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**The Impact Of Cellular Phone Base Station Towers On
Property Values**

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The Impact Of Cellular Phone Base Station Towers On Property Values

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Abstract: Studies show that devices that emit electromagnetic fields (EMFs) are no longer seen as a welcome sign of progress. Media attention to the potential health hazards of EMFs has caused changes in public perception. The introduction of cellular phone systems and a rapid increase in the number of users of cellular phones in the last decade has increased the exposure of the population to EMFs quite considerably. Health consequences of long-term use of cellular phones are not known in detail, but available data indicate that development of non-specific health symptoms is possible (Szmigielski & Sobiczewska, 2000). Conversely, it appears health effects from cellular phone equipment (antennas and base stations) pose few (if any) known health hazards (Barnes, 1999).

A concern associated with cellular phone usage is the siting of cellular phone transmitting antennas and their base stations (CPBSs). These are appearing at an alarming rate across the country mainly on the rooftops of buildings but with numerous base stations installed on towers. These towers are occasionally located in close proximity to houses and schools. The extent of opposition from property owners affected by the siting of these is increasing due to fears of health risks from exposure to EMFs (despite the research reports to the contrary), changes in neighbourhood aesthetics and loss in property values. However, the extent to which such attitudes are reflected in lower property values affected by proximity to CPBSs is not known in New Zealand.

This paper outlines the results of a pilot study carried out in 2002 to show the effect of CPBSs on residential property values in Auckland, New Zealand. The research examines residents' perceptions toward living near CPBSs and how they evaluate the impacts of these structures. A case study approach was used. The results were mixed with responses from residents ranging from having no concerns to being very concerned about proximity to a CPBS. Consequently, how these perceptions impact on property values was also mixed with responses from residents ranging from being prepared to pay the same to being prepared to pay more than twenty percent less for a property located near a CPBS. Interestingly, in general, those people living near the CPBSs were much less concerned about issues such as future health risks or the aesthetic problems caused by the sites than people who lived in areas further away from them. A more in-depth study to confirm these results is to follow in 2003 that will include econometric analysis of sales transaction data.

1. Introduction

Understanding the effects of CPBSs on property values is important to telecommunications companies in helping plan the siting of these and for determining likely opposition from property owners. Similarly, property valuers need to understand the valuation implications of CPBSs when valuing CPBSs-affected property. The owners of affected property also want to understand the magnitude of effects, particularly if compensation claims or an award for damages are to be made against such property.

CPBSs are increasingly in demand as the two major cellular phone companies, Telecom and Vodafone, seek to upgrade and extend their network coverage. This demand could provide the owner of a well-located property a yearly income for the siting of a CPBS (Williams, 2001). However, new technology that represents potential hazards to human health and safety may cause property values to diminish due to the existence of "widespread public fear" and "widespread public perceptions of hazards". The increased media attention to the potential health hazards of CPBSs has caused a spread of such fear with a resulting increase in resistance to CPBSs due to the perceived negative effects on health, aesthetics and property values in close proximity to CPBSs.

Studies (for example, Krause et al. 2000 and Fesenko et al. 1999) suggest a positive correlation between long-term exposure to the electromagnetic fields produced by CPBSs and certain types of cancer. Yet other studies (for example, the World Health Organisation 1993, Royal Society of Canada 1999, and the UK Independent Expert Group on Mobile Phones 2000) report inconclusive results on health effects. Notwithstanding these results, recent media reports (for example, Fox 2002) indicate that the extent of opposition from some property owners affected by the siting of CPBSs is still strong. However, the extent to which such attitudes are reflected in lower property values affected by CPBSs is not widely known in New Zealand.

The two studies that have been conducted (commissioned by Telecom in Auckland (1998/99) and Christchurch (2001)) to ascertain the adverse health and visual effects of CPBSs on property values but these have not been made publicly known. Further, although the researchers reported through personal correspondence with Bond in 2002 that the results showed that property prices are not statistically significantly affected by the presence of CPBSs, their research involved only limited sales data analysis. Further, no surveys of residents' perceptions were undertaken, nor of the media attention to the sites and the affect this may have on saleability of properties in close proximity to CPBSs. Hence, this initial study aims to help fill the research void on this contentious topic. The research develops a case study approach to determine residents' perceptions towards living near CPBSs in two Auckland neighbourhoods and to quantify these effects in monetary terms according to an increasing or decreasing percentage of property value.

A more in-depth study will be undertaken in 2003 in Christchurch, NZ using both an opinion survey and econometric analysis of sales transaction data. The final results can then be used to help resolve compensation issues and damage claims in a quantitative way. Further, they will provide a potential source of information for related government agencies in assessing the necessity for increasing health and other information pertaining to CPBSs to help allay public concerns about these.

The paper provides a brief review of the cellular phone technology and relevant literature. The following section describes the research procedure used, including a description of both case study and control areas. The results are then discussed. The final section provides a summary and conclusion.

2. Literature Review

2.1 Background: Cellular Telephone Technology¹

Increasing demand for a more convenient communication system has led to the emergence of the wireless (mobile) telephone technology through the allocation of a portion of the radio frequency

¹ The information in this section was sourced from <http://www.telecom.co.nz>, <http://www.mfe.govt.nz> and <http://www.moh.govt.nz>.

to this and through interconnection with the existing wire telephone network.

Mobile phones are sophisticated two-way radios that use ultra high frequency (UHF) radio waves to communicate information. The information is passed between a mobile phone and a network of low-powered transceivers, called mobile phone sites or cell sites. As mobile sites are very low powered they serve only a limited geographic area (or “cell”), varying from a few hundred metres to several kilometres, and can handle only a limited number of calls at one time. When a mobile phone user on the move leaves one “cell” and enters another, the next site automatically takes over the call, allowing contact to be maintained.

When a mobile phone connects to the network, it uses radio signals to communicate with the nearest mobile phone site. All of the mobile phone sites in a network are interlinked by cable or microwave beam, enabling phone calls to be passed from one cell to another automatically. Mobile phone sites are also linked to the public telephone network so callers can access other networks, cities or countries. A mobile phone site is typically made up of a mast with antennas connected to equipment stored in a cabinet. Power is fed into the cabinet by underground cable. The antennas are designed to transmit most of the signal away horizontally, or just below the horizontal, rather than at steep angles to the ground.

