Property Values Exhibits

Multnomah County File No. #T2-2025-0023 – AT&T Wireless Tower

Wireless Communications Facility (WCF)
On behalf of Applicant

- **No substantial evidence presented by commenters**. *Johnson v. City of Eugene*, LUBA 2002-031. Copy of decision attached as **Appendix I**. Substantial evidence not found:
  - Generalized testimony that is not site-specific or does not quantify the loss in property value for the particular site is not substantial evidence.
  - There, neighbors proffered newspaper articles, law review articles and real estate newsletters from national and state entities to estimate that their property values would drop 4-40%. *Johnson v. Eugene*, LUBA 2002-031.

- **Critique of Sandy Bond study in New Zealand:**
  - Exhibit D.5 cites a Sandy Bond study from New Zealand as evidence of impacts to property values of potentially more than 20 percent.
  - A copy of this study is attached as **Appendix II**.
  - This study is based on an opinion survey and other analysis of perceived health effects.
  - In addition, this 2003 study by Sandy Bond (published in 2005), has been since discredited, including by Dr. Jonathan L. Kramer, Esq., a telecommunications advisor to the League of California Cities and many California municipalities at: https://jonathankramer.com/?s=sandy+bond. Copy attached as **Appendix III**.

- **Sandy Bond's Florida study:**
  - Sandy Bond herself was unable to replicate the results of her 2003 study in a 2004 study in Florida, which found only a *de minimus* (approximately 2%) variation in property values. Sandy Bond, PhD, *"The Effect of Distance to Cell Phone Towers on House Prices in Florida" The Appraisal Journal* (Fall 2007) is attached as **Appendix IV**.

- **NISLPP Survey (2014) summary:**
  - Public comments often refer to a 2014 survey by the National Institute for Science, Law and Public Policy, which suggested that a high percentage (90%) of respondents believed that a cell tower would impact property values. This survey was far from a scientific study, and similar to the Bond study, its results are tied to perceived health effects. The sample used was self-selected through circulation of the survey through social media and

email, and the bias of the respondents is obvious when considering that a high percentage of respondents also believed that they had suffered physical (63%) or cognitive (57%) effects from radiation. A copy of the summary is attached as **Appendix V.**

- **Some property values studies show that impacts to property values are insignificant:**
    - **Joint Venture Silicon Valley Network** study (2012), copy attached as **Appendix VI**.
    - **Valbridge** studies (2018) in Boston, Dallas, Phoenix, and Raleigh, copy of summaries attached as **Appendix VII**.

JOHNSON v. CITY OF EUGENE, LUBA No. 2002-031 (Or. LUBA 7/10/2002)

Decision Date:	10 July 2002
Docket Number:	LUBA No. 2002-031.
Parties:	MARTHA JOHNSON, Petitioner, v. CITY OF EUGENE, Respondent, and MASTER TOWERS, LLC, Intervenor-Respondent.
Court:	Oregon Land Use Board of Appeals

Id. vLex Fastcase: VLEX-892289027

Link: https://fastcase.vlex.com/vid/johnson-v-city-of-892289027

Text

Page 1

MARTHA JOHNSON, Petitioner, v. CITY OF EUGENE, Respondent, and MASTER TOWERS, LLC, Intervenor-Respondent.

LUBA No. 2002-031.

Oregon Land Use Board of Appeals.

July 10, 2002.

Appeal from City of Eugene.

Martha Johnson, Eugene, filed the petition for review and argued on her own behalf.

No appearance by the City of Eugene.

H. Andrew Clark, Eugene, filed the response brief and argued on behalf of intervenor-respondent. With him on the brief was Gleaves, Swearingen, Potter and Scott, LLP.

BRIGGS, Board Member; HOLSTUN, Board Chair; BASSHAM, Board Member, participated in the decision.

AFFIRMED.

You are entitled to judicial review of this Order. Judicial review is governed by the provisions of ORS 197.850.

FINAL OPINION AND ORDER

Opinion by Briggs.

Page 2

NATURE OF THE DECISION

Petitioner challenges a city hearings officer's decision that approves the siting of a 100 foot tall telecommunications tower.

FACTS

Master Towers, LLC (Master Towers or intervenor) applied for site review to site a 100-foot telecommunications tower with enclosed antennas on a 768 square foot leased area located at the corner of River Road and Oakleigh Lane in northwest Eugene. The leased area is zoned General Commercial (C-2) and is currently improved with a used car lot.

The area surrounding the subject property includes strip commercial uses along River Road, and residential uses east and west of the commercial strip. Property to the north of the site is zoned Neighborhood Commercial with an Urbanizable Land Overlay (C-1/UL), and is developed with a Goodwill store and parking lot. Property to the east is zoned General Office with an Urbanizable Land Overlay (GO/UL), and is developed with the River Road Water District offices and parking lot. East of the subject property area are C-1/UL zoned properties, developed with nonconforming residential uses. Properties to the west of River Road, beyond the River Road commercial strip, include the River Road Elementary School and a residentially designated and developed neighborhood. C-2 zoning and commercial land use designations extend to the north and south of the subject site along River Road. The tower is proposed to be approximately three and one-half feet in diameter at its base, narrowing to 18 inches at the top. The tower will be surrounded by a slatted chain-link fence with barbed wire on top, and landscaping. The proposed telecommunications facility includes a utility cabinet that contains industrial batteries to operate the tower.

The city planning director approved Master Towers' application administratively. Petitioner and the River Road Community Organization appealed the planning director's

Page 3

decision to the city hearings officer, who affirmed the planning director's decision. This appeal followed.

FIRST ASSIGNMENT OF ERROR

Eugene City Code (ECC) 9.5750(6)(c)(3) provides in relevant part:

"In addition to [other] application requirements specified in [ECC 9.5750(6)(b)], applications for site review * * * shall include the following information:

"* * * * *

"3. Evidence demonstrating collocation is impractical on existing tall buildings, light or utility poles, water towers, existing transmission towers, and existing tower facility sites for reasons of structural support capabilities, safety, available space, or failing to meet service coverage area needs."

Petitioner argues that the hearings officer misconstrued ECC 9.5750(6)(c)(3) and that the findings the hearings officer adopted are not supported by substantial evidence.1 First, petitioner argues that the city's decision focused on whether the proposed *tower* could be

Page 4

collocated, when the standard requires consideration of whether the proposed *antenna* could be collocated. Petitioner notes that a telecommunications carrier has located its antenna on a 50 foot tall office building located approximately one mile north of the subject property. Petitioner argues that the city and intervenor erred by not considering the possibility of locating the proposed antenna on existing structures.

Second, petitioner argues that the city's decision is not supported by substantial evidence because intervenor only compared the coverage that could be achieved with an antenna on a 40-foot tower with the coverage that could be achieved with an antenna on a 100-foot tower. Petitioner contends that there is no evidence in the record to establish that a tower of 100 feet is necessary, given the fact that heights between 40 and 100 feet were not considered. According to petitioner, in other local decisions involving telecommunications towers, the city required applicants to modify their applications and provide an alternatives analysis that compared the applicant's preferred site to other locations. As a result of those alternatives analyses, petitioner argues that the applicants in those cases chose to lower the height of a tower or to locate the proposed antenna on a shorter building. Petitioner relies on the decisions in the other cases to support her contention that the city should have required a similar alternatives analysis in this case.

Intervenor responds that the hearings officer found that collocation of the *antenna* is impractical, because it must be located 100 feet high and within the chosen area on River Road in order to achieve adequate coverage of the preferred service area. According to intervenor, the hearings officer based her conclusion that ECC 9.5750(6)(c)(3) is met on evidence demonstrating that the only way to achieve the height at the chosen location is to build a tower. According to intervenor, there is substantial evidence in the record to demonstrate that the height of nearby utility poles is no greater than 70 feet, and there is evidence to show that a 100-foot height is necessary to ensure coverage within the area. Intervenor contends that its radio frequency engineers concluded that there are several trees

Page 5

within the vicinity that exceed 75 feet in height and that those trees would cast a "shadow" that would interfere with the coverage by a shorter antenna. Intervenor also contends that there is no evidence in the record to counter its evidence that an antenna on a slightly shorter tower would not be adequate. Intervenor argues that petitioner has not identified other locations within the area that might be of the appropriate height, nor has petitioner shown that shorter towers on existing structures would provide adequate coverage for the area. Therefore, intervenor argues, it did not have to consider other locations for the antenna that it did not identify as feasible.

We agree with intervenor that the hearings officer properly applied ECC 9.5750(6)(c)(3). The review criteria set out in the city's code provide regulatory incentives for collocating telecommunications antennas on existing towers and buildings.2 However, they also allow the establishment of a tower to house the antenna if an applicant demonstrates that there are coverage needs that cannot be addressed by collocating on an existing tower or other structure. The code does not require an alternatives analysis to demonstrate that a tower at a particular height at a particular location is the *only* way the applicant can achieve its business goals. Nor does the code require an applicant to modify its business goals by limiting its antenna siting choices to existing buildings or structures. The fact that an alternatives analysis may have been conducted in other cases does not impose a requirement that an alternatives analysis be conducted in this case, in the absence of evidence that feasible alternatives exist.

As a review body, we are authorized to reverse or remand the challenged decision if it is "not supported by substantial evidence in the whole record." ORS 197.835(9)(a)(C). Substantial evidence is evidence a reasonable person would rely on in reaching a decision.

Page 6

Carsey v. Deschutes County, 21 Or LUBA 118, *aff'd* 108 Or App 339, 815 P2d 233 (1991). In reviewing the evidence, we may not substitute our judgment for that of the local decision maker. Rather, we must consider and weigh all the evidence in the record to which we are directed, and determine whether, based on that evidence, the local decision maker's conclusion is supported by substantial evidence. *Younger v. City of Portland*, 305 Or 346, 358-60, 752 P2d 262 (1988); *1000 Friends of Oregon v. Marion County*, 116 Or App 584, 588, 842 P2d 441 (1992).

We agree with intervenor that there is substantial evidence in the record to support a finding that an antenna that is 100 feet high is necessary in order to provide adequate coverage to the River Road service area, and that there are no existing towers or structures in the vicinity that can provide the necessary height. We also agree with intervenor that, in the absence of evidence that a shorter antenna or alternative location would provide the needed coverage, it was not necessary for intervenor to conduct transmission tests to see whether an antenna height between 40 and 100 feet would provide coverage that would satisfy its business aims. Nor was it necessary for intervenor to investigate a multitude of alternative sites, in the absence of evidence that alternative sites in the vicinity exist to provide the needed coverage. Accordingly, the first assignment of error is denied.

