged over any one-gram [0.04 oz] portion of the body) is limited to 1.6 W/kg. Even the higher figure, an SAR of 1.6 W/kg, is a very low energy input. When you turn on a handheld flashlight, the bulb consumes about 3 to 4 watts, so 1.6 watts is about half the energy put out by a typical flashlight. With 1.6 watts of energy input to a kilogram of ice (0^o C), if this were the only energy input, it would take about 2 ½ days to melt the ice to water at 0^o C. At the whole-body exposure limit (0.08 W/kg), the time required for the heat input to melt the ice would be lengthened to beyond 50 days.

1. American Cancer Society (ACS). 1996. Electromagnetic field exposure and cancer: A review of epidemiologic evidence (by CW Heath). *CA, a Cancer Journal for Clinicians* (A publication of the ACS). 65:29-44.

2. Committee on Man and Radiation (COMAR) 2000. COMAR Technical Information Statement: Human exposure to radio frequency and microwave radiation from portable and mobile telephones and other wireless communication devices. See: www.seas.upenn.edu.8080/~kfoster/phone.htm

3. Environmental Protection Agency (United States) (USEPA).

   1978. Radiofrequency radiation levels and population exposure in urban areas of the eastern United States. EPA-520/2-77-008. Office of Radiation Programs, Silver Spring, MD (U.S. Dept. of Commerce Publication PB-292-855, May, 1978).

   1984. Biological Effects of Radiofrequency Radiation. Health Effects Research Laboratory, Research Triangle Park, NC. EPA-600/8-83-026F, September, 1984.

4. Food and Drug Administration (FDA). 2001. Consumer Update on Wireless Phones. www.fda.gov/cdrh/ocd/mobilphone.html#9

5. General Accounting Office (GAO). 2001. GAO-01-545 (2001). Research and Regulatory Efforts on Mobile Phone Health Issues, pp. 1-42. www.gao.gov/new.items/d01545.pdf

6. Independent Expert Group on Mobile Phones (IEGMP), Sir William Stewart FRS (Chairman). 2000. Mobile Phones and Health. www.iegmp.org.uk

7. Institute of Electrical and Electronic Engineers (IEEE). 1991. RF Standard IEEE-C95.1, 1991: Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz. IEEE, Piscataway, NJ. www.standards.ieee.org/catalog/olis/index.html

8. International Commission on Nonionizing Radiation Protection (ICNIRP). 1998. Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz), *Health Physics*, 74 (4): 494-522, 1998. www.icnirp.de

9. Massachusetts Department of Public Health (MADPH). 1988. Regulations for fixed facilities which generate electromagnetic fields in the frequency range of 300 kHz to 100 GHz and microwave ovens. 105 CMR 122.000 (Code of Massachusetts Regulations).

10. National Academy of Sciences (National Research Council). 1993. Assessment of possible health effects of the Ground Wave Emergency Network (150 kHz - 400 MHz). National Academy Press. Pp. 1-180.

11. National Council on Radiation Protection and Measurements (NCRP), Bethesda, MD. www.ncrp.com/

1981. Radiofrequency electromagnetic fields. Properties, quantities, and units. Biophysical Interactions and Measurements. NCRP Report No. 67.

1986. Nonionizing electromagnetic radiations and ultrasound. NCRP Proceedings No. 8 (Proceedings of the 22nd Annual Meeting of the NCRP.

1986. Biological effects and exposure criteria for radio frequency electromagnetic fields. Report 86, pp. 1-382.

12. National Radiation Protection Board (NRPB), Oxfordshire, UK. www.nrpb.org

1991. Biological effects of Exposure to Non-ionising Electromagnetic Fields and Radiation. III. Radiofrequency and Microwave Radiation. By RD Saunders, CI Kowalczuk, ZJ Sienkiewicz. NRPB-R240. Pp. 1-138.

1993. Board Statement on Restrictions on Human Exposure to Static and Time-Varying Electromagnetic Fields and Radiation, Documents of the NRPB, Vol. 4, No. 5.

13. Netherlands Health Council. Radiofrequency electromagnetic fields (300 Hz – 300 GHz), summary of an advisory report. *Health Physics* 75:51-55 (1998).

Health Council, 2001 press release: Health effects electromagnetic fields are unlikely: www.gr.nl/overig/persberichten/persbericht%20jaarbericht%202001%20eng.pdf

14. Office of Engineering and Technology (OET). Questions and answers about biological effects and potential hazards of radiofrequency radiation. OET Bulletin No. 56, January 1989. Federal Communications Commission, OET, Washington, DC. 1989.

15. World Health Organization (WHO), Geneva, Switzerland. www.who.int

1993. Environmental Health Criteria 137: Electromagnetic Fields (300 Hz to 300 GHz). pp. 1-290.

2000. Electromagnetic Fields and Public Health, Fact Sheet No. 193. Available at: www.who.int/inf-fs/en/fact193.html

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Appendix B: Web Sites for Blue-Ribbon Panels reviewing Health Effects of RF Waves:

The American Cancer Society, 2001: Unproven Risks
http://www.cancer.org/eprise/main/docroot/PED/content/PED_1_3X_Unproven_Risks?sitearea=PED
"Electromagnetic radiation at frequencies below ionizing and ultraviolet levels has not been shown to cause cancer." (ACS, 2001)

European Union, 2001: Possible effects of EMF, RF and Microwave Radiation on Human Health
http://europa.eu.int/comm/food/fs/sc/sct/out128_en.pdf
"Overall, the epidemiological evidence of RF and microwaves does not suggest consistent cancer excesses."

Federal Communications Commission, 2001: Frequently Asked Questions About RF Safety
http://www.fcc.gov/oet/rfsafety/rf-faqs.html
"There are thousands of radio and TV stations on the air in the United States. Broadcast stations transmit at various RF frequencies, depending on the channel, ranging from about 550 kHz for AM radio up to about 800 MHz for some UHF television stations. Measurements made by the FCC, EPA and others have shown that ambient RF radiation levels in inhabited areas near broadcasting facilities are typically well below the exposure levels recommended by current standards and guidelines."

Health Canada, 1999: Expert Panel Report on Radiofrequency Fields. The Royal Society of Canada
http://www.rsc.ca/english/RFreport.html
"Scientific studies performed to date suggest that exposure to low intensity non-thermal RF fields does not impair the health of humans or animals."

Health Council of the Netherlands, 2001: Health effects electromagnetic fields are unlikely
http://www.gr.nl/engels/welcome/frameset.htm
also: http://www.gr.nl/overig/persberichten/persbericht%20jaarbericht%202001%20eng.pdf
"Present scientific data do not indicate that exposure to environmental electromagnetic fields – such as generated by power lines and mobile phone base stations – constitute a health hazard."

International Commission on Non-Ionizing Radiation Protection
http://www.icnirp.de/Netscape/Publications.htm
"RF Exposure Guidelines: These are based on reviews of the science, they summarise scientific results and set out the basis for limiting exposure and recommend exposure limits. ICNIRP Exposure Guidelines are published in the Journal Health Physics."

Medical College of Wisconsin, 2001, Fact Sheet: Cellular Phone Antennas and Human Health
http://www.mcw.edu/gcrc/cop/cell-phone-health-FAQ/toc.html

National Radiological Protection Board, 2000: Expert Group on Mobile Phones and Health.
http://www.iegmp.org.uk/IEGMPtxt.htm
"The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population."