The actual use of radio frequency transmission requires only a small amount of energy, making mobile phone technology one of the most efficient forms of communication available. Unlike television and radio transmitters which work at full power all the time, a mobile phone site is designed to control its output so that it provides exactly the signal strength required to handle the number of calls being made at that moment, no more and no less. Therefore, if no calls are being made at any one moment, the cell site will virtually shut itself down.

As mobile phone sites can only accommodate a limited number of calls at any one time, when this limit is reached the mobile phone signal is transferred to the next nearest site. If this site is full or is too far away, the call will fail. One way of achieving an increased capacity is with the use of micro-sites or infill sites. These are mini mobile phone sites that can be mounted on street light poles, traffic lights or building verandas. They are common at busy intersections where they can help handle the increased capacity at rush hour and during the day they will rarely be required. Micro-sites only have a range of one to two hundred metres, and therefore cannot be used everywhere. They are designed for operation in dense urban areas in conjunction with conventional sites.

2.1.1 NZ Adoption of Cellular Phone Technology

The cellular telephone service first became available in New Zealand in 1987. By mid 1988 there were approximately 2,300 customers throughout New Zealand. In the late 1990's over 300,000 customers had cellular phones. This figure has continued to balloon in recent years. It is estimated that today over 2.3 million New Zealanders have a mobile phone and it is expected that 80 percent of people will be mobile within five years (Telecom, 2002)².

Cell site capacity is a major issue that the telecommunication companies are faced with at present. As the population continues to grow and so does the number of people using mobile phones, more and more cell sites are going to be required to meet customer demand for reliable coverage. In

² At the end of March 2002, Telecom had more than 1.3 million mobile phone customers and more than 750 mobile phone sites throughout New Zealand (a 54% share of the mobile market). Vodafone had over 1.1 million mobile phone customers throughout New Zealand (a 46% share of the mobile market), (Vodafone, 2002).

areas such as Auckland where almost complete coverage has been achieved, the main issue is ensuring that there is the capacity to handle the ever-increasing number of mobile phones and calls being made.

2.2 Locating Cellular Phone sites

Unlike higher-powered transmission sites such as television and radio, mobile phone sites are very low powered. Therefore, if cellular service companies are to provide a reliable service to their customers they are required to locate their sites where the service is needed.

For cellular phone service providers the main aims when locating cell sites are finding a site that provides the best possible coverage in the area without causing interference with other “cells” and one that causes the least amount of environmental impact on the surrounding area. Where possible service providers will attempt to locate cell sites on existing structures such as buildings where antennas can be mounted on the roof to minimize the environmental impact. Where this is not possible the site will require a mast to be erected to support the antennas.

For service providers, the preferred location for cell sites is in commercial or industrial areas due to the previous difficulty in obtaining resource consent for towers located in residential areas under the Resource Management Act.³ Under the Resource Management Act 1991 (RMA), resource consent may be required from the local council to establish a cell site in the area. This may be either notified or non-notified. If the council decides it is to be notified this allows anyone in the community to have their say about it. Once submissions have been received and a hearing is held (if required) the council decides whether or not to grant the consent. One of the positive outcomes of the RMA resource consent procedure is the resulting unobtrusive nature of most cell sites. Some sites have even been incorporated into clock towers, building’s chimneys and building signage.

There is no concern of the providers running out of room to locate the towers in the short term, however, it is expected that in the future, service providers will be required to share sites as they do overseas. If the service providers were to use the same mast they would have to be well separated meaning a much higher mast and a more undesirable structure in the community.

Despite the high level of demand for better cell phone coverage, the location of cell sites continues to be a contentious issue. The majority of people want better cell phone coverage in areas where they live and work, but they do not want a site in their neighbourhood. Thus, cell sites in or near residential areas are of particular concern. Concerns expressed usually relate to health, property values and visual impact (Szmigielski and Sobiczewska, 2000 and Barnes, 1999).

In general, uncertainties in the assessment of health risks from base stations is presented and distributed by organised groups of residents who protest against settlement of base stations. These reports appear to be exaggerated with a frequent tendency for including incredible extrapolation of results from microwave exposure systems which do not resemble either the intensities or the frequencies applied in the cell phone systems being tested. When the media publishes these stories it serves only to amplify the negative bias in these results and raises public concern. According to Covello (1998), this leads to incorrect assessment of risks and threats by the public with a tendency to overestimate risks from base stations and neglect risks from the use of cell phones.

³ This has now been amended and replaced with a much simpler consent process.

2.3 Assessment of Environmental Effects

2.3.1 Introduction: The Resource Management Act 1991

Under the Resource Management Act 1991 (RMA) an assessment of environmental effects is required every time an application for resource consent is made. Information that must be provided includes the following:

“An assessment of any actual or potential effects that the activity may have on the environment, and the ways in which any adverse effects may be mitigated”. (Section 88(4)(b), RMA).

An assessment of the environmental effects (AEE) of cell sites would take into consideration such things as:

- Health and Safety effects
- Visual effects
- Effects on the neighbourhood
- Interference with radio and television reception

2.3.2 Radio Frequency and Microwave Emissions from CPBSs

According to the Ministry for the Environment (2000), the factors that affect exposure to radiation are as follows.

- Distance: Increasing the distance from the emitting source, decreases the radiation's strength and decreases the exposure.
- Transmitter power: The stronger the transmitter, the higher the exposure.
- Directionality of the antenna: Increasing the amount of antennas pointing in a particular direction increases the transmitting power and increases the exposure.
- Height of the antenna above the ground: Increasing the height of an antenna increases the distance from the antenna and decreases the exposure.
- Local terrain: Increasing the intervening ridgelines decreases the exposure.