SECOND ASSIGNMENT OF ERROR

ECC 9.5750(6)(c)(2) provides, in relevant part:

"In addition to [other] application requirements specified in [ECC 9.5750(6)(b)], applications for site review * * * shall include the following information:

"* * * * *

"2. Documentation that alternative sites within a radius of at least 2,000 feet have been considered and have been determined to be technologically infeasible or unavailable. For site reviews, alternative sites zoned [Commercial Industrial (C-4), Special Light Industrial (I-1), Light Medium Industrial (I-2) and Heavy Industrial (I-3)] must be considered. For conditional use permits alternative sites zoned

Page 7

[Public Lane (PL), General Commercial (C-2), Major Commercial (C-3)], I-1, I-2 and I-3 must be considered."

Petitioner argues that the city's findings fail to demonstrate that alternative locations have been considered or that those alternative locations are inadequate to provide the type and range of coverage intervenor seeks. In particular, petitioner argues that the second sentence in ECC 9.5750(6)(c)(2) should be read to establish a minimum threshold, *i.e.*, that *at least* the C-4, I-1, I-2 and I-3 zones must be considered. Petitioner contends that the standard requires that all available sites within the 2,000-foot radius should be identified to ensure that all technologically feasible alternatives to the preferred site are considered. Intervenor responds that the hearings officer correctly interpreted the standard to require consideration of alternative sites only when those sites are within 2,000 feet of the proposed site and zoned C-4, I-1, I-2 or I-3. According to intervenor, there is uncontroverted evidence in the record that the nearest property with one of those zoning designations is approximately 4,000 feet to the southwest. Therefore, intervenor argues, the standard is either not applicable or has been satisfied.

The zones listed in the second sentence of ECC 9.5750(6)(c)(2) permit telecommunications towers outright. The zones listed in the third sentence of ECC 9.5750(6)(c)(2) permit telecommunications towers only after site review. Read in context, it appears that the thrust of ECC 9.5750(6)(c)(2) is to require applicants to consider alternative sites that have less restrictive zoning designations with respect to telecommunications towers. With that understanding, we believe the hearings officer correctly interpreted ECC 9.5750(6)(c)(2) to require consideration of alternative locations within 2,000 feet of the preferred site only if alternative locations are zoned C-4, I-1, I-2 or I-3. Petitioner does not contest the finding that there are no properties with those zoning designations within 2,000 feet of the subject property. Therefore, the second assignment of error provides no basis for reversal or remand.

The second assignment of error is denied.

Page 8

THIRD ASSIGNMENT OF ERROR

ECC 9.8440(4) requires that proposed development

"* * * will not be a significant risk to *public health and safety*, including but not limited to soil erosion, slope failure, stormwater or flood hazard, or an impediment to emergency response." (Emphasis added.)

Petitioner argues that the city erred in (1) concluding that ECC 9.8440(4) is preempted by federal law that limits the types of evidence a local government may consider when assessing the public safety risk of telecommunications towers; and (2) failing to respond to testimony presented by opponents regarding the impacts on public health as a result of the presence of a number of batteries and the increase in fire danger originating from improperly ventilated battery cabinets.3

Intervenor responds that there is a letter in the record from the fire marshal, indicating that he had no concerns about the siting of the telecommunications tower and associated facilities. According to intervenor, the fire marshal's letter is substantial evidence to support the hearings officer's finding that the proposed tower and battery cabinets will not pose a public health risk with respect to likely fire hazards.

In the planning director's decision, the planning director addressed the issue petitioner raised:

"The concerns raised in opposing testimony regarding battery hazards and licensing are * * * addressed through other state and federal regulatory authority. Local approval for the construction of such a facility would not exempt the developer or operator from compliance with other applicable state and federal regulations. To the extent that the proposed facility may create a fire hazard, it is notable that referral comments from the Eugene Fire Marshal's Office indicate no specific concerns or additional requirements at this time." Record 834.

The hearings officer specifically agreed with this analysis, and noted:

Page 9

"With regard to [petitioner's] concerns regarding batteries, there is no evidence in the record to support the assertion that the batteries used at the facility will create a health risk. As the applicant explains:

"`The facility will use 12 volt batteries, similar to car batteries, and will not pose a more significant risk to the public than other permitted uses, which include car repair shops and service stations. All of the proposed equipment will be contained within a secure fenced area topped by barbed wire. An emergency notification system will alert on-call engineers of power failures. Electrical plans will be reviewed in detail as part of the building permit process.'

"In addition, as the Planning Director's decision recites, the applicant is necessarily required to comply with all state and federal regulatory requirements, and the Fire Marshal expressed no concern regarding use of batteries." Record 27.

Petitioner does not explain why she believes that the proposed battery casing will not be properly ventilated and therefore poses a public safety risk. To the extent petitioner argues that the fire marshal's conclusion that the fire department can adequately respond to a fire at the site is not the same as a finding that there is no risk from fire, we do not believe that ECC 9.8440(4) requires that there be no fire risk. Rather, the standard appears to require that any risk to public safety as a result of fire not be "significant." The hearings officer's consideration of the fire risk and her explanation of fire reporting and response capability is sufficient to address that standard. The hearings officer's findings are adequate to address the arguments petitioner raised regarding potential public safety risk, and those findings are supported by substantial evidence. *See Hutmacher v. City of Salem*, 16 Or LUBA 187 (1987) (where the record contains evidence adequate to support the city's findings, LUBA will defer to the city, even if the record contains other evidence that could support a contrary conclusion).

The third assignment of error is denied.

FOURTH ASSIGNMENT OF ERROR

ECC 9.8440(1) provides that a site design may be approved only when:

Page 10

"The site review plan's general design and character is reasonably compatible with surrounding properties, as it relates to building locations, bulk and height, noise, glare, and odors."

According to petitioner, the requirement for site review in this area was imposed to ensure compatibility with residential uses to the east of the subject property. According to petitioner, the hearings officer erred in relying on the existence and nature of the narrow commercial strip on River Road to support the conclusion that the proposed tower is, overall, compatible with the surrounding neighborhood. In petitioner's view, the proper focus is whether the proposed tower is compatible with the residential uses to the east. Petitioner argues emphatically that it is not.

A. Tower Height and Bulk

Petitioner argues that the proposed tower will result in significant adverse visual impacts on residential uses in the vicinity. According to petitioner, the challenged decision fails to address concerns raised below regarding the tower's visual incompatibility with adjacent and nearby residential uses. In particular, petitioner argues that the photo simulations of the proposed tower provided by intervenor, and relied upon by the hearings officer, are flawed in several respects. For example, petitioner argues that intervenor's photo simulations (1) depict the tower in mid-summer, when the leaves from deciduous trees help to obscure the pole from adjacent and nearby residences, rather than during the winter, when the leaves are not present; (2) present views from other commercially zoned property in the vicinity, rather than from residentially zoned property; (3) depict a relative height of the tower in relation to other structures in the vicinity that is vastly different than is depicted on photo simulations presented by petitioner; (4) inappropriately downplay the effect the height and bulk of the tower will have on adjacent residential properties; (5) do not reflect the change in tower color from white to flat gray; and (6) inaccurately depict the tower as translucent. According to petitioner, intervenor's failure to explain the methods it used to generate the photo simulations means that those photo simulations do not constitute evidence

Page 11

that a reasonable decision maker would rely on, especially when faced with countervailing evidence such as that presented by petitioner. In addition, petitioner argues that the hearings officer's decision fails to explain why intervenor's evidence was more probative or accurate than the evidence presented by opponents.

Intervenor responds that petitioner does not challenge the hearings officer's finding that "surrounding properties," as that term is used in ECC 9.8840(1), means all of those properties that will be visually impacted by the tower. According to petitioner, the broader focus means that the hearings officer could consider the impact of the tower on commercially zoned properties as well as on residential properties, and that consideration of the impact on residential properties is not to be narrowly interpreted to mean "impact on adjacent properties." Intervenor contends that the hearings officer had all of the photo simulations before her, including those submitted by petitioner. According to intervenor, the hearings officer's decision did not specifically rely on intervenor's photo simulations; rather, she reviewed all of the photos and evidence in the record to reach the conclusion that the proposed tower is compatible with the surrounding neighborhood. Intervenor emphasizes that in the C-2 zone, the maximum height for buildings is 120 feet, 20 feet higher than the proposed tower. Given that a building of that height is allowed within the zone, the determination that a 100-foot tower with an 18-inch diameter at its apex, and a number of other features designed to mitigate its impact on its surroundings, is compatible with the surrounding neighborhood is reasonable, and that conclusion is supported by substantial evidence.

The hearings officer's findings state, in relevant part:

"[S]ince the visual impact [of the proposed tower] is the sole compatibility issue, the `surrounding properties' [as that term is used in ECC 9.8440(1)] consist of those properties in such proximity to the proposed facility that * * * will, as a matter of course, be visually impacted by the pole. The record establishes that some residences near River Road will be able to see the pole from the windows of their homes. Others will be able to see the pole from their yards. In addition, the pole will be visible from commercial uses along

Page 12

River Road. It is those properties that constitute the `surrounding properties' for the purposes of the compatibility evaluation.

"Within the context of the surrounding properties, the inquiry here is whether the pole's general design and character is `reasonably compatible.' The question is not whether the pole can be seen from the surrounding area, but whether, from a visual perspective, the `general design and character' [of] an 18-inch pole is compatible with the entire surrounding area as a whole. Under the wording of this criterion, `bulk and height' are combined in terms of defining the impact. The mere fact of its height does not unequivocally render a use incompatible with the surrounding area. Rather, height and bulk are both relevant, since together they constitute the size of the facility and thus the visual impact the facility will have on surrounding properties.

"In this case, the facility is designed to resemble a 100-foot flag pole, approximately 3 feet at its base, and 18 inches at the top. It will be located on a site that is already developed with a car sales lot and on River Road, an area that already is developed, and therefore impacted, with a wide range of commercial facilities. Obviously, none of those commercial facilities is 100 feet tall. Correspondingly, the bulk of the facility is minimal compared to other development in the area. This inquiry relates to the visual impact of a 100-foot pole that is, in its most visible part, less than 2 feet in diameter.