World Health Organization, 2000: Mobile Telephone Fact Sheet No. 193.
http://www.who.int/inf-fs/en/fact193.html
"While RF energy can interact with body tissues at levels too low to cause any significant heating, no study has shown adverse health effects at exposure levels below international guideline limits."

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Appendix C: Examples of Recent Publications on Radiofrequency Health Effects:

Adair ER, Mylacraine KS, Cobb BL. 2001. Human exposure to 2450 MHz CW energy at levels outside the IEEE C95.1 standard does not increase core temperature. *Bioelectromagnetics*. 22:429-39.

Dreyer NA, Loughlin JE, Rothman KJ. 1999. Cause-specific mortality in cellular telephone users. *JAMA* 282:1814-1816.

Ellwood, J.M. 1999. A critical review of epidemiologic studies of radiofrequency exposure and human cancers. *Environmental Health Perspectives* 107:155-168.

Frei MR, Jauchem JR, Dusch SJ, Merritt JH, Berger RE, and Stedham MA. 1998. Chronic, low-level exposure of mice prone to mammary cancer to 2450 MHz microwaves. *Rad. Res.* 150:568-576.

Frumkin H, *et al*. 2001. Cellular phones and risk of brain tumors. *CA Cancer J Clin.* 51(2):137-41.

Imaida K, Taki M, Watanabe S, Kamimura Y, Ito T, Yamaguchi T, Ito N, Shirai T. 1998. The 1.5 GHz electromagnetic near-field used for cellular phones does not promote rat liver carcinogenesis in a medium-term liver bioassay. *Japan Journal Cancer Research* 89:995-1002.

Inskip PD, Tarone RE, Hatch EE, *et al.* 2001. Cellular-telephone use and brain tumors. *New England Journal of Medicine*. 344:79-86.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). 1998. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields. *Health Physics* 74:494-522.

Johansen C, Boice JD, McLaughlin JK, Olsen JO. 2001. Cellular telephones and cancer – a nationwide cohort study in Denmark. *Journal of the National Cancer Institute.* 93:203-207.

Malyapa RS, Ahern EW, Straube WL, Moros EG, Pickard WF, Roti Roti JL. 1997. Measurement of DNA damage after exposure to electromagnetic radiation in the cellular phone communication frequency band. *Radiation Research* 148:618-627.

Morgan RW, Kelsh MA, KeZhao K, *et al.* 2000. Radiofrequency exposure and mortality from cancer of the brain and lymphatic/hematopoietic systems. *Epidemiology* 11:118-127.

Moulder JE, Erdreich LS, Malyapa RS, Merritt J, Pickard WF, Vijayalaxmi. 1999. Cell phones and cancer: What is the evidence for a connection? *Radiation Research* 151:513-531.

Muscat JE, Malkin MG, Thompson S, Shore RE, Stellman SD, McRee D, Neugut AI, Wynder EI. 2000. Handheld cellular telephone use and risk of brain cancer. *JAMA* 284:3001-3007.

Rothman KJ, Loughlin JE, Funch DP, Dreyer NA. 1996. Overall mortality of cellular telephone customers. *Epidemiology* 7:303-305.

Trichopoulos D, Adami HO. 2001. Cellular telephones and brain tumors. *New England Journal of Medicine*. 344:133-134.

Vijayalaxmi, Leal BZ, Szilagyi M, Prihoda TJ, Meltz ML. 2000. Primary DNA damage in human blood lymphocytes exposed in vitro to 2450 MHz radiofrequency radiation. *Radiat Res* 153(4):479-86.

Figure 1: The electromagnetic spectrum: wavelength, frequency, and energy

ELF	**AM Radio**	**FM / TV**	**Microwaves, Radar**	**Radiant Heating, Infrared**	**Sun Lamps, Visible Light**	**Medical X-Rays**	**Gamma Rays from Radio-activity**
1000 km **100 Hz** 10^{-12} eV	1 km **100 kHz** 10^{-9} eV	1 m **100 MHz** 10^{-6} eV	1 mm **100 GHz** 10^{-3} eV	10 μm **10^{13} Hz** 10^{-2} eV	100 nm **10^{15} Hz** 1 eV	1 Å **10^{18} Hz** 1 keV	0.1 pm **10^{21} Hz** 1 MeV
◆	◆	◆		◆	◆		
Power Lines	AM Radio	Cell Phones		Human body heat	Vision		
				← ← ←	Nonionizing ←	→ Ionizing	→ → →
(Induced	*Currents;*	*Induced*	*Currents)*	*(photo –*	*Chemistry)*	*(molecular,*	*DNA damage)*

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Figure 2: AM Radio is Not Equivalent to Cellular Telephones

	AM Radio	Cellular PCS
Broadcast Frequency	~ 1 MHz	~ 2,000 MHz
Wavelength	~ 600 feet	~ ½ foot
Years Technology Has Been Used	~ 85 years	~ 5 years
Modulation	Analog	Digital
Proximity of Transmitting Antennas	100's of feet	less than an inch

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Figure 3: Biological Effects of Photons for Different Types of Electromagnetic Radiation

Soft X-ray	10,000 eV	Ionize molecules
Visible Light	1.5 to 3.3 eV	Bend molecules
Thermal Energy of Atoms	0.03 eV	Dis-aggregate clusters
Millimeter Radar	0.0001 eV	Vibrate molecules
AM Radio, TV, FM	0.000004 eV	?

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Figure 4: Maximum RF Levels After Proposed Antenna Upgrade