The amount of radiofrequency power absorbed in the body, the dose, is measured in watts per kilogram, known as Specific Absorption Rate (SAR). The SAR depends on the power density in watts per square metre. The radio frequencies (RF) from cellular phone systems travel in a “line of sight”. The antennas are designed to radiate energy horizontally so that only small amounts of RF are directed down to the ground. The greatest exposures are in front of the antenna so that near the base of these towers, exposure is at minimum. Further, power density from the transmitter decreases rapidly as one moves away from the antenna. However, it should be noted that by initially walking away from the base, the exposure rises and then decreases again. The initial increase in exposure corresponds to the point where the lobe from the antenna beam intersects the ground. For instance, on the ground within 7-10 meters from the cell site, power densities are about 0.2 W/m² while within 100 metres, power densities will be around 0.0003-0.005W/m² (Ministry for the Environment, 2000 and Szmigielski and Sobiczewska, 2000).

2.3.3 Adverse Health Effects

According to Barnes (1999) and Szmigielski and Sobiczewska (2000) the analog phone system (using 800-900 Megahertz band) and digital phone system (using 1850-1990 Megahertz band) expose humans to electromagnetic field (EMF) emissions: radio frequency radiation (RF) and microwave radiation (MW), respectively. These two radiations are emitted from both the cellular phones and CPBSs.

For years the cell phone companies have assured the public that cell phones are perfectly safe. They state that the particular set of radiation parameters associated with cell phones are the same

as any other radio signal. However, reported scientific evidence challenges this view and shows that cell phone radiation causes various effects, including:⁴

- Alters brain activity
- Disturbs sleep
- Alters human reaction times: responses and speed of switching attention significantly worse
- Weakness the blood brain barrier
- Increased auditory brainstem response and hearing deficiency in 2 KHZ to 10 KHZ range
- Causes significant changes in local temperature, and in physiologic parameters of the cardiovascular system
- Causes memory loss, connection difficulties, fatigue, and headaches
- Increases blood pressure
- Reduces melatonin, etc..

According to Cherry (2000), there is strong evidence to conclude that cell sites are risk factors for:

- Cancer, specifically brain tumours and leukaemia
- Heart attack and heart disease, particularly arrhythmia
- Neurological effects including sleep disturbance, learning difficulties, depression and suicide
- Reproductive effects, especially miscarriage and congenital malformation
- Viral and infectious diseases because of reduced immune system competency associated with reduced melatonin and altered calcium ion homeostasis.

The main health concerns relating to EMF emissions from CPBSs are caused by the fact that radio frequency fields penetrate exposed tissues. Radio frequency energy is absorbed in the body and produces heat. All established health effects of radio frequency exposure are clearly related to heating. Public concern regarding both cell phones and CPBSs in many countries has led to a number of independent expert groups being requested by governments and cellular service providers to carry out detailed reviews of the research literature.

Research on the health effects of exposures to RF are reviewed by, for instance, The New Zealand Radiation Laboratory (2001), the World Health Organization (1993), International Commission on Non-Ionizing Radiation Protection (ICNIRP) (1997,1998), the Royal Society of Canada (1999) and the UK Independent Expert Group on Mobile Phones (2000). The reviews conclude that there are no clearly established health effects under low levels of exposure. Such exposures typically occur in publicly accessible areas around RF transmitters.

Various epidemiological studies⁵ have been undertaken on the health effects of exposure to RF/MW radiation. However, most of these studies are conducted with occupational groups exposed to the radiation at work rather than with the general population in the home environment. The results of such studies provide insufficient evidence of the linkage between exposure and cancers in the general population due to the different intensities and duration of MW exposure in workers compared to those in the general public. The MW exposure in the home environment is typically continuous but not exceeding $0.1\text{W}/\text{m}^2$ while in the working environment, the duration is

⁴ Mann & Roschkle (1996), Krause et al. (2000), Borbely et al. (1999), Kellenyi et al. (1999), Khdnisskil, Moshkarev & Fomenko (1999), Hocking (1998), Burch et al. (1998) and others as reported in Cherry, N. (2000).

⁵ Epidemiological studies study the relationship between exposure to EMFs and health in a population through observation. It is employed to provide evidence of EMF's association with any diseases, statistically. However, these studies cannot control for the degree of exposure. In the real world there are multiple exposures (such as radiation from television and radio).

limited to 1-2 hours period but intensities range between 2-10W/m² (Szmigielski and Sobiczewska, 2000).

According to Barnes (1999), the Institute of Electrical and Electronics Engineers (IEEE) and the American Food and Drug Administration (FDA) found no health hazard associated to cell phone use. Laboratory studies revealed no related cancer symptoms in people exposed to levels at or below current standards (refer to the discussion on standards, below, in section 2.3.4). Furthermore, Szmigielski and Sobiczewska (2000) add that MW radiation from cell phone systems contribute only 10 percent of the total MW energy emitted from other sources such as TV and radio signals. They conclude similarly to Barnes (1999) that there is currently no valid scientific data providing evidence of bio-effects from weak MW emission. However, there are questions over the delayed effects of exposure.

The Royal Society of Canada (1999) reports that biological effects, such as cell proliferation, are found at low levels of exposure and depend on other exposure conditions, stated earlier, but are not known to cause any adverse health effects. Nonetheless, at high exposures, heating is produced and can eventually damage tissues. Szmigielski and Sobiczewska (2000) state that at intense exposure the “thermal effect” from MW energy absorption inside tissues is associated with DNA damage. Further, they add that other non-specific health symptoms (NSHS) such as headaches, fatigue and small changes in blood pressure are also found.

While, at present, medical and epidemiological studies reveal weak association between bio-effects and low-level exposures of RF/MW fields, controversy remains between scientists, producers and the general public. Information from scientific or technological experts must be provided to the public to help allay fears about cell phone systems and help them to make rational investment decisions when considering the purchase of a property located in proximity to a CPBS. However, risk communication (“the exchange of information about the nature, magnitude, significance, acceptability and management of risk”, Covello 1998) has always posed a challenge to the policy makers (usually politicians) responsible for communicating risk data to the general public. Risk communication usually involves the provision of information about the probability of exposure to the risk and about the nature and extent of the consequences. Yet, events of a probabilistic nature relating to an uncertain science are not well understood by the general public. This, together with negative media attention, results in the perception of uncertainty over the health effects from cell phone systems.