"That residences near River Road will be able to see the 18-inch portion of the pole from their homes or yards does not render the pole incompatible. In this case, the pole has been designed so as to minimize any visual impact. Specifically, the minimal bulk of the pole mitigates the impact of its height to a large extent. It resembles a tall flag pole, is approximately 18 inches in diameter at the point where it will be most visible, with the antennas enclosed within the pole. The proposed pole will be along a highly developed commercial corridor, with numerous existing utility poles already exceeding the height of the surrounding commercial and residential development. The nature, intensity, and variety of the diverse commercial development along River Road will also mitigate the visual impact of the pole. Numerous tall trees throughout the area will further mitigate the impact of the height on the view of the skyline. With regard to the most immediate views from adjacent properties, while the 18-inch pole will exceed the height of the existing poles, its visual impact from the ground will not be significantly more intrusive than the existing utility poles. Viewed from River Road and other adjacent properties, the facility will consist of a landscaped, enclosed shelter on a car sales lot. While the proposed pole will be taller and less bulky than surrounding uses and thus will not `look like' surrounding uses, it will, nonetheless, be reasonably compatible with the surrounding commercial and residential environment." Record 24.

Page 13

As the findings make clear, the hearings officer relied on the evidence of existing mixed commercial and residential uses, as well as the relatively small diameter of the pole, to conclude that the height and bulk of the proposed tower will be reasonably compatible with the surrounding properties. Those findings are supported by substantial evidence.

B. Effect on Property Values

Petitioner argues that the city's decision fails to address testimony by neighbors that the telecommunications tower's location will have a substantial negative effect on residential property values in the immediate vicinity of the tower. Petitioner cites to newspaper articles, law review articles and real estate newsletters from national and state entities that conclude that telecommunications towers substantially reduce the property values of residences located immediately adjacent to them, and argues that there is no evidence in the record that rebuts opponents' claims that the proposed tower will have a substantial negative effect on neighborhood residential property values.

Intervenor responds that telecommunications towers are permitted in the C-2 zone, subject to site review. Intervenor contends that the *only question* in site review is whether the design as proposed is compatible with the surrounding neighborhood, *not* whether the telecommunications towers should be permitted in C-2 zones, or whether telecommunications towers should be located in proximity to residential uses. Intervenor contends that petitioner's arguments go to the latter questions.

The hearings officer's findings state, in relevant part:

"[Opponents] argue that [a flag-pole type tower] is incompatible `in the midst of a primarily residential neighborhood.' They further argue, based on additional photo simulations, that `a 100-foot flag pole would be twice as tall as any structure in the vicinity, and would dominate the viewshed from a number of neighbors' homes and yards.' * * * They argue that the cell tower could be located further away from this residential neighborhood, in a more `appropriate' industrial or commercial location[.] * * * [Opponents] urge that the proposed facility is incompatible because it would devalue their properties from somewhere between 4 and 40%.

Page 14

"[Opponents'] arguments are based, at least to some extent, on a premise that the proposed facility should not be permitted in this C-2 zone, either because the C-2 zone is the exception in this area, or because, notwithstanding the C-2 zone, the proximity to the nearby residences renders such a facility *per se* incompatible with the neighborhood. However, notwithstanding their characterizations or disagreement with the zoning, the subject property and much of the surrounding area along River Road is designated and zoned for commercial development. Subject to site review, telecommunications facilities are permitted in the subject C-2 zone. The C-2 zone is not `exceptional' in this area, nor is the location of a flag pole type facility *per se* incompatible on this C-2 zoned and developed car sales lot. Subject to compliance with the site review criteria, the C-2 zone is an appropriate location for the proposed tower[.] * * * Further, to the extent the argument is even arguably relevant to this criterion, there is no evidence in the record to document the assertion that the presence of this flag pole type structure itself will `devalue' properties from 4 to 40%." Record 22-23.

ECC 9.8440(1) is limited to consideration of "building location, bulk and height, noise, glare and odors." The issue of possible impacts of a proposed use on property values is at best indirectly related to ECC 9.8440(1). In any event, the hearings officer did not ignore petitioner's testimony concerning potential impacts on residential property values. Rather, the hearings officer concluded that, despite the evidence about the impacts of siting telecommunications towers within residential areas on property values generally, there was no evidence in the record that the tower that is proposed in this case will devalue surrounding properties. Although the hearings officer did not agree with petitioner's concerns about impacts on property values, she did not fail to address those concerns.

The fourth assignment of error is denied.

The city's decision is affirmed.

1. The hearings officer's findings state, in relevant part:

"With regard to [ECC] 9.5750(6)(c)(3), the [opponents] challenge the applicant's evidence demonstrating collocation is impractical on existing tall buildings, light or utility poles, water towers, existing transmission towers, and existing tower facility sites for reasons of structural support capabilities, safety, available space or failing to meet service coverage area needs. The [opponents] argue, essentially, that the height of the tower and the service area has been artificially determined in order to justify locating [the tower and antenna on the subject parcel], and that the applicant could collocate additional facilities on other surrounding buildings with lesser height and achieve the same objectives.

"This application requirement requires the applicant to establish that the tower, as it is proposed, cannot be collocated. It does not require the applicant to adjust its business needs or reconfigure its proposal in order to attempt to demonstrate that a different proposal, which would not serve its business needs, could potentially be collocated on an existing structure.

"The [opponents] also urge that the applicant has failed to demonstrate that it cannot collocate on the existing radio tower north of Goodpasture Island Road. The applicant disputes the distance of that tower from the subject property, but asserts that regardless of the distance, the radio tower is too far from the site to satisfy its service coverage area needs and that, in any event, radio towers are too `hot' to be able to collocate the necessary antennas.

"The applicant has provided the required evidence demonstrating that [collocating] on existing structures is impractical." Record 29.

2. *See*, *e.g.*, ECC 9.5750(3)(a), which allows outright the siting of a telecommunications antenna on an existing tower, and ECC 9.5750(4), which allows the siting of a telecommunications antenna on an existing utility pole or building, so long as the antenna does not exceed the maximum building height in the zone and the color of the antenna blends in with the existing structure and surroundings.

3. At oral argument, petitioner also argued that the proposed tower will pose an attractive nuisance to children. However, she did not raise this issue in her brief and, therefore, we do not address that argument here. *See DLCD v. Douglas County*, 28 Or LUBA 242, 252 (1994) (LUBA does not address issues that are raised for the first time at oral argument).

APPENDIX II

features

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

by Sandy Bond, PhD, and Ko-Kang Wang

abstract

This article examines whether proximity to cellular phone towers has an impact on residential property values and the extent of any impact. First, a survey approach is used to examine how residents perceive living near cellular phone base stations (CPBSs) and how residents evaluate the impacts of CPBSs. Next, a market study attempts to confirm the perceived value impacts reported in the survey by analyzing actual property sales data. A multiple regression analysis in a hedonic pricing framework is used to measure the price impact of proximity to CPBSs. Both the survey and market sales analysis find that CPBSs have a negative impact on the prices of houses in the study areas.

The introduction of cellular phone systems and the rapid increase in the number of users of cellular phones have increased exposure to electromagnetic fields (EMFs). Health consequences of long-term use of cellular phones are not known in detail, but available data indicates that development of nonspecific health symptoms is possible.[1] Conversely, it appears health effects from cellular phone equipment (antennas and base stations) pose few, if any, known health hazards.[2]

A concern associated with cellular phone usage is the siting of cellular phone transmitting antennas (CPTAs) and cellular phone base stations (CPBSs). In New Zealand, CPBS sites are increasingly in demand as the major cellular phone companies there, Telecom and Vodafone, 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.[3] However, new technology that represents potential hazards to human health and safety may cause property values to diminish due to public perceptions of hazards. Media attention to the potential health hazards of CPBSs has spread concerns among the public, resulting in increased resistance to CPBS sites.

Some studies suggest a positive correlation between long-term exposure to the electromagnetic fields and certain types of cancer,[4] yet other studies report inconclusive results on health effects.[5] Notwithstanding the research results, media reports indicate that the extent of opposition from some property owners

1. Stanislaw Szmigielski and Elizbieta Sobiczewska, "Cellular Phone Systems and Human Health—Problems with Risk Perception and Communication," *Environmental Management and Health* 11, no. 4 (2000): 352–368.
2. Jerry R. Barnes, "Cellular Phones: Are They Safe?" *Professional Safety* 44, no. 12 (Dec. 1999): 20–23.
3. R. Williams, "Phone Zone—Renting Roof Space to Ma Bell," *The Property Business* 12 (April 2001): 6–7.
4. C. M. Krause et al., "Effects of Electromagnetic Field Emitted by Cellular Phones on the EEG During a Memory Task," *Neuroreport* 11, no. 4 (2000): 761–764.
5. Independent Expert Group on Mobile Phones, *Mobile Phones and Health* (Report to the United Kingdom Government, 2000), http://www.iegmp.org.uk.

affected by the siting of CPBSs remains strong.[6] However, the extent to which such attitudes are reflected in lower property values for homes located near CPBSs is not known.

Understanding the impact of CPBSs on property values is important to telecommunications companies both for planning the siting of CPBSs and for determining likely opposition from property owners. Similarly, property appraisers need to understand the valuation implications of CPBSs when valuing CPBS-affected property. The owners of affected property also want to understand the magnitude of any effects, particularly if compensation claims or an award for damages are to be made based on any negative effects on value.

The research here uses a case study approach to determine residents' perceptions towards living near CPBSs in Christchurch, New Zealand, and to quantify these effects in monetary terms according to an increasing or decreasing percentage of property value. The case study uses both an opinion survey and an econometric analysis of sales transaction data. A comparison of the results can be used to help appraisers value affected property as well as to resolve compensation issues and damage claims in a quantitative way. Further, the results provide a potential source of information for government agencies in assessing the necessity for increased information pertaining to CPBSs.

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

Cellular Telephone Technology[7]

Cellular (mobile) telephones are sophisticated two-way radios that use ultrahigh 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 meters to several kilometers; they 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 call is initiated, the phone connects to the network by using radio signals to communicate with the nearest mobile phone site. 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. 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 horizontal, rather than at steep angles to the ground.

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.

Cell site capacity is a major issue for telecommunication companies. As the number of people using mobile phones grows, more and more cell sites are required to meet customer demand for reliable coverage. 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. Vodafone had over 1.1 million mobile phone customers.[8] In areas, such as Auckland (the largest city in New Zealand, with close to a third of the NZ population), 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.