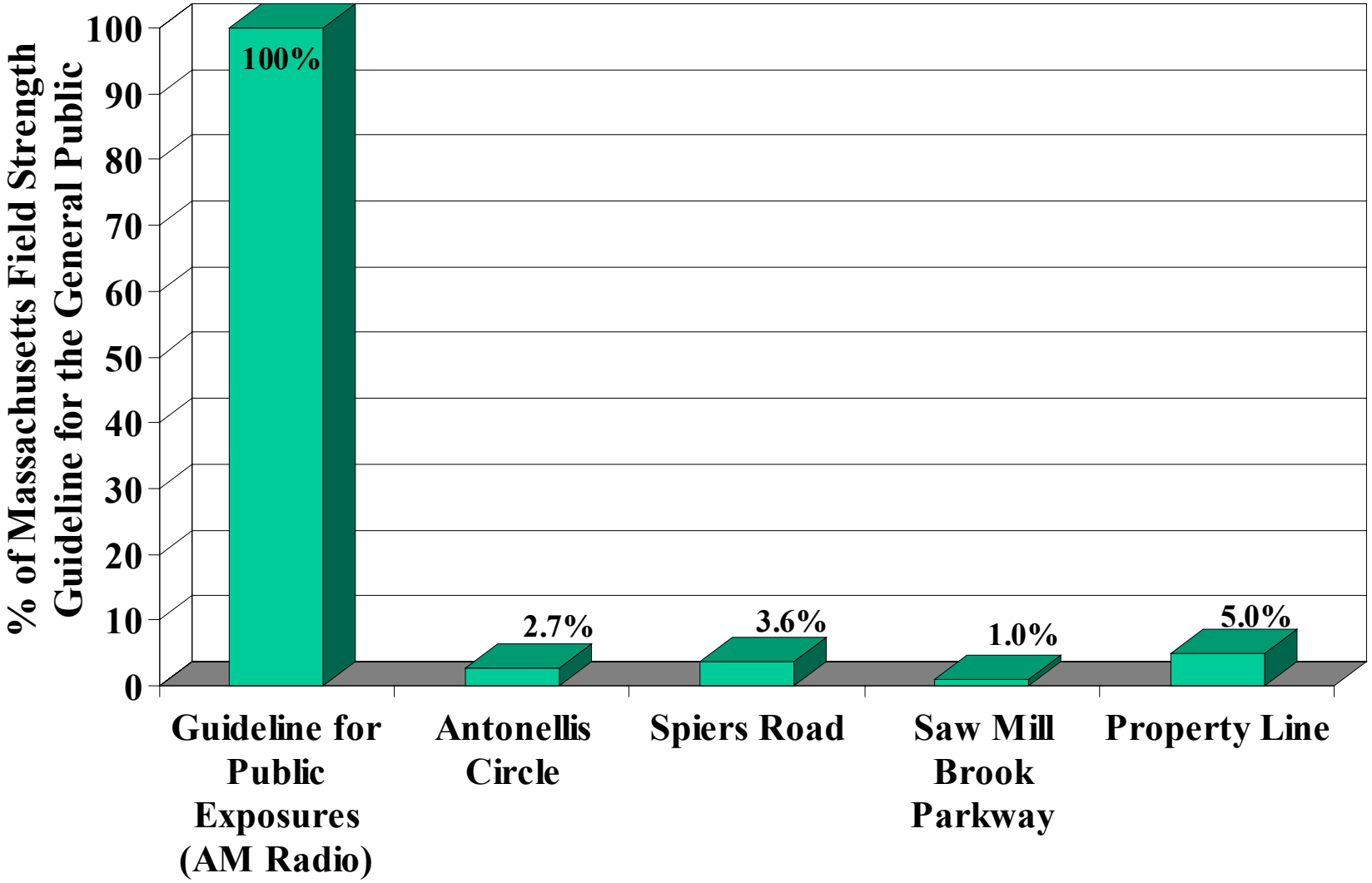

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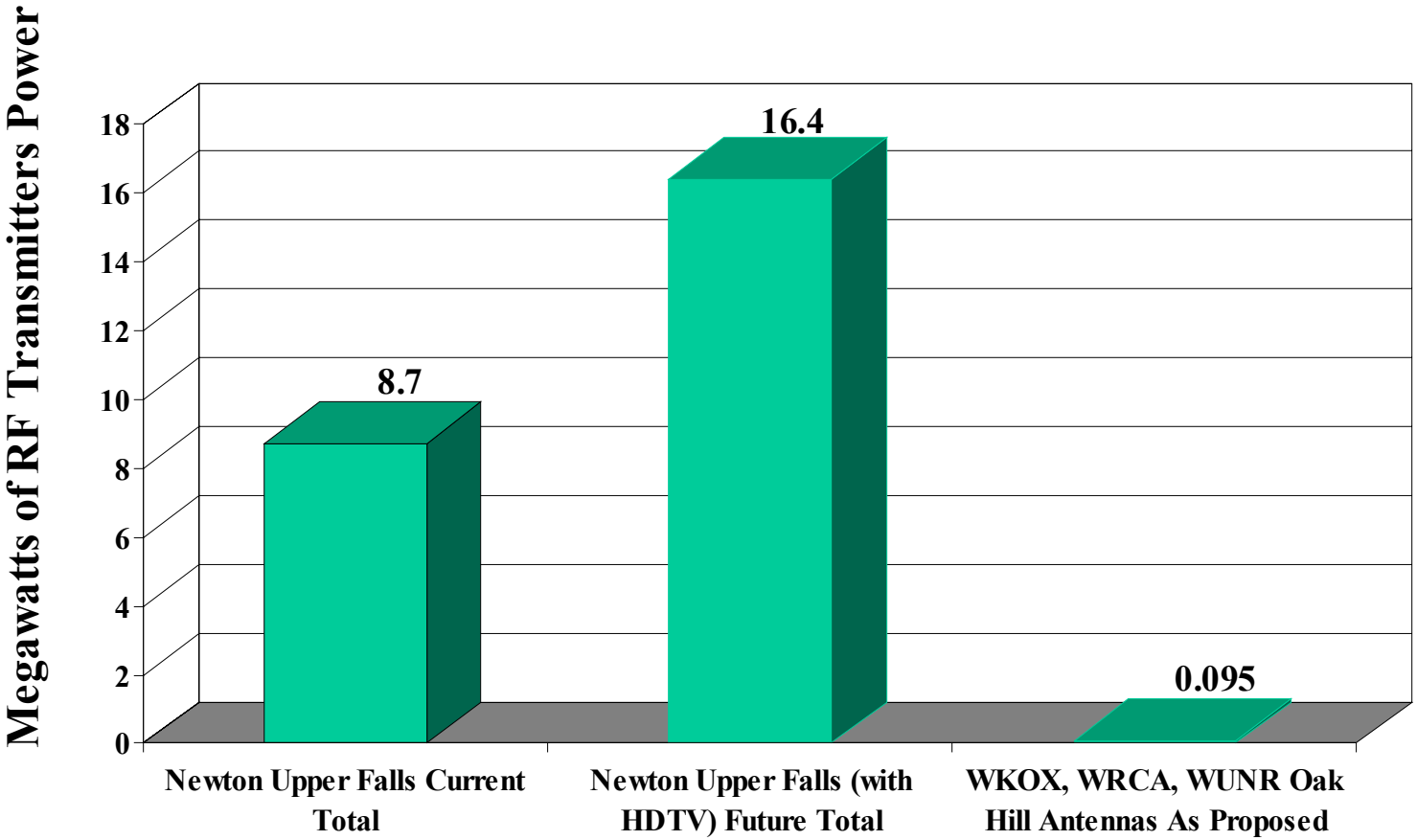
Figure 5: Radiowave Power from Oak Hill AM Antennas *versus* Newton Upper Falls FM/TV Antennas



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ELECTROMAGNETIC FIELD CALCULATIONS

FOR PROPOSED FACILITIES

AT THE WUNR(AM) TRANSMITTER SITE

NEWTON, MA

Prepared on behalf of

WKOX(AM), 1200 kHz, WRCA(AM), 1330 kHz
& WUNR(AM)1600 kHz

31 January 2002

INTRODUCTION

The purpose of this report is to provide calculations of the radio frequency (RF) fields exposure conditions from the proposed facilities of Medium Wave (MW) radio stations WKOX(AM), 1200 kHz, WRCA(AM), 1330 kHz and WUNR(AM),1600 kHz. These stations propose to co-locate their facilities on a new five tower antenna array to be located on Saw Mill Brook Parkway in Newton, MA. These facilities will replace the existing facility of WUNR at this site. The following table is a summary of the proposed facilities. A more detailed description of the antenna patterns is included in the Appendix