2.3.4 Radio Frequency Exposure Standards

2.3.4.1 International Standards

Despite ongoing controversy, the reviews of research on the health effects of exposures to RF helped establish the basis for exposure standards that will limit exposures to a level for safe and healthy living and working conditions. Most standards set by, for example, the International Commission on Non-Ionising Radiation Protection (ICNIRP), the American National Standards Institute (ANSI) and New Zealand are based on the most adverse effects. These standards have been developed to give people an assurance that what cellular service providers are doing complies with safety guidelines.

The 1998 ICNIRP guidelines have been accepted by the world’s scientific and health communities as these are not only consistent with other stated standards but are also published by ICNIRP, a highly respected and independent scientific organisation. ICNIRP is responsible for providing guidance and advice on the health hazards of non-ionising radiation for the World Health

Organization (WHO) and the International Labour Office (Ministry for the Environment and Ministry of Health, 2000).

2.3.4.1 The New Zealand Standard

When a mobile phone site is being planned, radio frequency engineers calculate the level of electromagnetic energy (EME) that will be emitted by the site. The level of EME is predicted by taking into account power output, cable loss, antenna gain, path loss, height and distance from the antenna, etc. These calculations result in figures that allow engineers to calculate maximum possible emissions in a worst-case scenario – as if the site was operated at maximum power all the time. The aim is to produce EME levels that are below international and New Zealand standards in areas where the general public have unrestricted access.

It is a requirement that all mobile phone sites in New Zealand comply, in all respects, with the New Zealand Standard for radio frequency exposures, NZS 2772.1:1999 Radiofrequency Fields Part I: Maximum Exposure Levels – 3kHz to 300GHz. This standard, which was adopted in April 1999, was based largely on the 1998 ICNIRP recommendations for maximum human exposure levels to radio frequency. The standard also includes a requirement for:

“Minimising, as appropriate, Radio Frequency exposure which is unnecessary or incidental to achievement of service objectives or process requirements, provided that this can be achieved at modest expense.” (National Radiation Laboratory, 2001, p.7).

Currently this standard sets out a limit of continuous exposure to the public for radio frequency levels from mobile phone sites of 450 microwatts per square centimetre. This standard is the same as used in most European countries, and is more stringent than that used in the United States, Canada and Japan. This exposure level has been lowered even further in some cases. For example, the Christchurch City Council has made their allowable standard 200 microwatts per square centimetre (which is less than 50% of the New Zealand Standard). In reality however, mobile phone sites only operate at a fraction of the level set by the standard. The National Radiation Laboratory has measured exposures around many operating cell sites. Maximum exposures in publicly accessible areas around the great majority of sites are less than 1% of the public exposure limit in the standard. Exposures are rarely more than a few percent of the limit, and none have been above 10%.

2.3.5 Effects on Property Values in New Zealand

In New Zealand, based on two court cases: McIntyre and others vs. Christchurch City Council [1996] NZRMA 289 and Shirley Primary School vs. Telecom Mobile Communications Ltd [1999] NZRMA 66, there are two main alleged adverse effects of cell-phone base station on property values:

- The risk of adverse health effects from radio frequency radiation emitted from cell-phone base stations
- The adverse visual effects

Very few cell site cases have actually proceeded to Environment Court hearings. In McIntyre and others vs. Christchurch City Council, Bell South applied for resource consent to erect a cell phone base station in Fendalton, Christchurch. The activity was a non-complying activity under the Transitional District Plan. Residents’ objected to the application. Their objections were related to the harmful health effects from radio frequency radiation. In particular, they argued it would be an error of law to decide on the present state of scientific knowledge that there were no harmful health effects from low-level radio frequency exposure levels. It was also argued that the Resource

Management Act (1991) contains a precautionary policy and that section 104 requires a consent authority to have regard to potential effects of low probability but high impact in considering an application.

The Planning Tribunal considered residents' objections and heard experts' opinions as to the potential health effects, and granted the consent, subject to conditions. It was found that there would be no adverse health effects from low levels of radiation from the proposed transmitter, not even effects of low probability but high potential impact.

In *Shirley Primary School vs. Telecom Mobil Communication Limited*, Telecom applied to the Christchurch City Council for resource consent to establish, operate and maintain a CPBS on land at Shirley Road, Christchurch, adjacent to the Shirley Primary School. This activity was also non-complying under the Transitional District Plan. Again, the Council granted the consent subject to conditions. However, the school appealed the decision, alleging four main adverse effects, as follows:

- The risk of adverse health effects from the radio frequency radiation emitted from the cell site
- The school's perception of the risks and related psychological adverse effects on pupils and teachers
- Adverse visual effects
- Reduced financial viability of the school if pupils were withdrawn because of the perceived adverse health effects

The Court concluded that the risk of the school children or teachers at the school incurring leukaemia or other cancer from radio frequency radiation emitted by the cell site is extremely low, and the risk to the pupils of exposure to radio frequency radiation causing sleep disorders or learning disabilities is higher but still very small. Accordingly, the Telecom proposal was allowed to proceed.

In summary, the Environmental Court has ruled that there are no established adverse health effects arising from the emission of radio waves from CPBSs as there is no epidemiological evidence to show this. The court was persuaded by the ICNIRP guidelines that risk of health effects from low-level exposure is very low and that the cell phone frequency imposed by the NZ standard is safe, being almost two and a half times lower than that of the ICNIRP's.

However, in the court's decisions they did concede that while there is no proven health effects that there is evidence of property values being affected by both of the above allegations. However, the court suggests that such a reduction in property values should not be counted as a separate adverse effect from, for example, adverse visual or amenities effects. That is, a reduction in property values is not an environmental effect in itself; it is merely evidence, in monetary terms, of the other adverse effects noted.