Locating Cellular Phone Sites

For cellular phone service providers, the main goals when locating cell sites are (1) finding a site that provides the best possible coverage in the area without causing interference with other cells, and (2) finding a site that causes the least amount of environmental impact on the surrounding area. Service providers usually attempt to locate cell sites on existing structures such as buildings, where antennas can be mounted on the roof to minimize the environmental impact. If this is not possible, a mast will need to be erected to support the antennas for the new cell site.

---

6. S. Fox, "Cell Phone Antenna Worries Family," *East & Bays Courier,* November 8, 2002, 1.
7. The information in this section was sourced from Telecom, http://www.telecom.co.nz; New Zealand Ministry for the Environment, http://www.mfe.govt.nz; and New Zealand Ministry of Health, http://www.moh.govt.nz.
8. Vodafone, "Cell Sites and the Environment," http://www.vodafone.co.nz/aboutus/vdfn_about_cellsites.pdf (accessed December 19, 2002) and "Mobile Phones and Health," http://www.vodafone.co.nz/aboutus/vdfn_about_health_and_safety.pdf (accessed December 19, 2002); and Telecom, "Mobile Phone Sites and Safety," http://www.telecom.co.nz/content/0,3900,27116-1536,00.html (accessed December 19, 2002).

Service providers prefer to locate cell sites in commercial or industrial areas due to the "resource consent" procedure required by the Resource Management Act 1991[9] for towers located in residential areas.

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 where they live and work, but they do not want a site in their neighborhood. Thus, cell sites in or near residential areas are of particular concern. Concerns expressed usually relate to health, property values, and visual impact.[10]

In general, uncertainties in the assessment of health risks from base stations are presented and distributed in reports by organized groups of residents who protest against siting of base stations. When the media publishes these reports it amplifies the negative bias and raises public concerns. According to Covello, 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.[11]

Assessment of Environmental Effects

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 "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."[12] An assessment of the environmental effects of cell sites would take into consideration such things as health and safety effects; visual effects; effects on the neighborhood; and interference with radio and television reception.

Radio Frequency and Microwave Emissions from CPBSs

According to the Ministry for the Environment, 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.[13]

The amount of radiofrequency power absorbed by the body (the dose) is measured in watts per kilogram, known as the specific absorption rate (SAR). The SAR depends on the power density in watts per square meter. The radio frequencies from cellular phone systems travel in a "line of sight." The antennas are designed to radiate energy horizontally so that only small amounts of radio frequencies 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 minimal. Further, power density from the transmitter decreases rapidly as it 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.[14]

Health Effects

According to Szmigielski and Sobiczewska, the analogue phone system (using the 800–900 megahertz band) and digital phone system (using the 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 cellular phones and CPBSs.[15]

For years cellular phone companies have assured the public that cell phones are safe. They state that the particular set of radiation parameters associated with cell phones is the same as any other ra-

9. The Resource Management Act 1991 is the core of the legislation intended to help achieve sustainability in New Zealand; see http://www.mfe.govt.nz/laws/rma.
10. Szmigielski and Sobiczewska; and Barnes.
11. Vincent T. Covello, "Risk Perception, Risk Communication, and EMF Exposure: Tools and Techniques for Communicating Risk Information," in *Risk Perception, Risk Communication and Its Application to EMF Exposure: Proceedings of the World Health Organization and ICNIRP Conference,* ed. R. Matthes, J. H. Bernhardt, M. H. Repucholi, 179–214 (Munich, Germany, May 1998).
12. Section 88(4), (b), Resource Management Act 1991.
13. Ministry for the Environment and Ministry of Health, *National Guidelines for Managing the Effects of Radiofrequency Transmitters,* available at http://www.mfe.govt.nz and http://www.moh.govt.nz (accessed May 21, 2002).
14. Ibid.; and Szmigielski and Sobiczewska.
15. Szmigielski and Sobiczewska.

dio signal. However, reported scientific evidence challenges this view and shows that cell phone radiation causes various effects, such as altered brain activity, memory loss, and fatigue.[16]

According to Cherry, there is also strong evidence to conclude that cell sites are risk factors for certain types of cancer, heart disease, neurological symptoms and other effects.[17] The main concerns related to EMF emissions from CPBSs are linked to the fact that radio frequency fields penetrate exposed tissues.

Public concern regarding both cell phones and CPBSs in many countries has led to establishment of independent expert groups to carry out detailed reviews of the research literature. Research on the health effects of exposures to RF are reviewed by, for instance, the NZ Radiation Laboratory, the World Health Organization, the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Royal Society of Canada, and the UK Independent Expert Group on Mobile Phones. The reviews conclude that there are no clearly established health effects for low levels of exposure. Such exposures typically occur in publicly accessible areas around radio frequency transmitters. However, there are questions over the delayed effects of exposure.

While present medical and epidemiological studies reveal weak association between health effects and low-level exposures of RF/MW fields, controversy remains among scientists, producers, and the general public. Negative media attention has fuelled the perception of uncertainty over the health effects from cell phone systems. Further scientific or technological information is needed to allay fears of the public about cell phone systems.

Radio Frequency Radiation Exposure Standards

International Standards. The reviews of research on the health effects of exposures to RF have helped establish exposure standards that limit RF exposures to a safe level. Most standards–including those set by the ICNIRP, the American National Standards Institute (ANSI), and New Zealand–are based on the most-adverse potential effects.

The 1998 ICNIRP guidelines have been accepted by the world's scientific and health communities; these guidelines are both consistent with other stated standards and published by a highly respected and independent scientific organization. The ICNIRP is responsible for providing guidance and advice on the health hazards of nonionizing radiation for the World Health Organization (WHO) and the International Labour Office.[18]

The New Zealand Standard. In New Zealand, 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 factors such as power output, cable loss, antenna gain, path loss, and height and distance from the antenna. These calculations allow engineers to determine the maximum possible emissions in a worst-case scenario, i.e., as if the site was operated at maximum power all the time. The aim is to ensure that EME levels are below international and NZ standards in areas where the general public has unrestricted access.

All mobile phone sites in New Zealand must comply in all respects with the NZ standard for radio frequency exposures.[19] 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. Some local communities in New Zealand have even lower exposure-level standards; however, in reality mobile phone sites only operate at a fraction of the level set by the NZ standard. The National Radiation Laboratory has measured exposures around many operating cell sites, and maximum exposures in publicly accessible areas around the great majority of sites are less than 1% of the exposure limit of the NZ standard. Exposures are rarely more than a few percent of the limit, and none have been above 10%.

Court Decisions

Two court cases in New Zealand have alleged adverse effects due to CPBSs: *McIntyre v. Christchurch City*

16. K. Mann and J. Röschke, "Effects of Pulsed High-Frequency Electromagnetic Fields on Human Sleep," *Neuropsychobiology* 33, no. 1 (1996): 41–47; Krause et al.; Alexander Borbely et al., "Pulsed High-Frequency Electromagnetic Field Affects Human Sleep and Sleep Electroencephalogram," *Neurosci Let,* 275, no. 3 (1999): 207–210; L. Kellenyi et al., "Effects of Mobile GSM Radiotelephone Exposure on the Auditory Brainstem Response (ABR)," *Neurobiology* 7, no. 1 (1999): 79–81; B. Hocking, "Preliminary Report: Symptoms Associated with Mobile Phone Use," *Occup Med* 48, no. 6 (Sept. 1998): 357–360; and others as reported in Neil Cherry, *Health Effects Associated with Mobil Base Stations in Communities: The Need for Health Studies,* Environmental Management and Design Division, Lincoln University (June 8, 2000); http://pages.britishlibrary.net/orange/cherryonbasestations.htm.

17. Cherry.

18. Ministry for the Environment and Ministry of Health.

19. NZS 2772.1:1999, "Radiofrequency Fields Part I: Maximum Exposure Levels – 3kHz to 300GHz." This standard was based largely on the 1998 ICNIRP recommendations for maximum human exposure levels to radio frequency. The standard also includes a requirement for minimizing radio frequency exposure. See National Radiation Laboratory, *Cell Sites* (March 2001), 7; available at http://www.nrl.moh.govt.nz/CellsiteBooklet.pdf.

Council[20] and *Shirley Primary School v. Telecom Mobile Communications Ltd.*[21] Very few cell site cases have actually proceeded to Environment Court hearings. In these two cases the plaintiffs claimed that there was a risk of adverse health effects from radio frequency radiation emitted from cell phone base stations and that the CPBSs had adverse visual effects.

In *McIntyre*, Bell South applied for resource consent to erect a CPBS. The activity was a noncomplying 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, based on the present state of scientific knowledge, that there are no harmful health effects from low-level radio frequency exposure. It was also argued that the Resource Management Act contains a precautionary policy and also requires a consent authority to consider potential effects of low probability but high impact in reviewing 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*, Telecom applied to the Christchurch City Council for resource consent to establish, operate, and maintain a CPBS on land adjacent to the Shirley Primary School. This activity was a noncomplying activity under the Transitional District Plan. Again, the city council granted the consent subject to conditions. However, the school appealed the decision, alleging the following four adverse effects:

- Risk of adverse health effects from the radio frequency radiation emitted from the cell site
- Adverse psychological effects on pupils and teachers because of the perceived health risks
- Adverse visual effects
- Reduced financial viability of the school if pupils withdraw because of the perceived adverse health effects

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

In summary, the Environmental Court ruled that there are no established adverse health effects from the emission of radio waves from CPBSs and 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 one-half times lower than that of the ICNIRP.

The court did concede that while there are no proven health effects, there was evidence of property values being affected by both of the health allegations. The court suggested 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 a third case, *Goldfinch v. Auckland City Council*,[22] 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 the adverse effects of the CPBS. Further, it concluded that the effects are more than just minor as the CPBS stood upon the immediately neighboring property.

Literature Review

While experimental and epidemiological studies have focused on the adverse health effects of radiation from the use of cell phones and CPBSs, few studies have been conducted to ascertain the impact of CPBSs on property values. Further, 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 is reflected in lower property values is not well known in New Zealand.

Two studies have been conducted to ascertain the adverse health and visual effects of CPBSs on property values. Telecom commissioned Knight Frank (NZ) Ltd to undertake a study in Auckland in 1998/

20. NZRMA 289 (1996).
21. NZRMA 66 (1999).
22. NZRMA 97 (1996).

99 and commissioned Telfer Young (Canterbury) Ltd to undertake a similar study in Christchurch in 2001. Although the studies show that there is not a statistically significant effect on property prices where CPBSs are present,[25] the research in both cases involves only limited sales data analysis. Further, no surveys of residents' perceptions were undertaken, and the studies did not examine media attention to the sites and the impact this may have on saleability of properties in close proximity to CPBSs. Finally, as the sponsoring party to the research was a telecommunication company it is questionable whether the results are completely free from bias. Hence, the present study aims to help fill the research void on this contentious topic in an objective way.