Station	Frequency	Daytime Power Number of Towers Used	Nighttime Power Number of Towers Used
WKOX	1200 kHz	50 kW - 3 Towers	50 kW - 3 Towers
WRCA	1330 kHz	25 kW - 5 Towers	17 kW - 4 Towers
WUNR	1600 kHz	20 kW - 5 Towers	20 kW - 5 Towers

FCC EXPOSURE GUIDELINES

The FCC Maximum Permissible Exposure (MPE) for radiofrequency fields, outlined in *47 C.F.R §1.1310 Radiofrequency radiation exposure limits,* was developed as a result of the 1996 Telecommunications Act. Congress required the Federal Communications Commission (FCC) to adopt guidelines and methods for evaluating the environmental effects of radiofrequency exposure. The FCC based these guidelines on the RF safety standards developed by the Institute of Electrical and Electronics Engineers (IEEE), which were adopted by the American National Standards Institute (ANSI), and those standards of the National Council on Radiation Protection and Measurements (NCRP). Specifically, the Standards are contained in the reports *Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz* ANSI/IEEE C95.1-1992, and *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, NCRP Report No. 86, 1986. The FCC rulemaking process invited recommendations in the form of comments from the public and other interested parties. These parties included governmental

agencies such as the U.S. Environmental Protection Agency (EPA), National Institute for Occupational Safety and Health (NOSH), individual researchers, and institutions and industrial interests. The FCC guidelines in essence are comprised of the more restrictive aspects of both the ANSI/IEEE and NCRP recommendations.

The IEEE developed their exposure standard by following a rigorous scientific process. The IEEE committees are made up of volunteers from government , research and industry who serve without compensation. The C95.1-1992 standard represents a consensus of the broad expertise of those committee members. The members of the committee reviewed all available scientific research literature on this subject. The literature showing radiofrequency exposure risks to humans was reviewed for engineering, biological and statistical validity. The evaluation of the literature identified an exposure threshold for unfavorable biological effects in humans. A safety factor of 10 was applied to this exposure threshold for workers, and an additional safety factor of 5 was applied for general public.

The NCRP is a nonprofit corporation chartered by Congress to collect, analyze, develop and disseminate information and recommendation on exposure to both ionizing and non-ionizing radiation. The NCRP also based its recommendations on a review of the scientific literature for exposure to humans.

The Maximum Permissible Exposure (MPE) limits for the General Population[1] for the MW frequencies to be used by these stations are:

Frequency	Electric Field (V/m)	Magnetic Field (A/m)	Power Density (mW/cm^2)
0.300 MHz - 1.340 MHz	614	1.63	100
1.340 MHz - 30 MHz	824/f	2.19/f	900/f
Where f is frequency in MHz			

[1]Uncontrolled Exposure, as outlined in *47 C.F.R §1.1310 Radiofrequency radiation exposure limits*

For the stations to be located at this site, the MPE are:

Station - Frequency	Electric Field (V/m)	Magnetic Field (A/m)	Power Density (mW/cm^2)
WKOX(AM), 1200 kHz	614	1.63	100
WRCA(AM), 1330 kHz	614	1.63	100
WUNR(AM),1600 kHz	515	1.35	70.3

CALCULATION PROCEDURES

The calculation in this report were performed using the methods outlined in OET BULLETIN 65, (EDITION 97-01), "Evaluating Compliance With FCC-Specified Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields",*ANSI/IEEE Std C95.1-1991, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, and NCRP Report No. 119, *"A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields"*.

Specifically, the fields were calculated using the moment method model *Expert MININEC Broadcast Professional for Windows Version 4.0.*[2] The moment method model[3] expands the use of basic electromagnetic physics principles to solve complex "real world" problems. The *Expert MININEC Broadcast Professional* program is specifically adapted for calculating the various fields and other parameters associated with MW broadcast antenna arrays.[4]

This model was used to calculate the contour around the each tower where the fields are above the FCC General Population/Uncontrolled Exposure MPEs, and to calculate the fields at nearby houses

[2] Published by EM Scientific, Inc. Carson City, Nevada, J.W. Rockway and J.C. Logan

[3]Harrington, Roger F. *Field Computations by Moment Methods*, IEEE Press, Piscataway, NJ,1992.

[4]Hatfield, James, B,, *"Computer Simulation of AM Radio Antenna Systems", NAB Engineering Handbook, 9th Edition*, 1999, Page 719.

and at the outer perimeter fence that is nearest to each tower. The fields contributed from each station were summed using the following formulae:

for Electric Field $$\sum_{i=1}^{n} \frac{E_i^2}{MPE_i^2} \leq 1$$

for Magnetic Field[5] : $$\sum_{i=1}^{n} \frac{H_i^2}{MPE_i^2} \leq 1$$

In multiple transmitter sites the summation of the individual contributions to the RF exposure environment is based on power density.[6] For frequencies below 30 MHz the exposure is given in terms of Electric Field (E field in V/m) and Magnetic Field (H field in A/m) and Power Density (mW/cm^2). This is because of nearfield effects of antennas where the E field and the H field are not necessarily related by the impedance of free space (377 Ohms). The above equations are the simplified summation of RF power density. The result of the frequency-weighted power density summation is expressed as a ratio of the MPE.

RESULTS

The calculations show that co-location of WKOX, WRCA and WUNR at this site will comply with FCC requirements. The towers on this site will be fenced to restrict access to all areas that are in excess of the MPE as is required by the FCC. The worst case distance is 5.5 meters from the north central (Labeled NC) tower. Appropriate warning signs that comply with the requirements of

[5] IEEE Standards Committee 28, *ANSI/IEEE Std C95.1-1991, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, IEEE, New York, NY 1999, Annex D

[6] FCC, OET BULLETIN 65, (EDITION 97-01), Evaluation Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields., 1997, Pages37-38

OST65 will be posted at all restricted areas. The off-site locations are well within the FCC guidelines for human exposure.

STATEMENT OF ENGINEER

This Engineering Report, regarding radio frequency field calculations around the WUNR Transmitter Facility on Saw Mill Brook Parkway in Newton MA, has been prepared by me or under my direct supervision. All representations contained herein are true to the best of my knowledge. I am an experienced radio engineer whose qualifications are a matter of record with the Federal Communications Commission. I am a partner in the firm of Hatfield and Dawson Consulting Engineers and am Registered as a Professional Engineer in the States of Washington and Alaska.

Stephen S. Lockwood, P.E.