In *Chen vs. Christchurch City Council* the court stated that valuation is simply another expert opinion of the adverse effect (loss). Further, in this case the court established a precedent relating to the effects on property values. In *Goldfinch vs. Auckland City Council (NZRMA 97)* the Planning Tribunal considered evidence on potential losses in value of the properties of objectors to a proposal for the siting of a CPBS. The Court concluded that the valuer's monetary assessments support and reflect that the adverse effects of the CPBS. Further, it concluded that the effects are more than just minor as the CPBS stood upon the immediately neighbouring property.

2.3.6 Research on Property Value Effects

While experimental and epidemiological studies focus on the adverse health effects of radiation from the use of cell phones and CPBSs few studies have been conducted to ascertain the adverse health and visual effects of CPBSs on property values. Further, as there has been very few cell site cases proceeding to the Environment Court little evidence of property value effects has been provided by the courts. Thus, the extent to which opposition from property owners affected by the siting of CPBSs are reflected in lower property values is not well known in New Zealand. Two studies have been commissioned by Telecom in Auckland (1998/99) and Christchurch (2001) but these have not been made publicly known. Further, although the researchers communicated with the authors that results showed that property prices are not statistically significantly affected by the presence of CPBSs, their research involved only limited sales data analysis. Further, no surveys of residents' perceptions were undertaken, nor of the media attention to the sites and the affect this may have on saleability of properties in close proximity to CPBSs. This initial study aims to help fill the research void in this area.

3.0 DATA COLLECTION AND ANALYSIS

3.1 Research Objectives and Methodology

An opinion survey was conducted to investigate the current perceptions of residents towards living near cell-phone base stations and how this proximity might affect property values. Residents were asked questions, about: how they rate the suburb they live relative to other similar suburbs; when the CPBS was constructed and the proximity of it in relation to their home; the importance they place on the CPBS as a factor in relocation decisions and on the price/rent they were prepared to pay for their house; the degree of concern of the effects of health/stigma/aesthetic/property values, etc.

Two case study areas in the city of Auckland, New Zealand were selected for this pilot study: the residential suburbs of Clover Park, Manakau in south-Auckland and St Johns in east-Auckland. Each case study included residents in two areas: the case study area (within 300 metres of a cell phone tower) and a control area (over 1km from the cell phone tower). Both areas within each case study had the same living environment (in socio-economic terms) except that the former is an area with a CPBS while the latter is without a CPBS.

Sixty questionnaires⁶ were randomly distributed to each of the areas (case study and control) in each neighbourhood (i.e. 240 surveys were delivered in total). As time and cost in conducting the survey were both limited delivery of the surveys was by hand to the property owner's letterbox. Respondents were instructed to complete the survey and return it to the letterbox. These were collected by hand two days after delivery.

The surveys were coded and the property address of each, once delivered, was recorded. This enabled each respondent's property to be located on a map and to show this in relation to the cell site. With a sample size of just 60 for each area within each neighbourhood the results are not fully representative of how the entire population perceive cell sites. However, the results do provide a gauge of the perceptions that people have about living near a cell site, or moving to an area near one, and how this might impact on values of properties in proximity to a CPBS.

The analysis of responses included the calculation of means and percentage of responses to each question to allow for an overview of the response patterns in each area. Comparison of the results between the case study area and the control area reveal any significant differences.

⁶ Approved by the University of Auckland Human Subjects Ethics Committee (reference 2002/185).

3.2 Case Study Areas

3.2.1 St Johns

The east-Auckland suburb of St Johns was selected (see Appendix A for a location map) as there are two CPBSs within close proximity of each other on St Johns Road near its intersection with St Heliers Bay Road. It is a medium to upper priced residential housing suburb⁷ in a generally sought after neighbourhood due to its close proximity to beaches, schools, shopping, recreational facilities and the Auckland CBD.

3.2.2. Manakau

The south-Auckland neighbourhood of Clover Park, Manukau City was selected (see Appendix A for a location map) as it is also proximate to a CPBS but it provides a different (lower) socio-economic sample to the first study area. The address of the CPBS site is 726 Great South Road, Manukau City and is located on a BP petroleum station property. It is situated among trees between Valentine Restaurant and Rainbows End Theme Park, at the corner of Great South Road and Redoubt Road, Manukau City.

The questionnaires were distributed to properties in Sikkim Crescent, the residential area that runs off Great South Road. The area is an older, lower-priced residential suburb area characterised by houses in a poor state of repair.⁸ It has good access to the Auckland-Hamilton Motorway and is within close proximity to a primary school and recreational facilities such as the Cycling Velodrome, Manukau Sports Bowl and the Greyhound Race Track. However, there are no shops nearby apart from the basic supplies available from the BP petroleum station. Some properties are also near a high voltage power pylon.

3.3 Control Areas

3.3.1 St Johns

The control area for St Johns is located further away (over 1 kilometre) from the CPBS in the case study area and is in the same suburb. The area contains a living environment and housing stock very similar to the case study area, as stated above, the only exception is that there is no cell site.

3.3.2 Manakau

The control area for Manakau is in the neighbourhood of Manukau Heights, Manukau City. It is located further away (over 1.5 kilometre) from Clover Park. The area contains a living environment and housing stock very similar to Clover Park, as stated above, the only exception is that there is no cell site. The questionnaires were distributed to properties in the streets of Sidey Avenue, Dillion and Darrell Crescents. Manakau Heights has good access to the Auckland-Hamilton Motorway and is within close proximity to a primary school and recreational facilities (Totara Park and Murphys Bush Scenic Reserve).

4. Research Results

Appendix B provides a summary of the main findings from the survey. These are outlined and discussed in more detail below.

⁷ The median house price for Auckland city in October 2002 was \$335,000 and for St Johns it was \$375,000. St Johns borders the high-priced Eastern Suburbs where the median house price was \$515,000.

⁸ The median house price for Auckland city in October 2002 was \$335,000 and for Manakau it was \$278,000.

4.1 Survey 1: Cell Site: St Johns

Of the 60 questionnaires mailed to homeowners and tenants in the study area, 53% were completed and returned. Over half (56%) of the respondents were homeowners.