CPBSs are very similar structures to high-voltage overhead transmission lines (HVOTLs); therefore it is worthwhile to review the body of literature on the property values effects of HVOTLs. The only recently published study in New Zealand on HVOTLs effects is by Bond and Hopkins.[24] Their research consists of both a regression analysis of residential property transaction data and an opinion survey to determine the attitudes and reactions of property owners in the study area toward living close to HVOTLs and pylons.

The results of the sales analysis indicate that having a pylon close to a particular property is statistically significant and has a negative effect of 20% at 10–15 meters from the pylon, decreasing to 5% at 50 meters. This effect diminishes to a negligible amount after 100 meters. However, the presence of a transmission line in the case study area has a minimal effect and is not a statistically significant factor in the sale prices.

The attitudinal study results indicate that nearly two-thirds of the respondents have negative feelings about the HVOTLs. Proximity to HVOTLs determines the degree of negativity: respondents living closer to the HVOTLs expressed more negative feelings towards them than those living farther away. It appears, however, from a comparison of the results, that the negative feelings expressed are often not reflected in the prices paid for such properties.

There have been a number of HVOTLs studies carried out in the United States and Canada. A major review and analysis of the literature by Kroll and Priestley indicates that in about half the studies, HVOTLs have not affected property values and in the rest of the studies there is a loss in property value between 2%–10%.[25] Kroll and Priestley are generally critical of most valuer-type studies because of the small number of properties included and the failure to use econometric techniques such as multiple regression analysis. They identify the Colwell study as one of the more careful and systematic analyses of residential impacts.[26] That study, carried out in Illinois, finds that the strongest effect of HVOTLs is within the first 15 meters, but the effect dissipates quickly with distance, disappearing beyond 60 meters.

A Canadian study by Des Rosiers, using a sample of 507 single-family house sales, finds that severe visual encumbrance due to a direct view of either a pylon or lines exerts a significant, negative impact on property values; however location adjacent to a transmission corridor may increase value.[27] This was particularly evident where the transmission corridor was on a well-wooded, 90-meter right-of-way. The proximity advantages include enlarged visual field and increased privacy. The decrease in value from the visual impact of the HVOTLs and pylons (on average between 5% and 10% of mean house value) tends to be cancelled out by the increase in value from proximity to the easement.

A study by Wolverton and Bottemiller[28] uses a paired-sale analysis of home sales in 1989–1992 to ascertain any difference in sale price between properties abutting rights-of-way of transmission lines (subjects) in Portland, Oregon; Vancouver, Washington; and Seattle, Washington; and those located in the same cities but not abutting transmission line rights-of-way (comparisons). Subjects sold during the study period were selected first; then a matching comparison was selected that was as similar to the subject as possible. The study results did not support a finding of a price effect from abutting an HVTL right-of-way. In their conclusion, the authors

23. Mark Dunbar, Telfer Young research valuer, personal communication with Bond, 2002. The results of these studies have not been made publicly known. The study by Knight Frank of Auckland was conducted by Robert Albrecht.
24. S. G. Bond and J. Hopkins, "The Impact of Transmission Lines on Residential Property Values: Results of a Case Study in a Suburb of Wellington, New Zealand," *Pacific Rim Property Research Journal* 6, no. 2 (2000): 52–60.
25. C. Kroll and T. Priestley, "The Effects of Overhead Transmission Lines on Property Values: A Review and Analysis of the Literature," Edison Electric Institute (July 1992).
26. Peter F. Colwell, "Power Lines and Land Value," *Journal of Real Estate Research* 5, no. 1 (Spring 1990): 117–127.
27. François Des Rosiers, "Power Lines, Visual Encumbrance and House Values: A Microspatial Approach to Impact Measurement," *Journal of Real Estate Research* 23, no. 3 (2002): 275–301.
28. Marvin L. Wolverton and Steven C. Bottemiller, "Further Analysis of Transmission Line Impact on Residential Property Values," *The Appraisal Journal* (July 2003): 244–252.

warn that the results cannot and should not be generalized outside of the data. They explain that

> limits on generalizations are a universal problem for real property sale data because analysis is constrained to properties that sell and sold properties are never a randomly drawn representative sample. Hence, generalizations must rely on the weight of evidence from numerous studies, samples, and locations.[29]

Thus, despite the varying results reported in the literature on property value effects from HVOTLs, each study adds to the growing body of evidence and knowledge on this (and similar) valuation issue(s). The study reported here is one such study.

Opinion Survey Research Objectives and Methodology

Research by Abelson;[30] Chalmers and Roehr;[31] Kinnard, Geckler and Dickey;[32] Bond;[33] and Flynn et al.,[34] recommend the use of market sales analysis in tandem with opinion survey studies to measure the impact of environmental hazards on residential property values. The use of more than one approach provides the opportunity to compare the results from each and to derive a more informed conclusion than obtained from relying solely on one approach. Thus, the methods selected for this study include a public opinion survey and a hedonic house price approach (as proposed by Freeman[35] and Rosen[36]). A comparison of the results from both of these techniques will reveal the extent to which the market reacts to cell phone towers.

Public Opinion Survey

An opinion survey was conducted to investigate the current perceptions of residents towards living near CPBSs and how this proximity might affect property values. Case study areas in the city of Christchurch were selected for this study. The study included residents in ten suburbs: five case study areas (within 300 meters of a cell phone tower) and five control areas (over 1 kilometer from the cell phone tower). The five case study suburbs were matched with five control suburbs that had similar living environments (in socioeconomic terms) except for the presence of a CPBS.

The number of respondents to be surveyed (800) and the nature of the data to be gathered (perceptions/personal feelings towards CPBSs) governed the choice of a self-administered questionnaire as the most appropriate collection technique. Questionnaires were mailed to residents living in the case study and control areas.

A self-administered survey helps to avoid interviewer bias and to increase the chances of an honest reply where the respondent is not influenced by the presence of an interviewer. Also, mail surveys provide the time for respondents to reflect on the questions and answer these at their leisure, without feeling pressured by the time constraints of an interview. In this way, there is a better chance of a thoughtful and accurate reply.

The greatest limitation of mail surveys is that a low response rate is typical. Various techniques were used to help overcome this limitation, including careful questionnaire design; inclusion of a free-post return envelope; an accompanying letter ensuring anonymity; and reminder letters. An overall response rate of 46% was achieved for this study.

The questionnaire contained 43 individual response items. The first question acted as an identifier to determine whether the respondent was a homeowner or tenant. While responses from both groups were of interest, the former was of greater importance, as they are the group of purchasers/sellers that primarily influence the value of property. However, it was considered relevant to survey both groups as both are affected by proximity to a CPBS to much the same extent from an occupiers' perspective, i.e., they both may perceive risks associated with a CPBS. It was hypothesized that tenants, being less-permanent residents, would perceive the effects in a similar way, but to a much lesser degree.

Other survey questions related to overall neighborhood environmental desirability; the timing of

29. Ibid., 252.
30. P. W. Abelson, "Property Prices and Amenity Values," *Journal of Environmental Economics and Management* 6 (1979): 11–28.
31. James A. Chalmers and Scott Roehr, "Issues in the Valuation of Contaminated Property," *The Appraisal Journal* (January 1993): 28–41.
32. W. N., Kinnard, M. B. Geckler, and S. A. Dickey, "Fear (as a Measure of Damages) Strikes Out: Two Case Studies Comparisons of Actual Market Behaviour with Opinion Survey Research" (paper presented at the Tenth Annual American Real Estate Society Conference, Santa Barbara, California, April 1994).
33. S. G. Bond, "Do Market Perceptions Affect Market Prices? A Case of a Remediated Contaminated Site," in *Real Estate Valuation Theory,* ed. K. Wang and M. L. Wolverton, 285–321 (Boston: Kluwer Academic Publishers, 2002).
34. James Flynn et al., "Survey Approach for Demonstrating Stigma Effects in Property Value Litigation," *The Appraisal Journal* (Winter 2004): 35–45.
35. A. Myrick Freeman, *The Benefits of Environmental Improvement: Theory and Practice* (Baltimore: John Hopkins Press, 1979).
36. Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy* 82, no. 1 (Jan/Feb 1974): 34–55.

the CPBS's construction and its proximity in relation to the respondent's home; the importance placed on the CPBS as a factor in relocation decisions and on the price/rent the respondent was prepared to pay for the house; how a CPBS might affect the price the respondent would be willing to pay for the property; and the degree of concern regarding the effects of CPBSs on health, stigma, aesthetics, and property values. The surveys were coded to identify the property address of the respondent. This enabled each respondent's property to be located on a map and to show this in relation to the cell site.

Eighty questionnaires[37] were distributed to each of the ten suburbs (five case study and five control areas) in Christchurch. Respondents were instructed to complete the survey and return it in the free-post, self-addressed envelope provided. The initial response rate was 31%. A month later, a further 575 questionnaires with reminder letters were sent out to residents who had not yet responded. A total response rate of 46% was achieved. Response rates from each suburb ranged from 33% (Linwood) to 61% (Bishopdale).

The questionnaire responses were coded and entered into a computerized database.[38] 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.

Case Study and Control Areas

The suburbs of Beckenham, Papanui, Upper Riccarton, Bishopdale, and St Albans were selected for the case study because there is at least one CPBS within each of these communities. Census data, providing demographic and socioeconomic characteristics of geographic areas, was used to select the control suburbs of Spreydon, Linwood, Bromley, Avonhead, and Ilam.[39] The control areas are located further away (over 1 kilometer) from the CPBS in their matched case study area. As well as matching demographic and socioeconomic characteristics, each suburb was selected based on its similarity to its matched case study area in terms of living environment and housing stock, distance to the central business district, and geographic size; the only dissimilarity is that there are no CPBSs in the control areas. (See Appendix I for a location map.)