31 January 2002

Appendix

DISTANCES AND BEARINGS FROM REFERENCE TOWER (NW) TO SURROUNDING RESIDENCES

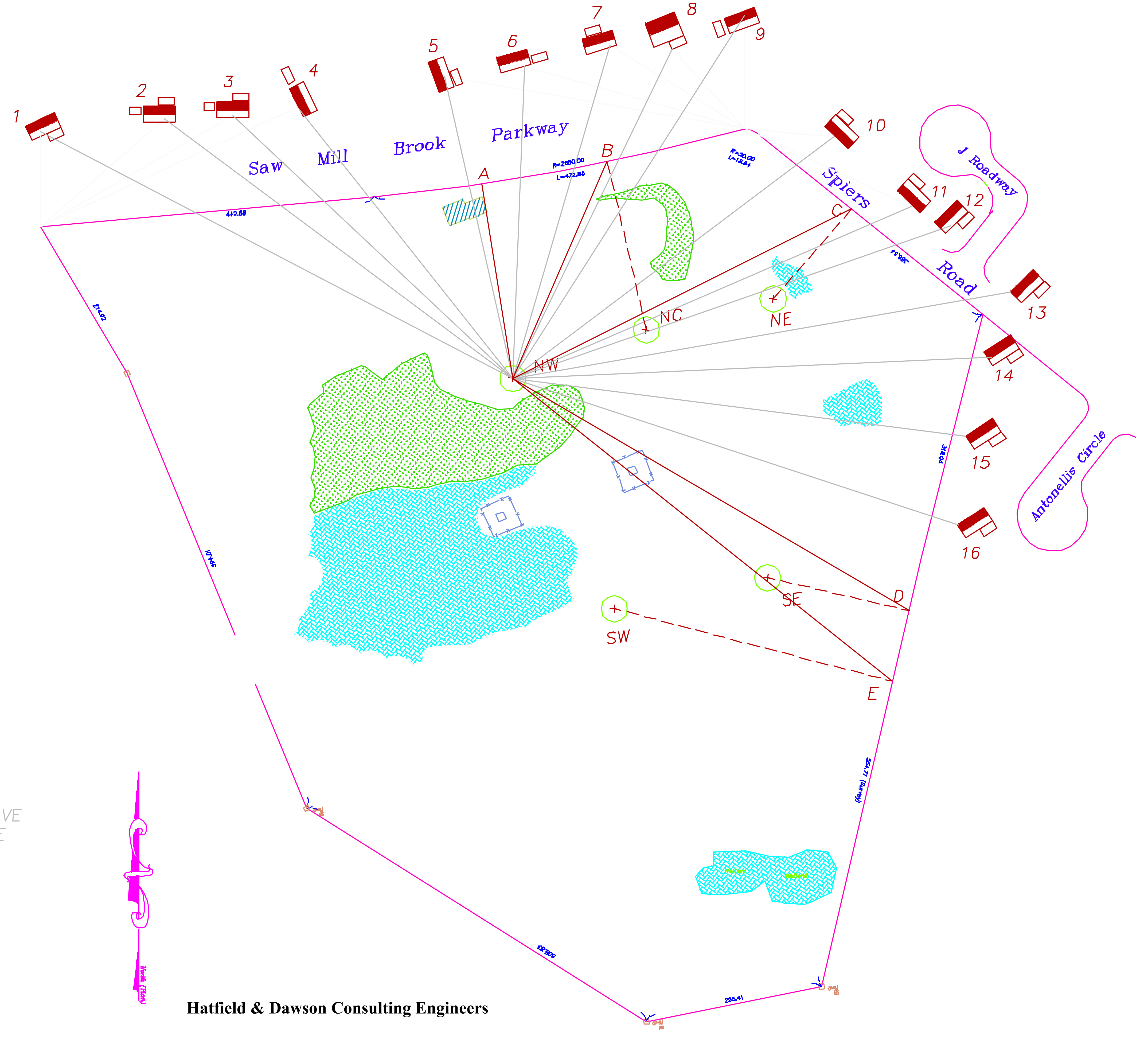
HOUSE	DISTANCE IN meters	BEARING DEGREES TRUE
1	205	280°
2	167	307°
3	148	313°
4	133	321°
5	119	347°
6	120	002°
7	134	016°
8	141	025°
9	166	032°
10	154	052°
11	167	066°
12	178	070°
13	194	080°
14	184	087°
15	176	097°
16	180	108°

DISTANCES AND BEARINGS FROM NW TOWER (REFERENCE) TO EACH OF THE FIVE POINTS CLOSEST TO ARRAY

CLOSEST POINT TO ARRAY	DISTANCE IN meters	BEARING DEGREES TRUE
NW–A	76	351°
NW–B	91	024°
NW–C	146	063°
NW–D	177	120°
NW–E	187	129°

DISTANCES AND BEARINGS FROM EACH OF THE FIVE TOWERS TO NEAREST PROPERTY BOUNDARY LINE

TOWER	DISTANCE IN meters	BEARING DEGREES TRUE
NW	76	351°
NC	66	347°
NE	46	041°
SW	56	104°
SE	111	105°



Hatfield & Dawson Consulting Engineers

17-Jan-02

Residential **Electric** fields in the vicinity of Saw Mill Brook Parkway
Newton, Massachusetts

Ground loss due to Earth's conductivity has been ignored.

	DAYTIME				NIGHTTIME			
HOUSE	WKOX V/m	WRCA V/m	WUNR V/m	%STD	WKOX V/m	WRCA V/m	WUNR V/m	%STD
1	1.967	0.632	0.519	0.001	0.389	0.888	0.519	0.000
2	3.673	1.171	1.085	0.004	1.973	0.656	1.085	0.002
3	4.745	1.363	1.466	0.007	2.676	0.636	1.466	0.003
4	6.384	1.622	1.984	0.013	3.682	0.684	1.984	0.005
5	12.513	2.990	3.355	0.048	7.280	1.987	3.355	0.019
6	15.697	4.507	4.188	0.077	9.916	3.748	4.188	0.036
7	18.399	6.450	6.124	0.115	12.942	6.440	6.124	0.070
8	19.838	8.171	8.522	0.149	15.966	8.819	8.522	0.116
9	18.948	9.043	10.266	0.157	17.908	10.431	10.266	0.154
10	24.520	15.665	17.506	0.340	27.942	17.096	17.506	0.400
11	24.828	19.693	20.022	0.418	30.836	18.844	20.022	0.498
12	23.622	20.000	19.559	0.398	29.598	17.936	19.559	0.462
13	21.525	20.892	19.564	0.383	26.866	16.372	19.564	0.407
14	21.868	22.732	21.254	0.434	26.866	16.829	21.254	0.437
15	20.967	22.911	21.153	0.425	24.459	15.985	21.153	0.395
16	18.241	18.764	16.516	0.285	19.586	13.289	16.516	0.251
FENCE								
NW	16.653	4.291	5.247	0.089	10.724	3.324	5.247	0.044
NC	26.019	9.022	8.391	0.228	17.891	8.367	8.391	0.130
NE	27.532	20.654	22.342	0.502	33.261	20.998	22.342	0.599
SW	15.790	14.145	9.914	0.156	14.733	10.152	9.914	0.122
SE	13.191	10.262	5.180	0.084	11.031	7.317	5.180	0.057

House and Fence Locations are show on enclosed drawing.

17-Jan-02

Residential **Magnetic** fields in the vicinity of Saw Mill Brook Parkway
Newton, Massachusetts

Ground loss due to Earth's conductivity has been ignored.