4.1.1 Desirability of the suburb as a place to live

One-third (34%) of respondents have lived in St Johns for between 1- 4 years, and 40% for more than five years. Two-thirds (66%) rated St Johns as either desirable or very desirable as a place to live when compared with other similar suburbs. The reasons given for this include that the suburb is within walking distance to shops and is clean and relatively graffiti-free. The reasons 17% responded that St Johns is less desirable compared with other suburbs is that it is not as close to the waterfront/beaches as the adjoining suburbs of Kohimarama and St Heliers.

4.1.2 Feelings towards the CPBS as an element of the neighbourhood

The CPBS was already constructed when 81% of the respondents bought their house or began renting. Of these respondents, 21 (80%) said the proximity of the tower was of no concern to them. For the 20% of respondents' that said the proximity of the tower was of concern to them the most common reasons given for this were: health reasons, as proclaimed by the media, and that it obstructed their views somewhat. Of the 19% that said the CPBS was not constructed when they bought the house or began renting all said they would have gone ahead with the purchase anyway if they had known that the CPBS was to be constructed.

4.1.3 Affect on Decision to Purchase or Rent

The tower was visible from the house of 60% (19) of the respondents, yet the majority (13) said it was barely noticeable. Over two-thirds (71%) of the respondents said the location of the cell site nearby did not affect the price they were prepared to pay for the property. Ten percent said they were prepared to pay a little less (between 0-9% less) and the remaining 19% bought their property before the cell site was constructed.

4.1.4 Concerns About the Proximity to the CPBS

Generally, residents were not particularly worried about the effects that proximity to a CPBS has on health, stigma, property value or aesthetics. Of the concerns about towers that respondents were asked to comment on, the negative effects on aesthetics and future health were what respondents were most worried about, but only to a limited degree. Over two-thirds were not worried about the possibility of harmful health effects in the future (28% were somewhat worried) and 72% were not worried about "stigma" associated with houses near CPBSs (18% were somewhat worried and 10% were very worried). The majority of respondents (90%) were not worried about the affect that proximity to a CPBS will have on property values in the future (10% were somewhat worried) and just over half (53%) were not worried about the aesthetic problems caused by CPBSs (47% were somewhat worried).

4.2 Survey 2: Control Group: St Johns

Of the 60 questionnaires mailed to homeowners and tenants in the study area, 57% were completed and returned. Nearly two-thirds (65%) of the respondents were homeowners.

4.2.1 Desirability of the suburb as a place to live

Nearly a third (29%) of respondents have lived in St Johns for between 1- 4 years, and over half (53%) for more than five years. Over three-quarters (76%) of the respondents rated St Johns as either desirable or very desirable as a place to live when compared with other similar suburbs. The reasons given for this include that the suburb has cheaper house prices but is still central to

services and the beaches, it has good views, the houses are of a good quality and the area is well serviced by public transport. The reasons 6% responded that St Johns is less desirable compared with other suburbs include its proximity to lower socio-economic areas and the high number of sub-standard rental properties in the area.

4.2.2 Feelings towards a CPBS as an element of the neighbourhood

Two-thirds (65%) of the respondents would be opposed to the construction of a cell phone tower nearby. The location of a CPBS would be taken into account by 82% of respondents if they were to consider moving.

4.2.3 Affect on Decision to Purchase or Rent

If a CPBS were located nearby over half (53%) of the respondents would be prepared to pay substantially less for their property, and nearly one-third (29%) would be prepared to pay just a little less for their property.

4.2.4 Concerns About the Proximity to a CPBS

Of the concerns about towers that respondents were asked to comment on, the negative effects on aesthetics and future health were what respondents were most worried about. More than half (59%) of the respondents were worried somewhat and over one-third (35%) were very worried about the possibility of harmful health effects in the future and the aesthetic problems caused by CPBSs. Similar responses were recorded for the “stigma” associated with houses near CPBSs (59% were somewhat worried and 23% were very worried) and the affect that proximity to a CPBS will have on property values in the future (53% were somewhat worried and 35% were very worried).

Other comments provided by respondents at the end of the survey, include:

- “In no way would I choose to live near such a cell phone site at all”.
- “A decisive statement on the health, aesthetic and property value issues by the authorities concerned is long overdue – there seems to have been a great deal of procrastination to date”.
- “This survey appears to be biased as you haven’t asked, for example, how important coverage is, and if this meant putting in a cell phone site what would this mean for you. Also, a lot of people are complaining about roads being dug up to lay phone cables – at least cell sites are not disruptive to the same extent when being installed”.

4.3 Discussion of the Results: St Johns

From the above responses it appears that people who live near cell sites seem to be far less concerned about the possible associated health risks and aesthetic issues of the sites than those people who live further away from the sites. An explanation for the difference between the case study and control groups’ responses is that the case study group are those people that have already purchased or rent in an area where a CPBS is constructed and may not represent the entire population of potential land purchasers/renters. Such residents are, by the very fact that they have purchased/rented in an area where a CPBS is located, less sensitive to this than might be the case for the market as a whole. Such people who live near something that is perceived but not proven to be a risk tend may pass the threat off and take the view that there is no evidence of it being a problem so why worry about it.

Alternatively, the case study residents’ apparent lower sensitivity to the CPBS than the control group residents may be due to the possible affect of cognitive dissonance reduction. In this case,

they are not necessarily less sensitive to the CPBS but are unwilling to admit, due to the large amounts of money already paid, that they may have made a poor purchasing/renting decision to buy a property located in close proximity to a CPBS.

4.4 Survey 1: Cell Site: Manakau Results

After the distribution of the questionnaires, the collection of survey responses resulted in only 3 responses (5%) from each area. With such a lower than expected response rate, the results are unlikely to be representative of the total population and the impact that CPBSs have on property values could not be conclusively determined. However, some interesting perceptions were revealed and are described generally below.

4.4.1 Desirability of the suburb as a place to live

Two-thirds (67%) of the respondents were homeowners and have been residing in the area for over 5 years. Half of the respondents rated Clover Park as desirable and the other 50% rated it as less desirable as a place to live compared to other similar suburbs (for example, East Tamaki and Manakau Heights).