Demographic statistics show that Bromley and Ilam comprise a younger population (median age about 33), with Bishopdale and Upper Riccarton having an older population (median age about 40). The ethnic breakdown of each suburb indicates that Papanui and Spreydon have the highest proportion of Europeans (about 90%), Bromley has the highest proportion of both Maoris and Pacific Islanders (13.9% and 8.5% respectively), while Ilam, Avonhead, and Upper Riccarton have the highest proportion of Asians (16.1% to 18.5%).[40]

Median household and median family incomes (MHI and MFI) are highest in Ilam and Avonhead (MHI: $34,751NZ, $53,405NZ; MFI: $51,530NZ, $65,804NZ, respectively) and lowest in Linwood and Beckenham (MHI: $22,275NZ, $26,398NZ; MFI: $29,673NZ, $33,847NZ respectively).[41] Residents of St Albans West have the highest levels of education (21.7% have a degree or a higher degree) followed by Upper Riccarton (18.7%), Ilam (16.7%), and Avonhead (16.2%). These same suburbs have the highest proportion of professionals by occupational class (20.3% to 27.3%). Residents of Bromley have the lowest education (40% have no qualification) and the lowest proportion of professionals (5.5%).[42]

In summary, the socioeconomic data shows that Ilam is the more superior suburb, followed by Avonhead, Upper Riccarton, St Albans West, and Papanui. The lower socioeconomic areas are, in decreasing order, Spreydon, Bishopdale, Bromley, Beckenham, and Linwood.

Survey Results

A summary of the main findings from the survey is presented in Appendix II, and the survey results are discussed in the following.

Response Rates

Of the 800 questionnaires mailed to homeowners and tenants in the case study and control areas (400 to each group), 50% from the case study area and 41%

37. Approved by the University of Auckland Human Subjects Ethics Committee (reference 2002/185).
38. The computer program SPSS was selected as the appropriate analytical tool for processing the data.
39. The census is conducted in New Zealand every five years, and the data used to define the control areas is from the latest census conducted in 2001, see Christchurch City Area Unit Profile, 2001 at http://www.ccc.govt.nz/Census/ChristchurchCityAreaUnitProfile.xls.
40. Christchurch City Area Unit Profile statistics.
41. $1NZ = $0.65US, thus, $34,751NZ = $22,588US.
42. The median house price for Christchurch city in August 2003 was $185,000NZ/$120,000US (New Zealand national median house price at this time was $215,000NZ/$140,000US), http://www.reinz.co.nz/files/HousingFacts-Sample-Pg1-5.pdf (accessed March 17, 2004). Median house prices in each individual suburb could not be obtained as the median sales data from the Real Estate Institute of NZ (REINZ) contains more than one suburb in each location grouping.

from the control area were completed and returned. Over three-quarters (78.5%) of the case study respondents were homeowners compared to 94% in the control area.

Desirability of the Suburb as a Place to Live

More than half (58.3%) the case study respondents have lived in their suburb for more than five years (compared to 65% in the control group) and a quarter (25%) have lived in their suburb between 1 and 4 years (compared to 28% in the control group).

Around two-thirds (65% of the case study respondents and 68% of the control group respondents) rated their neighborhoods as either above average or superior as a place to live when compared with other similar named suburbs. The reasons given for this include close proximity to amenities (shops, library, medical facilities, public transport, and recreational facilities) and good schools.

Reasons given for rating the case study neighborhoods inferior to other similar neighborhoods include lower house prices, older homes, more student housing and lower-income residents. The reasons given by the control group respondents for an inferior rating include distance from the central business district (Avonhead); smell from the sewerage oxidation ponds and composting ponds (Bromley); and lower socioeconomic area and noise from the airport (Linwood).

Feelings About a CPBS as an Element of the Neighborhood

In the case study areas, a CPBS had already been constructed when only 39% of the respondents bought their houses or began renting in the neighborhood. Some responded that they were not notified that the CPBS was to be built, that they had no opportunity to object to it, and that they felt they should have been consulted about its construction. For the respondents who said that proximity to the tower was of concern to them, the most common reasons given for this were the impact of the CPBS on health, aesthetics, and property values. Nearly three-quarters (74%) of the respondents said they would have gone ahead with the purchase or rental of their property anyway if they had known that the CPBS was to be constructed.

In the control areas nearly three-quarters (72%) of the respondents indicated they would be opposed to construction of a CPBS nearby. The location of a CPBS would be taken into account by 83% of respondents if they were to consider moving. As with the case study respondents, the control group respondents who were concerned about proximity to a CPBS were most often concerned about the effects of CPBSs on health, aesthetics, and property values.

Impact on Decision to Purchase or Rent

In the case study areas, the tower was visible from the houses of 46% of the respondents, yet two-thirds (66%) of these said it was barely noticeable, and one-quarter said it mildly obstructed their view. When asked in what way the CPBS impacts the enjoyment of living in their home, 37% responded that its impact was related to health concerns, 21% said it impacted neighborhood aesthetics, 20% said it impacted property value, and 12% said it impacted the view from their property.

When asked about the impact that the CPBS had on the price/rent they were prepared to pay for their property, over half the case study respondents (53.1%) said that the tower was not constructed at the time of purchase/rental, and 51.4% of the respondents said the proximity to the CPBS did not affect the price they were prepared to pay for the property. Nearly 3% said they were prepared to pay a little less, 2% said they were prepared to pay a little more. For the control group respondents, 45% of the respondents would pay substantially less for a property if a CPBS were located nearby, over one-third (38%) were prepared to pay just a little less for such a property, and 17% responded that a CPBS would not influence the price they would pay.

Only 10% of the case study respondents gave an indication of the impact that the CPBS had on the price/rent they were prepared to pay for the property; one-third of these felt it would decrease price/rent by 1% to 9%. For the control group, over one-third (38%) of the respondents felt that a CPBS would decrease price/rent by more than 20%, and a similar number (36%) said they would be prepared to pay 10% to 19% less for property located near a CPBS. The responses are outlined in Table 1.

Table 1 Impact of a CPBS on Purchase/Rental Price Decision

Price/Rent Effect	Percent of Case Study Respondents (Control Group Responses)
20% more	5% (3%)
10–19% more	10% (2%)
1–9% more	14% (2%)
1–9% less	33% (19%)
10–19% less	24% (36%)
20% or greater reduction in price/rent	14% (38%)

Interestingly, it would seem that those living farther away from the CPBSs (the control group) are far more concerned about proximity to CPBSs than those living near CPBSs (the case study group); they indicated that a CPBS would have a greater price/rent effect. The possible explanations for this are discussed in the survey results section.

Concerns About Proximity to the CPBS

Most case study respondents were not worried about the effects of proximity to a CPBS related to health (50%), stigma (55%), future property value (61%), or aesthetics (63%). About one-quarter to one-third of these respondents were somewhat worried about the impact of proximity to a CPBS on health (38%), stigma (34%), future property value (25%), or aesthetics (25%). From the list of issues, respondents were most worried about future property value, but only 13.5% of the respondents responded this way.

Here again, control group respondents were much more concerned about the effects of proximity to a CPBS than their case study counterparts. Of the possible concerns about CPBSs on which respondents were asked to comment, control group respondents were most worried about the negative effects on future property values and aesthetics. Nearly half the respondents were worried a lot about these issues. Similar responses were recorded for the possibility of harmful health effects in the future from CPBSs (42% were worried a lot about this) and stigma associated with houses near CPBSs (34% were worried a lot). The responses regarding concerns about living near a CPBS are shown in Table 2.

In both the case study and control areas, the issue of greatest concern for respondents was the impact of proximity to CPBSs on future property values. The main concerns related to CPBSs were the unknown potential health effects, the possible socioeconomic implications of the siting of CPBSs, and how CPBSs affect property values. There also were concerns that the city council was not notifying the public about the possible construction of CPBSs.

Discussion of the Survey Results

The results were mixed, with responses from residents ranging from having no concerns to being very concerned about proximity to a CPBS. In general, those people living in areas farther from CPBSs were much more concerned about issues related to proximity to CPBSs than residents who lived near CPBSs.

Over 40% of the control group respondents were worried a lot about future health risks, aesthetics, and future property values compared with the case study areas, where only 13% of the respondents were worried a lot about these issues. However, in both the case study and control areas, the impact of proximity to CPBSs on future property values is the issue of greatest concern for respondents. If purchasing or renting a property near a CPBS, over a third (38%) of the control group respondents said a CPBS would reduce the price of their property by more than 20%. The perceptions of the case study respondents were again less negative, with a third saying they would reduce the price by only 1%–9%, and 24% saying they would reduce the price by 10%–19%.

The lack of concern shown by the case study respondents may be due to the CPBSs being either not visible or only barely visible from their homes. The CPBSs may be far enough away from respondents' properties (as was indicated by many respondents, particularly in St Albans West, Upper Riccarton, and Bishopdale) or hidden by trees and consequently not perceived as affecting the properties. The results may have been quite different had the CPBS being more visually prominent.

Alternatively, the apparent lower sensitivity to CPBSs of case study residents compared to the control group residents may be due to cognitive dissonance reduction. In this case, respondents may be unwilling to admit, due to the large amounts of money already paid, that they may have made a poor purchase or rental decision in buying or renting property located near a CPBS. Similarly, the homeowners may be unwilling to admit there are concerns about CPBSs when the CPBSs were built

Table 2 **Concerns about Living Near a CPBS***

Concern	Does not worry me	Worries me somewhat	Worries me a lot
Possibility of harmful health effects	50% (20%)	38% (38%)	12% (42%)
Stigma effect	55% (21%)	34% (45%)	12% (34%)
Effect on future property values	61% (15%)	25% (37%)	13% (47%)
Aesthetics	63% (18%)	25% (37%)	11% (45%)

* Percent of case study respondents having that concern (control group respondents). All numbers are rounded.

after they had purchased their homes, because to do so might have a negative impact on property values.

Regardless of the reasons for the difference in responses from the case study and control groups, the overall results show that residents perceive CPBSs negatively. In both the case study and control areas, the impact of proximity to CPBSs on future property values was the issue of greatest concern for respondents. Overall, respondents felt that proximity to a CPBS would reduce value by from 10% to over 20%. The second part of the study outlined below, involving an econometric analysis of Christchurch property sales transaction data, helps to confirm these results.

Respondents' comments added at the end of the survey indicate that residents have ongoing concerns about CPBSs. Although some people accepted the need for CPBSs, they said that they did not want them built in their back yard, or they preferred that they be disguised to blend better with their environment.

Market Study Research Objectives and Methodology

A market study was undertaken to test the hypothesis that in suburbs where there is a CPBS it will be possible to observe discounts to the selling price of homes located near these structures. Such discounts would be observed where buyers of proximate homes view the CPBSs in negative terms due to a perceived risk of adverse effects on health, aesthetics, and property value.