	DAYTIME				NIGHTTIME			
HOUSE	WKOX A/m	WRCA A/m	WUNR A/m	%STD	WKOX A/m	WRCA A/m	WUNR A/m	%STD
1	0.006	0.002	0.001	0.002	0.002	0.002	0.001	0.000
2	0.011	0.003	0.003	0.005	0.005	0.002	0.003	0.002
3	0.014	0.004	0.004	0.009	0.008	0.002	0.004	0.003
4	0.019	0.004	0.005	0.016	0.011	0.003	0.005	0.006
5	0.037	0.009	0.010	0.060	0.024	0.008	0.010	0.029
6	0.048	0.014	0.015	0.106	0.035	0.014	0.015	0.065
7	0.056	0.019	0.020	0.153	0.044	0.021	0.020	0.111
8	0.061	0.024	0.025	0.195	0.051	0.027	0.025	0.159
9	0.056	0.026	0.029	0.188	0.053	0.030	0.029	0.184
10	0.074	0.047	0.052	0.434	0.087	0.052	0.052	0.531
11	0.074	0.058	0.060	0.525	0.098	0.059	0.060	0.685
12	0.069	0.057	0.058	0.481	0.091	0.055	0.058	0.605
13	0.062	0.057	0.055	0.428	0.080	0.048	0.055	0.489
14	0.063	0.061	0.058	0.469	0.080	0.050	0.058	0.515
15	0.061	0.060	0.056	0.443	0.072	0.046	0.056	0.442
16	0.052	0.053	0.044	0.311	0.056	0.037	0.044	0.273
FENCE								
NW	0.056	0.016	0.016	0.141	0.039	0.014	0.016	0.078
NC	0.096	0.033	0.036	0.457	0.081	0.037	0.036	0.368
NE	0.084	0.065	0.070	0.686	0.114	0.070	0.070	0.935
SW	0.045	0.051	0.028	0.216	0.042	0.028	0.028	0.138
SE	0.037	0.038	0.017	0.121	0.032	0.020	0.017	0.069

House and Fence Locations are show on enclosed drawing.

Newton Mass AM Transmitter Site NIER Calculations- Final Design Jan 02

PUBLIC STANDARD SAFETY LIMITS (FCC 47 CFR §1.1310 Radiofrequency Radiation Exposure Limits)

Points are clockwise from true north from each tower base

	NORTH WEST TOWER					NORTH CENTRAL TOWER				
	DAYTIME		NIGHTTIME			DAYTIME		NIGHTTIME		
ANGLE	ELECT.	MAG.	ELECT.	MAG	MAX	ELECT.	MAG.	ELECT.	MAG	MAX
DEGREES	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS
0	1.5	3.0	1.0	3.0	3.0	2.0	4.5	2.0	5.0	5.0
10	1.5	3.0	1.0	3.0	3.0	2.0	4.5	2.0	5.0	5.0
20	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.0	5.0
30	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
40	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
50	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
60	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
70	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
80	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
90	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
100	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
110	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
120	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
130	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.0	5.0
140	1.5	3.0	1.0	3.0	3.0	2.0	5.0	2.0	5.5	5.5
150	1.5	3.0	1.0	3.0	3.0	2.0	4.5	2.0	5.5	5.5
160	1.5	3.0	1.0	2.5	3.0	2.0	4.5	2.0	5.5	5.5
170	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
180	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
190	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
200	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
210	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
220	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
230	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
240	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
250	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
260	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
270	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
280	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
290	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
300	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
310	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
320	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
330	1.5	2.5	1.0	2.5	2.5	2.0	4.5	2.0	5.5	5.5
340	1.5	3.0	1.0	2.5	3.0	2.0	4.5	2.0	5.5	5.5
350	1.5	3.0	1.0	3.0	3.0	2.0	4.5	2.0	5.5	5.5

Newton Mass AM Transmitter Site NIER Calculations- Final Design Jan 02

General Population/Uncontrolled Exposure (FCC 47 CFR §1.1310 Radiofrequency Radiation Exposure Limits)

Points are clockwise from true north from each tower base

	NORTH EAST TOWER					SOUTH WEST TOWER					SOUTH EAST TOWER		
	DAYTIME		NIGHTTIME			DAYTIME		NIGHTTIME			DAYTIME		
ANGLE	ELECT.	MAG.	ELECT.	MAG	MAX	ELECT.	MAG.	ELECT.	MAG	MAX	ELECT.	MAG.	MAX
DEGREES	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS	METERS
0	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
10	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
20	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
30	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
40	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
50	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
60	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
70	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
80	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
90	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
100	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
110	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
120	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
130	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
140	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
150	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
160	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
170	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
180	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
190	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
200	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
210	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
220	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
230	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
240	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
250	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
260	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
270	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
280	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
290	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
300	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
310	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
320	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
330	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
340	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5
350	2.5	2.0	3.0	4.0	4.0	1.0	1.5	1.0	1.0	1.5	1.0	1.5	1.5

1200	Distance	Bearing	
NW	0.0	0.0	85.6
NC	78.8	70.0	85.6
NE	151.0	73.0	85.6
SW	139.4	156.3	85.6
SE	179.2	128.1	85.6

Tower Locations

0	0	85.6
78.8	70	85.6
151	73	85.6
139.4	156.3	85.6
179.2	128.1	85.6

1330	Distance	Bearing	
NW	0.0	0.0	94.9
NC	87.3	70.0	94.9
NE	167.3	73.0	94.9
SW	154.5	156.3	94.9
SE	198.6	128.1	94.9

0	0	94.9
87.3	70	94.9
167.3	73	94.9
154.5	156.3	94.9
198.6	128.1	94.9

1600	Distance	Bearing	
NW	0.0	0.0	114.2
NC	105.0	70.0	114.2
NE	201.3	73.0	114.2
SW	185.9	156.3	114.2
SE	238.9	128.1	114.2

0	0	114.2
105	70	114.2
201.3	73	114.2
185.9	156.3	114.2
238.9	128.1	114.2

Distance Between Towers
Electrical Degrees

1200	Tower 1	Tower 2	Tower 3	Tower 4	Tower 5
NW	0.0	78.8	151.0	139.4	179.2
NC	78.8	0.0	72.5	155.6	153.0
NE	151.0	72.5	0.0	193.2	154.7
SW	139.4	155.6	193.2	0.0	86.7
SE	179.2	153.0	154.7	86.7	0.0

1330	Tower 1	Tower 2	Tower 3	Tower 4	Tower 5
NW	0.0	87.3	167.3	154.5	198.6
NC	87.3	0.0	80.3	172.5	169.5
NE	167.3	80.3	0.0	214.1	171.5
SW	154.5	172.5	214.1	0.0	96.1
SE	198.6	169.5	171.5	96.1	0.0

1600	Tower 1	Tower 2	Tower 3	Tower 4	Tower 5
NW	0.0	105.0	201.3	185.9	238.9
NC	105.0	0.0	96.6	207.5	203.9
NE	201.3	96.6	0.0	257.6	206.3
SW	185.9	207.5	257.6	0.0	115.6
SE	238.9	203.9	206.3	115.6	0.0

Meters	Tower 1	Tower 2	Tower 3	Tower 4	Tower 5
NW	0.0	54.6	104.8	96.7	124.4
NC	54.6	0.0	50.3	108.0	106.1
NE	104.8	50.3	0.0	134.1	107.4
SW	96.7	108.0	134.1	0.0	60.2
SE	124.4	106.1	107.4	60.2	0.0

Feet	Tower 1	Tower 2	Tower 3	Tower 4	Tower 5
NW	0.0	179.3	343.7	317.4	408.0
NC	179.3	0.0	165.0	354.3	348.3
NE	343.7	165.0	0.0	439.8	352.3
SW	317.4	354.3	439.8	0.0	197.3
SE	408.0	348.3	352.3	197.3	0.0