4.4.2 Feelings towards the CPBS as an element of the neighbourhood

Two-thirds of the respondents did not know about the existence of the CPBS when they bought or began renting their house. The remaining third said it was not constructed. Consequently, the proximity of the CPBS was not of concern to them. If they had known at the time of purchase or rental that the CPBS was to be constructed half said they would not have gone ahead with the purchase/rental whereas the other half said they would have.

4.4.3 Affect on Decision to Purchase or Rent

None of the respondents could see the CPBS from their house. Consequently, it did not affect the price or rent they were prepared to pay for the property.

4.4.4 Concerns About the Proximity to a CPBS

Of the concerns about CPBSs that respondents were asked to comment on two-thirds (66%) were somewhat worried about the possibility of harmful health effects in the future, the stigma associated with houses near CPBSs and the affect on property values. The remaining one-third was not worried about these things. All respondents were somewhat concerned about the aesthetic problems caused by the towers.

4.5 Survey 2: Control Group: Manakau

Two-thirds of the control group respondents were tenants living in the area between 6 months and 4 years. They rated their suburb as either desirable or very desirable as a place to live compared to other similar suburbs due to the easy access to amenities.

4.5.1 Feelings towards a CPBS as an element of the neighbourhood

Two-thirds of respondents would be opposed to the construction of a CPBS nearby. Yet, at odds to this response, only a third said it would be a factor to consider when relocating.

4.5.2 Affect on Decision to Purchase or Rent

One-third of the respondents said they would be prepared to pay 0-9% less for a property nearby a CPBS, one-third were prepared to pay 10-19% less and the remaining one-third would pay 20% or more, less for such a property.

4.5.3 Concerns About the Proximity to a CPBS

All of the respondents were greatly concerned about the harmful health effects from proximity to a CPBS while two-thirds were worried a lot about stigma, loss in property values in the future and aesthetic problems associated with houses near CPBSs. The remaining one-third or respondents were only somewhat worried about these factors.

4.6 Discussion of the Results: Manakau

From the responses above, it appears that the effects of CPBSs tend to be ignored in Manakau if the residents are unaware of them in their neighbourhood, as would be expected. Yet, there are strong concerns about the effects of CPBSs from residents in the control area. Nonetheless, these survey results are inconclusive due to the limited response rate.

5. Limitations of the Research

There are a number of limitations affecting this survey in addition to the limited response rate for Manakau. There was a time constraint in locating an appropriate CPBS that was visible to the residents in the Manakau case study area. The selected site is situated amongst trees and not highly visible. Many of the residents were not aware of its existence that likely affected both the responses and response rate. Further, giving respondents only two days to complete the survey may have been insufficient. Fortunately, this time constraint did not adversely affect the St Johns area response rate.

Finally, it must be kept in mind that these results are the product of only two case studies carried out in a specific area (Auckland) at a specific time (2002). The value-effects from CPBSs may vary over time as market participant's perceptions change due to increased public awareness regarding the potential adverse health and other effects of living near a CPBS. Perceptions toward CPBSs can change either positively or negatively over time. For example, as the World Health Organisation's ten-year study of the health effects from CPBSs is completed and becomes available consumers' attitudes may either increase or decrease depending on the outcome of those studies. To confirm this, many similar studies, of similar design to allow comparison between them, need to be conducted over time and the results made public.

As a result of these limitations caution must be used in making generalisations from the study or applying the results directly to other similar studies or valuation assignments.

6. Areas for Further Study

This research has focused on residents' perceptions of negative affects from proximity to CPBSs rather than the scientific or technological estimates of these risks. The technologists' objective view of risk is that risk is measurable solely in terms of probabilities and severity of consequences, whereas the public, while taking experts' assessments into account, view risk more subjectively, based on other factors. Further, the results of scientific studies about the health effects of radio frequency and microwave radiation from CPBSs are not always consistent. Residents' perceptions and assessments of risk vary according to a wide range of processes including psychological, social, institutional, and cultural and a reason why their assessments may be at odds with those of the experts.

Given the public concerns about the potential risk arising from being located nearby a CPBS it is important for future studies to focus more attention on this issue. More information is needed on the kinds of health and other risks the public associates with CPBSs, and the level of risk

perceived. How far away from the CPBS do people feel they have to be to be safe? What are the social, economic, educational and other demographic variables that influence how people perceive the risks from CPBSs? Are these perceived risks reflected in property values and to what extent? Do these perceived risks vary over time, and to what degree?

Answers to these questions, if shared amongst researchers and made public, could lead to the development of a global database. Such a database could assist valuers in determining the perceived level of risk associated with CPBSs from geographically and socio-economically diverse areas to aid in the valuation of property affected by these, anywhere in the world. Similarly, knowledge of the extent these risks are incorporated into property prices and how they vary over time will lead to more accurate value assessments of properties in close proximity to a CPBS.

7. Summary and Conclusions

This research report presents the results of an opinion survey undertaken in 2002 to residents' perceptions towards living near CPBSs and how this impacts on property values. From the results it appears that people whom live close to a CPBS perceive the sites less negatively than those whom live further away.

As research to date (ICNIRP, 1998) reports that there are no clearly established health effects from RF emissions of CPBSs operated at, or below, the current safety standards the only reason a rational investor might continue to avoid property near a cell site would be because it was intrusive on the views received from the property or because of the adverse aesthetic effects of the CPBS on the property. Yet, recent media reports (for example, Fox, 2002) indicate that people still perceive that CPBSs have harmful health effects.

Thus, whether or not CPBSs are ever proven conclusively to be free from health risks is only relevant to the extent that buyers of property near a CPBS perceive this to be true. Consequently, values of residential property located in close proximity to CPBSs may be adversely affected by the negative perceptions of buyers, regardless of research evidence to the contrary.

Further research is needed to provide more statistically valid conclusions than this pilot study provide about the public perceptions towards the health and visual effects of CPBSs and how this influences property values. To this end a larger study is to be conducted in 2003 that will include, in addition to a survey of affected residents living in close proximity to a CPBS, econometric analysis of the sales transaction data.