The literature dealing specifically with the measurement of the impact of environmental hazards on residential sale prices (including proximity to transmission lines, landfill sites, and ground water contamination) indicates the popularity of hedonic pricing models, as introduced by Court[43] and later Griliches,[44] and further developed by Freeman[45] and Rosen.[46] The more recent studies, including those by Dotzour;[47] Simons and Sementelli;[48] and Reichert,[49] focus on proximity to an environmental hazard and demonstrate that this reduces residential house prices by varying amounts depending on the distance from the hazard.[50] However, there are no known published studies that use hedonic housing models to measure the impact of proximity to a CPBS on residential property values.

As in the previous residential house price studies, the standard hedonic methodology was used here to quantify the impact of a CPBS on sale prices of homes located near a CPBS. The results from this study in tandem with the opinion survey results will help test the hypothesis that proximity to a CPBS has a negative impact on property value and will reveal the extent to which the market reacts to CPBSs.

Model Specification

A hedonic price model is constructed by treating the price of a property as a function of its utility-bearing attributes. Independent variables used in the model to account for the property attributes are limited to those available in the data set and known, based on other well-tested models reported in the literature and from valuation theory, to be related to property price. The basic model used to analyze the impact on sale price of a house located near a CPBS, is as follows:

$$P_i = f(X_{1,i}, X_{2,i} \dots \dots \dots \dots \dots X_{n,i})$$

where:

P_i = property price at the i th location

$X_{1,i} \dots X_{n,i}$ = individual characteristics of each sold property (e.g., land area, age of house, floor area, sale date, construction materials, house condition, CPBS construction date, etc.)

The more recent hedonic pricing studies that demonstrate the effects of proximity to an environmental hazard use different functional forms to represent the relationship between price and various property characteristics.[51] In hedonic housing models the linear and log-linear models are most popular. The linear model implies constant partial effects between house prices and housing characteristics, while the log-linear model allows for nonlinear price effects and is shown in the following equation:

43. A. T. Court, "Hedonic Price Indexes with Automotive Examples," in *The Dynamics of Automobile Demand* (New York: General Motors, 1939).

44. Zvi Griliches, ed. *Price Indexes and Quality Change* (Cambridge, Mass.: Harvard University Press, 1971).

45. Freeman.

46. Rosen.

47. Mark Dotzour, "Groundwater Contamination and Residential Property Values," *The Appraisal Journal* (July 1997): 279–285.

48. Robert A. Simons and Arthur Sementelli, "Liquidity Loss and Delayed Transactions with Leaking Underground Storage Tanks," *The Appraisal Journal* (July 1997): 255–260.

49. Alan K. Reichert, "Impact of a Toxic Waste Superfund Site on Property Values," *The Appraisal Journal* (October 1997): 381–392.

50. Only Dotzour found no significant impact of the discovery of contaminated groundwater on residential house prices. This was likely due to the nonhazardous nature of the contamination where the groundwater was not used for drinking purposes.

51. See for example L. Dale et al., "Do Property Values Rebound from Environmental Stigmas? Evidence from Dallas," *Land Economics* 75, no. 2 (May 1999): 311–326; Dotzour; Simons and Sementelli; and Reichert.

$$\ln P_i = b_0 + b_1 \times X_{1,i} + b_2 \times X_{2i} + b_3 \times X_{3i} \ldots\ldots\ldots + b_n \times X_{n+1} + a_o \times D_o + \ldots\ldots + a_m \times D_m + e_0$$

where:

$\ln P_i$ = the natural logarithm of sale price

b_0 = the intercept

$b_1 \ldots b_n$; $a_o \ldots a_m$ = the model parameters to be estimated, i.e., the implicit unit prices for increments in the property characteristics

$X_1 \ldots X_n$ = the continuous characteristics, such as land area

$D_o \ldots D_m$ = the categorical (dummy) variables, such as whether the sale occurred before (0) or after (1) the CPBS was built

Sometimes the natural logarithm of land area and floor area is also used. The parameters are estimated by regressing property sales on the property characteristics and are interpreted as the households' implicit valuations of different property attributes. The null hypothesis states that the effect of being located near a CPBS does not explain any variation in property sale prices.

The Data

Part of the process for selecting appropriate case study areas was identifying areas where there had been a sufficient number of property sales to provide statistically reliable and valid results. Sales were required for the period before and after the CPBS had been built in order to study the impact of the CPBS on the surrounding properties' sale prices.

Further, due to the multitude of factors that combine to determine a neighborhood's character, such as proximity to the central business district, standard of schooling, recreational facilities provided, standard of housing, proximity to amenities, and the difficulty in allowing for these separately, sales located in areas with comparable neighborhood characteristics were preferred.

Four of the suburbs in the survey case study met the criteria for the market study: St Albans, Beckenham, Papanui, and Bishopdale. No sales data was available for Upper Riccarton after the CPBS was built in this suburb, hence this suburb was not included in the market analysis study. As each CPBS was built at a different date, the sales from each suburb were separately analyzed. The uniformity of locational and neighborhood characteristics in each of these suburbs allows the analysis to be simplified and to focus on the properties' physical attributes. The relative homogeneity of housing, locational, and neighborhood attributes was verified through field inspections.

The dependent variable is the property sale price. The data set includes 4283 property sales that occurred between 1986 and 2002 (approximately 1000 sales per suburb).[52]

The independent data set was limited to those variables that correspond to property attributes known and suspected to influence price. These variables are floor area (m^2); land area (ha); age of the house (the year the house was built); tower (a dummy variable indicating whether the sale occurred before or after the CPBS was built); sale date (month and year); time of sale based on the number of quarters before or after the CPBS was built (to help control for movements in house prices over time); category of residential property (stand-alone dwelling, dwelling converted into flats, ownership unit, etc); quality of the principal structure (as assessed by an appraiser); and roof and wall materials. The number of bedrooms was not available in the data set, but would not have been included as an independent variable since the number of bedrooms is highly correlated with floor area.

Since the GIS coordinates of properties for the initial analysis were not available, street name was included as an independent variable instead. To a limited extent, street name helped to control for the proximity effects of a CPBS. It was suspected that houses on a street close to a CPBS may, on average, sell for less than houses on a street farther away from the CPBS.

While views, particularly water views, have been shown in previous empirical studies to be an important attribute affecting sale price, in the present study the flat contour of the landscape where the homes are located, together with the suburban nature of the environment surrounding these, precluded any significant views. Thus, views were not included in the analysis. Further, due to the large number of sales included in the analysis, inspections of each individual property were not made to determine the view, if any, of a CPBS from each house. It was felt that it is not merely the view that may impact on price, but also proximity to a CPBS due to the potential effect this may have on health, cell phone coverage, and neighborhood aes-

52. These sales were obtained from Headway Systems Ltd, a data distribution and system development company. Headway is the major supplier of property market sales information to New Zealand's valuation profession; it is jointly owned by the NZ Institute of Valuers (NZIV) and PT Investments, a consortium of 28 shareholders from within the property industry.

thetics. Hence, view of a CPBS was not included as an independent variable. The variable descriptions are listed in Table 3. Variable codes are shown in Appendix III and basic descriptive statistics for selected quantitative variables are shown in Appendix IV.

Table 3 **Variable Descriptions**

Variable*	Definition
SLNETX	Sale price of the house (NZ$)
SITSTX	Street name
CATGYX2	Category of dwelling: D, E, etc.†
CATGYX4	Quality of the structure: A, B, C†
TIMESOLD.Q	Using the time the cell phone tower was built as a baseline quarter, the number of quarters before (–) and after (+) it was built
AGE	Year the house was built
LANDAX	Land area (ha)
MATFAX	Total floor area (m^2)
WALLCNX	Wall construction: W, B, C, etc. †
ROOFCNX	Roof construction: W, B, C, etc. †
TOWER	An indicator variable: 0 if before the cell phone tower was built, or 1 after it was built

* Sale price is the dependent variable.

† See Appendix III for explanation of variable codes.

Market Study Results

An econometric analysis of Christchurch property transaction data helped to confirm the opinion survey results. In the analysis of selected suburbs, the sales data from sales that occurred before a CPBS was built was compared to sales data from after a CPBS was built to determine any variance in price, after accounting for all the relevant independent variables.

Empirical Results

The model of choice is one that best represents the relationships between the variables and has a small variance and unbiased parameters. Various models were tested and the results are described in the next section. The following statistics were used to help select the most appropriate model: the adjusted coefficient of determination (adjusted R^2); the standard error of the regression equation; the AIC[53] and BIC[54] statistics; and *t*-test of significance of the coefficients and *F*-statistic.

Significance of Variables and the Equation: St Albans

As hedonic prices can vary significantly across different functional forms, various commonly used functional forms were examined to determine the model specification that best describes the relationship between price and the independent variables. Also, to test the belief that the relationship between *Price* and *Land Area* is not a linear function of *Price,* the variable *LANDAX* (land area) was transformed to reflect the correct relationship. Several transformations were tested including: linear of *SLNETX* (sale price) and log of *LANDAX*; log of *SLNETX* and linear of *LANDAX;* and log of *SLNETX* and log of *LANDAX*. All dummy variables remained in their linear form in each model.

It was found that the best result was obtained from using the log of *SLNETX* and log of *LANDAX*, and the linear form of all the dummy variables. Taking the log of an independent variable implies diminishing marginal benefits. For example, an extra 50 square meters of land area on a 550-square-meter site would be worth less than the previous 50 square meters. The log-log model shows the percent change in price for a one-percent change in the independent variable, while all other independent variables are held constant (as explained in Hill, Griffiths, and Judge).[55]

In the semilogarithmic equation the interpretation of the dummy variable coefficients involves the use of the formula: $100(e^{b_n} - 1)$, where b_n is the dummy variable coefficient.[56] This formula derives the percentage effect on price of the presence of the factor represented by the dummy variable and is advocated over the alternative, and commonly misused, formula of 100. (b_n). The resulting model included all the available variables as follows:

$$\begin{aligned}\log(SLNETX) = \alpha &+ \beta_1 \times TOWER + \beta_2 \times SITSTX \\ &+ \beta_3 \times CATGYX2 + \beta_4 \times CATGYX4 \\ &+ \beta_5 \times TIMESOLD \times Q + \beta_6 \times AGE \\ &+ \beta_7 \times \log(LANDAX) \\ &+ \beta_8 \times MATFAX \\ &+ \beta_9 \times WALLCNX \\ &+ \beta_{10} \times ROOFCNX\end{aligned}$$

53. AIC is the Akaike Information Criterion, and is a "goodness of fit" measure involving the standard error of the regression adjusted by a penalty factor. The model selected is the one that minimizes this criterion (Microsoft SPSSPC Online Guide, 1997).
54. The BIC is the Bayesian Information Criterion. Like the AIC, BIC takes into account both how well the model fits the observed data, and the number of parameters used in the model. The model selected is the one that adequately describes the series and has the minimum SBC. The SBC is based on Bayesian (maximum-likelihood) considerations. (Microsoft SPSSPC Online Guide, 1997).
55. R. Carter Hill, William E. Griffiths, and George G. Judge, *Undergraduate Econometrics* (New York: John Wiley & Sons, 1997).
56. See Robert Halvorsen and Raymond Palmquist, "The Interpretation of Dummy Variables in Semi-Logarithmic Equations," *American Economic Review* 70, no. 3 (1980): 474–475.