195 foot radiator

Wave Length				
1200	kHz	3E+08	249.8	meters
			819.6	feet
1330	kHz	3E+08	225.4	meters
			739.5	feet
1600	kHz	3E+08	187.4	meters
			614.7	feet

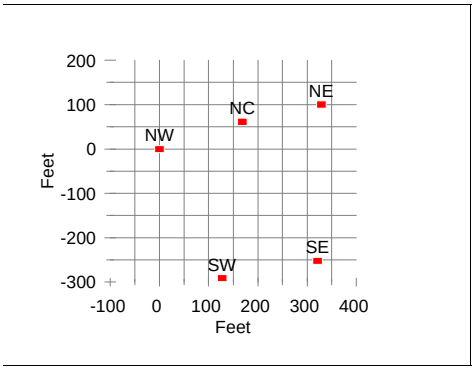
Proposed Daytime
WKOX FRAMINGHAM, MA
1200 kHz 3E+08 249.8 meters
50 kW RMS 2345.5 mV/m@1km

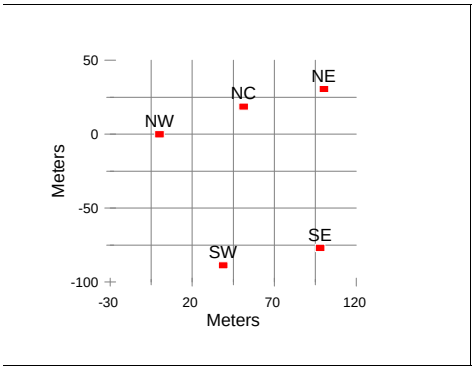
Tower	Field	Phase	Distance	Bearing	Height
NW	0.550	120.0	0.0	0.0	85.6
NC	1.000	0.0	78.8	70.0	85.6
NE	0.200	-150.0	151.0	73.0	85.6
SW	0.000	0.0	139.4	156.3	85.6
SE	0.000	0.0	179.2	128.1	85.6

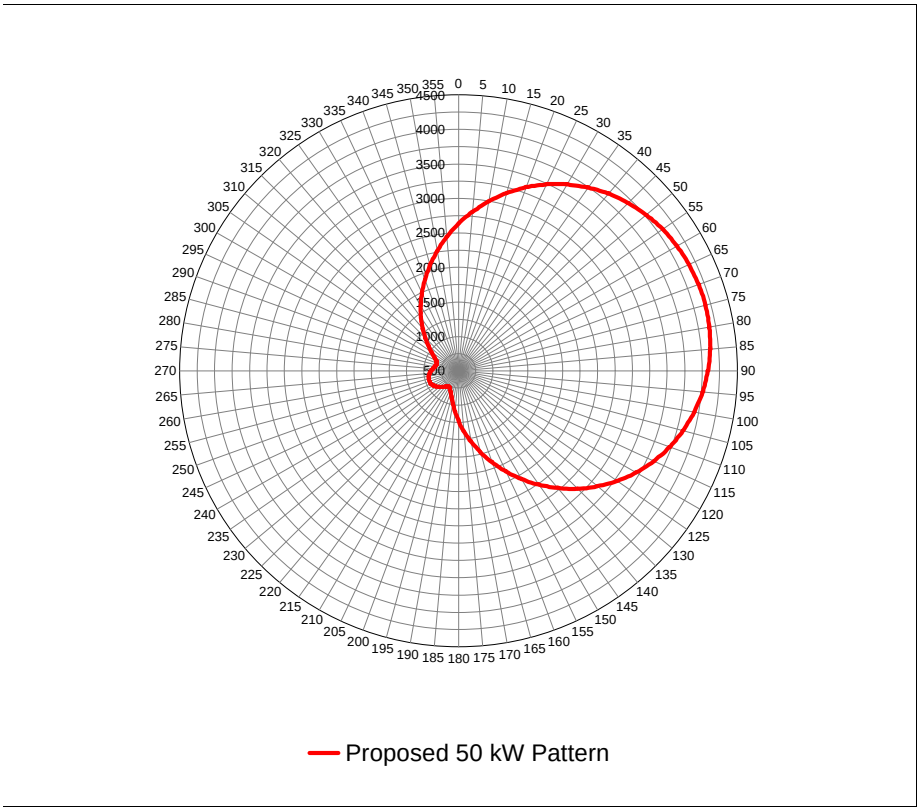
Tower Placement

Tower	Degrees	
	x	y
NW	0.0	0.0
NC	74.0	27.0
NE	144.4	44.1
SW	56.0	-127.6
SE	141.0	-110.6

Tower	Meters		feet	
	x	y	x	y
NW	0.00	0.00	0.0	0.0
NC	51.39	18.70	168.6	61.4
NE	100.21	30.64	328.8	100.5
SW	38.88	-88.58	127.6	-290.6
SE	97.86	-76.73	321.1	-251.8







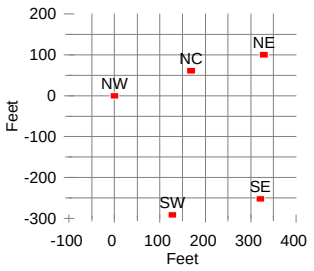
Proposed Nighttime
WKOX FRAMINGHAM, MA
1200 kHz 3E+08 249.8 meters
50 kW RMS 2401.9 mV/m@1km

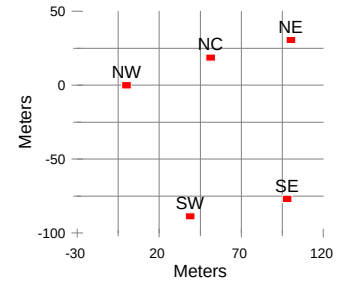
Tower	Field	Phase	Distance	Bearing	Height
NW	0.511	122.3	0.0	0.0	85.6
NC	1.000	0.0	78.8	70.0	85.6
NE	0.518	-129.5	151.0	73.0	85.6
SW	0.000	0.0	139.4	156.3	85.6
SE	0.000	0.0	179.2	128.1	85.6

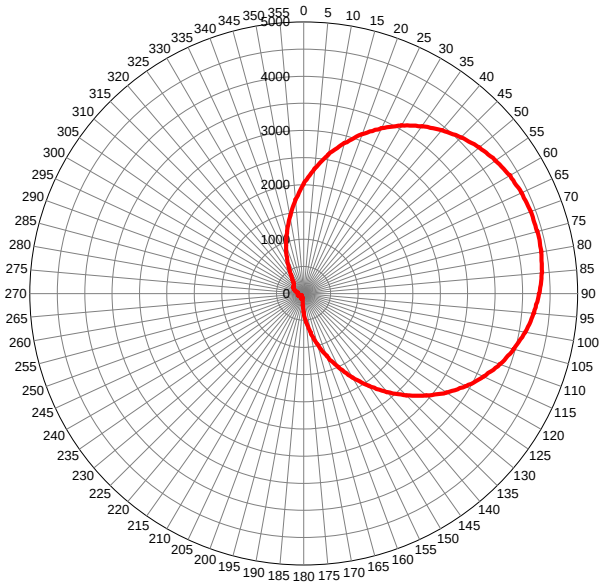
Tower Placement

Tower	Degrees	
	x	y
NW	0.0	0.0
NC	74.0	27.0
NE	144.4	44.1
SW	56.0	-127.6
SE	141.0	-110.6