The results from such studies can provide useful information to related government agencies in assessing the need for increasing the public's understanding of CPBSs of how radio frequency transmitting facilities operate and of the strict exposure standard limits imposed on the telecommunication industry. A lack of understanding of these issues creates public concern about the location of CPBSs. As more information is discovered that refutes any adverse health effects from CPBSs and as this, together with information about the NZ Standards for high safety margins regarding the emission of RF and MW radiation, are made more publicly available, the perceptions of risk may gradually change. The visual effects can still pose a concern to residents, however, but this may vary according to the size, height and design of the CPBSs as well as the landscape surrounding them.

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Appendix A- Survey Location Map

Appendix B - Survey Results

Case Study Area:

Questions	St Johns Response (*%, n = 32)	Manakau Response (*%, n = 3)
1. Which one of the following categories best describes you?	- Homeowner (56%) - Tenant (44%)	- Homeowner (67%) - Tenant (33%)
2. How long have you lived at this address?	- Less than 6 months (12%) - 6 months ~ 1 year (12%) - 1 ~ 4 years (34%) - More than 5 years (40%)	- Less than 6 months (0%) - 6 months ~ 1 year (0%) - 1 ~ 4 years (33%) - More than 5 years (67%)
3. Comparing your suburb to other similar suburbs, how do you consider your suburb:	- Very desirable (22%) - Desirable (44%) - Less desirable (19%) - About average (15%)	- Very desirable (0%) - Desirable (50%) - Less desirable (50%) - About average (0%)
4. When you purchased this house / began renting, was the cell phone tower already constructed?	- Yes (81%) - No (19%)	- Yes (0%) - No (33%) - I don't know (67%)
5. Was the proximity of the cell phone site of concern to you?	- Yes (80%) - No (20%)	- Yes (0%) - No (100%)
6. If you had known at the time of purchase or rental that a CPBS was to be constructed, would you still have purchased or rented?	- Yes (100%) - No (0%)	- Yes (50%) - No (50%)
7. Is the cell phone tower visible from your house?	- Yes (60%) - No (40%)	- Yes (0%) - No (100%)
8. How did the cell phone site affect the price or rent you were prepared to pay for this property?	-Substantially more (0%) -A little more (0%) -No Influence (71%) -A little less (10%) -Substantially less (0%) Tower not constructed (19%)	-Substantially more (0%) -A little more (0%) -No Influence (100%) -A little less (0%) -Substantially less (0%)
9. Concerns associated with properties near a CPBS: (a) The possibility of harmful health effects in the future. (b) The stigma associated with houses near cell phone sites. (c) The affect on your properties value in the future (d) The aesthetic problems caused by the tower	- Not worried (69%) - Somewhat worried (28%) - This worries you a lot (3%) - Not worried (72%) - Somewhat worried (18%) - This worries you a lot (10%) - Not worried (90%) - Somewhat worried (10%) - This worries you a lot (0%) - Not worried (53%) - Somewhat worried (47%) - This worries you a lot (0%)	- Not worried (33%) - Somewhat worried (67%) - This worries you a lot (0%) - Not worried (33%) - Somewhat worried (67%) - This worries you a lot (0%) - Not worried (33%) - Somewhat worried (67%) - This worries you a lot (0%) - Not worried (0%) - Somewhat worried (100%) - This worries you a lot (0%)

* Valid Percentage: This indicates the percent of those respondents that answered that specific question (it does not include non-responses).

Appendix B continued - Survey Results

Control Area

Questions	St Johns Response (*%, n = 34)	Manakau Response (*%, n = 3)
1. Which one of the following categories best describes you?	- Homeowner (65%) - Tenant (35%)	- Homeowner (33%) - Tenant (67%)
2. How long have you lived at this address?	- Less than 6 months (12%) - 6 months ~ 1 year (6%) - 1 ~ 4 years (29%) - More than 5 years (53%)	Less than 6 months (0%) - 6 months ~ 1 year (33%) - 1 ~ 4 years (33%) - More than 5 years (33%)
3. Comparing your suburb to other similar suburbs, how do you consider your suburb:	- Very desirable (35%) - Desirable (41%) - Less desirable (6%) - About average (18%)	- Very desirable (33%) - Desirable (33%) - Less desirable (0%) - About average (33%)
4. Would you be opposed to the construction of a cell phone site nearby?	- Yes (65%) - No (35%)	- Yes (67%) - No (33%)
5. If you were to consider moving houses, would the location of a CPBS be a factor?	- Yes (82%) - No (18%)	- Yes (33%) - No (67%)
6. How would a cell phone site nearby affect the price or rent you would be prepared to pay for this property? Please specify as a % of total property price	- Pay substantially more (0%) - Pay a little more (0%) - No Different (18%) - Pay a little less (29%) - Pay substantially less (53%) - +20% or more (0%) - +10% to +20% (0%) - 1% to +9% (0%) - -9% to 0% (47%) - -19% to -10% (0%) - -20% or less (53%)	- Pay substantially more (0%) - Pay a little more (0%) - No Different (33%) - Pay a little less (0%) - Pay substantially less (67%) - +20% or more (0%) - +10% to +20% (0%) - 1% to +9% (0%) - -9% to 0% (33%) - -19% to -10% (33%) - -20% or less (33%)
7. Concerns associated with properties near CPBSs: (a) The possibility of harmful health effects in the future. (b) The stigma associated with houses near cell phone sites. (c) The affect on your properties value in the future (d) The aesthetic problems caused by the tower	- Not worried (6%) - Somewhat worried (59%) - This worries you a lot (35%) - Not worried (18%) - Somewhat worried (59%) - This worries you a lot (23%) - Not worried (12%) - Somewhat worried (53%) - This worries you a lot (35%) - Not worried (6%) - Somewhat worried (59%) - This worries you a lot (35%)	- Not worried (0%) - Somewhat worried (0%) - This worries you a lot (100%) - Not worried (0%) - Somewhat worried (33%) - This worries you a lot (67%) - Not worried (0%) - Somewhat worried (33%) - This worries you a lot (67%) - Not worried (0%) - Somewhat worried (33%) - This worries you a lot (67%)