Tower	Meters		feet	
	x	y	x	y
NW	0.00	0.00	0.0	0.0
NC	51.39	18.70	168.6	61.4
NE	100.21	30.64	328.8	100.5
SW	38.88	-88.58	127.6	-290.6
SE	97.86	-76.73	321.1	-251.8







Proposed 50 kW Pattern

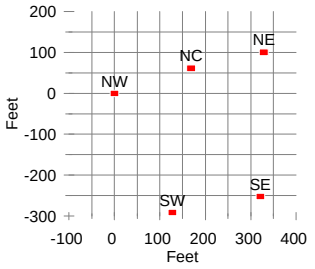
Proposed Daytime
WRCA WALTHAM, MA (Clark Array 3 July 2001)
1330 kHz 3E+08 225.4 meters
25 kW RMS 1502.1 mV/m@1km

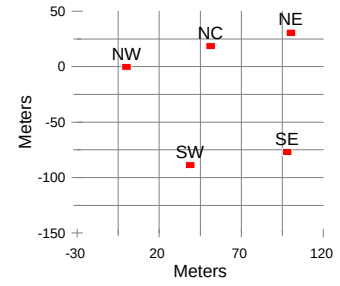
Tower	Field	Phase	Distance	Bearing	Height
NW	0.426	-266.1	0.0	0.0	94.9
NC	1.000	0.0	87.3	70.0	94.9
NE	0.451	-97.9	167.3	73.0	94.9
SW	0.713	-286.2	154.5	156.3	94.9
SE	0.776	-31.7	198.6	128.1	94.9

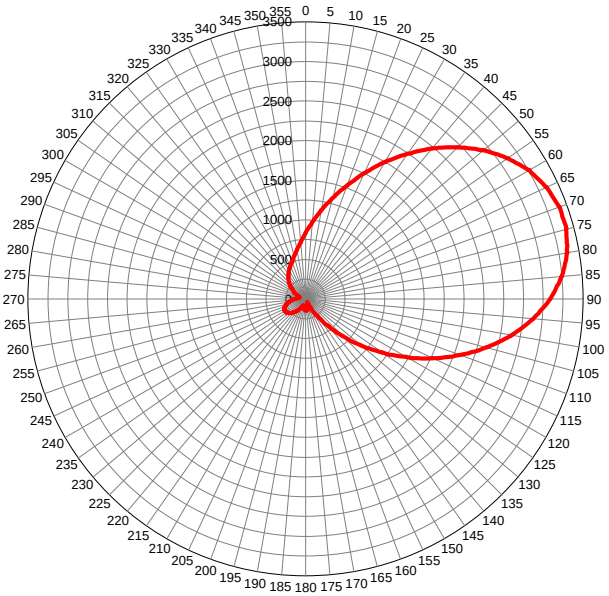
Tower Placement

Tower	Degrees	
	x	y
NW	0.0	0.0
NC	82.0	29.9
NE	160.0	48.9
SW	62.1	-141.5
SE	156.3	-122.5

Tower	Meters		feet	
	x	y	x	y
NW	0.00	0.00	0.0	0.0
NC	51.36	18.70	168.5	61.3
NE	100.17	30.63	328.7	100.5
SW	38.88	-88.58	127.6	-290.6
SE	97.86	-76.73	321.0	-251.7







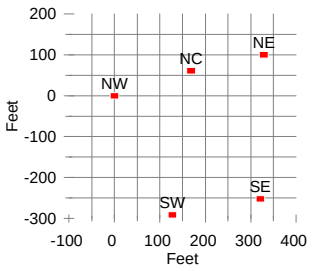
Proposed Nighttime
WRCA WALTHAM, MA (Revised Nov 2001)
1330 kHz 3E+08 225.4 meters
17 kW RMS 1411.5 mV/m@1km

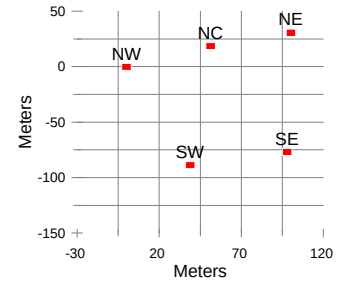
Tower	Field	Phase	Distance	Bearing	Height
NW	0.467	123.6	0.0	0.0	94.9
NC	1.000	0.0	87.3	70.0	94.9
NE	0.601	-117.2	167.3	73.0	94.9
SW	0.115	-25.6	154.5	156.3	94.9
SE	0.000	0.0	198.6	128.1	94.9

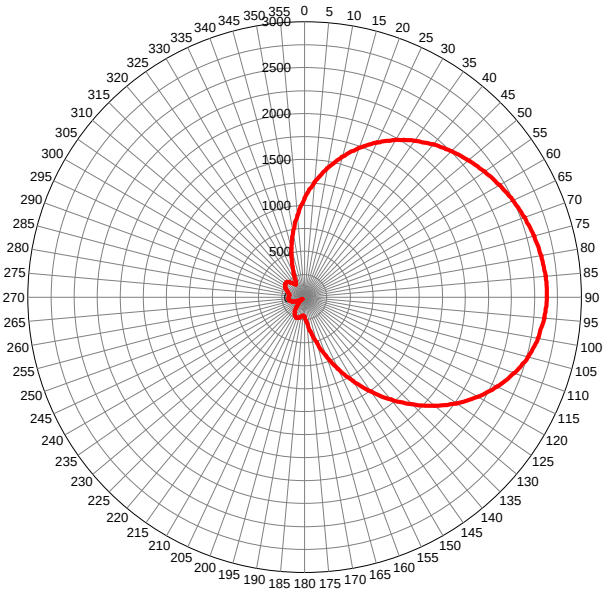
Tower Placement

Tower	Degrees	
	x	y
NW	0.0	0.0
NC	82.0	29.9
NE	160.0	48.9
SW	62.1	-141.5
SE	156.3	-122.5

Tower	Meters		feet	
	x	y	x	y
NW	0.00	0.00	0.0	0.0
NC	51.36	18.70	168.5	61.3
NE	100.17	30.63	328.7	100.5
SW	38.88	-88.58	127.6	-290.6
SE	97.86	-76.73	321.0	-251.7







Proposed Daytime & Nighttime
WUNR BOOKLINE, MA

1600	kHz	3E+08	187.4	meters
20	kW	RMS	1538.0	mV/m@1km

Tower	Field	Phase	Distance	Bearing	Height
NW	0.508	115.6	0.0	0.0	114.2
NC	1.000	0.0	105.0	70.0	114.2
NE	0.595	-117.0	201.3	73.0	114.2
SW	0.222	21.5	185.9	156.3	114.2
SE	0.218	-52.5	238.9	128.1	114.2

Tower Placement

Tower	Degrees	
	x	y
NW	0.0	0.0
NC	98.7	35.9
NE	192.5	58.9
SW	74.7	-170.2
SE	188.0	-147.4

Tower	Meters		feet	
	x	y	x	y
NW	0.00	0.00	0.0	0.0
NC	51.35	18.69	168.5	61.3
NE	100.19	30.63	328.7	100.5
SW	38.89	-88.60	127.6	-290.7
SE	97.85	-76.72	321.0	-251.7