From the regression output, the variables *ROOFCNX* and *WALLCNX* were found to be insignificant so these were removed from the model and the regression was rerun. The table in Appendix V summarizes these results. The *F*-statistic (123) shows that the estimated relationship in the model is statistically significant at the 95% confidence level and that at least one of the coefficients of the independent variables within the model is not zero.

Table 4 summarizes the model selection test statistics. Based on the AIC and BIC, the regression that excludes the variables *ROOFCNX* and *WALLCNX* is superior to the regression that includes them (AIC and BIC are minimized). For this reason, the model excluding these variables was selected for analysis, and it is discussed next.

Table 4 Test Statistics — St Albans

	Adjusted R^2	AIC	BIC
Full Model	0.82	-118.38	36.55
Sub Model	0.82	-121.64	5.95

Tests for normality, heteroskedasticity, and multicollinearity generally indicated that the model was adequately specified and that the data were not severely ill conditioned (heteroskedasticity and multicollinearity were diminished when the data were transformed).

The coefficient of determination (R^2) indicates that approximately 82% of the variation in sale price is explained by the variation in the independent variable set. All variable coefficients had the expected signs,[57] except for *TOWER*, which was positive. The positive coefficient for *TOWER* shows that, when all the other variables are held constant, after the installation of a CPBS in St Albans, the price of a house would increase by $e^{0.1133} \approx 1.12$ (12%). A possible explanation is that cell phone technology was quite new at the time (1994), and as there had been little in the media about possible adverse health effects from CPBSs, people may have perceived it as a benefit as they were likely to get better cell phone coverage.

The most significant variables were *TIMESOLD.Q* (the quarter in which the sale occurred before or after the CPBS was built), *log(LANDAX)* (log of land area), and *MATFAX* (total floor area) and all have a positive influence on price. The positive *TIMESOLD.Q* indicates that the market was increasing over time since the CPBS was built (1994), but only to a limited extent (1.38%). The positive log of land area and total floor area shows that prices increase with increasing size.

The regression coefficient on *log(LANDAX)* is 0.3285, which indicates that, on average, a 10% increase in *LANDAX* will generate a 3.285% increase in price. The positive coefficient for *MATFAX* indicates that, when all the other variables are held constant, for each additional m^2 the price would increase by $e^{0.0022314} \approx 1.0022314$ (0.22% increase).

Significance of Variables and the Equation: Papanui

The same functional form used for St Albans was used for Papanui. From the regression output, the variable *CATGYX2* was found to be insignificant so it was removed from the model and the regression was rerun; Appendix VI summarizes the results. The *F*-statistic (152) shows that the estimated relationship in the model is statistically significant at the 95% confidence level and that at least one of the coefficients of the independent variables within the model is not zero.

Table 5 summarizes the model selection test statistics. Based on the AIC and BIC, the regression that excludes the variable *CATGYX2* is superior to the regression that includes it (AIC and BIC are minimized). For this reason, the model excluding this variable was selected for analysis, and is discussed next.

Table 5 Test Statistics — Papanui

	Adjusted R^2	AIC	BIC
Full Model	0.87	-509.91	-371.99
Sub Model	0.87	-510.57	-381.56

The coefficient of determination (R^2) indicates that approximately 87% of the variation in sale price is explained by the variation in the independent variable set. This would be considered high in comparison with the amount of explanation obtained in similar hedonic house studies reported in the literature.[58] All variable coefficients had the expected signs.

The most significant variables were *TIMESOLD.Q, MATFAX* (total floor area), and *TOWER*. The former two have a positive influence on price. The positive *TIMESOLD.Q* indicates that the

57. Note that the variable *AGE* is positive as this variable indicates the year the house was built; therefore, the higher the year, the younger the home. Newer houses have less wear and tear than older homes and sell, on average, for more than older homes.

58. For example, Reichert obtained an adjusted R^2 of 84%; Simons and Sementelli, 78%; Abelson, 68%; Dotzour, 56%–61%.

market was increasing over time since the CPBS was built (2000), but only by 1.4% per quarter. The positive coefficient for *MATFAX* indicates that, when all the other variables are held constant, the price would increase by $e^{0.0042576} \approx 1.00427$ (0.43%), with increasing size. The negative coefficient for *TOWER* shows that, when all the other variables are held constant, after the installation of a CPBS in Papanui, the price of a house would decrease by $e^{-0.2340} \approx 0.79$ (21% decrease).

Significance of Variables and the Equation: Beckenham

The same functional form used for Papanui and St Albans was used for Beckenham. From the regression output, the variable *ROOFCNX* was found to be insignificant so it was removed from the model and the regression was rerun; Appendix VII summarizes these results. The *F*-statistic (214) shows that the estimated relationship in the model is statistically significant at the 95% confidence level and that at least one of the coefficients of the independent variables within the model is not zero.

Table 6 summarizes the model selection test statistics. Based on the AIC and BIC, the regression that excludes the variable *ROOFCNX* is superior to the regression that includes it (AIC and BIC are minimized). For this reason, the model excluding this variable was selected for analysis.

Table 6 Test Statistics — Beckenham

	Adjusted R^2	AIC	BIC
Full Model	0.89	-819.00	-641.39
Sub Model	0.89	-818.66	-650.66

The coefficient of determination (R^2) indicates that approximately 89% of the variation in sale price is explained by the variation in the independent variable set. Again, as with the model for Papanui this amount of explanation would be considered high.

The most significant variables were *TIMESOLD.Q, MATFAX,* and *TOWER.* The former two have a positive influence on price. The positive *TIMESOLD.Q* indicates that the market was increasing over time since the CPBS was built in 2000, but only by 1.91% per quarter. The positive coefficient for *MATFAX* indicates that, when all the other variables are held constant, the price would increase by $e^{0.0042054} \approx 1.00421$ (0.42%), with increasing size. The negative coefficient for *TOWER* shows that, when all the other variables are held constant, after the installation of a CPBS in Beckenham, the price of a house would decrease by $e^{-0.23019} \approx 0.793$ (20.7% decrease).

Significance of Variables and the Equation: Bishopdale

The same functional form used for the other three suburbs was used for Bishopdale. From the regression output, the variables *ROOFCNX* and *CATGYX* were found to be insignificant so these were removed from the model and the regression was rerun; Appendix VIII summarizes these results. The *F*-statistic (122) shows that the estimated relationship in the model is statistically significant at the 95% confidence level and that at least one of the coefficients of the independent variables within the model is not zero.

Table 7 Test Statistics — Bishopdale

	Adjusted R^2	AIC	BIC
Full Model	0.79	-927.48	-775.71
Sub Model	0.79	-929.32	-796.52

Table 7 summarizes the model selection test statistics. Based on the AIC and BIC, the regression that excludes the variable *ROOFCNX* and *CATGYX* is superior to the regression that includes it (AIC and BIC are minimized). For this reason, the model excluding these variables was selected for analysis.

Again, the most significant variables were *TIMESOLD.Q* and *MATFAX*; the variable of interest, *TOWER*, was not a significant variable in the model so it is not discussed further. The former two variables have a positive influence on price. The positive *TIMESOLD.Q* indicates that the market was increasing over time since the CPBS was built in 1994, but only at 0.98% per quarter. The positive coefficient for *MATFAX* indicates that, when all the other variables are held constant, the price would increase by $e^{0.0039665} \approx 1.004$ (0.40%), with increasing size.

Summary of Results

The above analysis shows that the most significant variables and their impact on price were similar between suburbs. This indicates the relative stability of the coefficients between each model. Interestingly, the impact of *TOWER* on price (a decrease of between 20.7% and 21%) was very similar in the two suburbs where the towers were built in the year 2000. This may be due to the much greater media publicity given to CPBSs after the two legal cases in Christchurch (*McIntryre* and *Shirley Primary School* in 1996 and 1999, respectively). The two suburbs where *TOWER* was either insignificant or increased prices by around 12%, were suburbs where towers had been built in 1994, prior to the media publicity.

Limitations of the Research

The main limitation affecting this survey was in the selection of the case study areas. Specifically, the areas selected had CPBSs that were not highly visible to residents. If more-visible CPBSs had been selected, the results may have been quite different. Thus, caution must be used in making generalizations from this study or applying the results directly to other similar studies or valuation assignments. Factors that could affect results are the distance of homes from the CPBS, the style and appearance of the CPBS, how visible the CPBS is to residents, the type of home (single family, multifamily, rental, etc.), and the socioeconomic make-up of the resident population.

To help address the proximity factor, a study is in progress examining the role of distance to the CPBSs and price effects; that study uses GIS analysis to determine the impact this has on residential property prices. It is expected that this will provide a more precise estimation of the impact of a CPBS on price.

It must be kept in mind that these results are the product of only one case study carried out in a specific area (Christchurch) at a specific time (2003). The above results indicate that value effects from CPBSs may vary over time as market participants' perceptions change. Perceptions toward CPBSs can change either positively or negatively over time. For example, as the World Health Organization's ten-year study of the health effects from CPBSs is completed and becomes available, consumers' attitudes may become more positive or negative depending on the outcome of that study. Consequently, studies of the price effects of CPBSs need to be conducted over time.

Areas for Further Study

This research has focused on residents' perceptions of negative effects from proximity to CPBSs and how these impact property values, 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 consistent. Residents' perceptions and assessments of risk vary according to a wide range of psychological, social, institutional, and cultural processes, and this may explain why their assessments differ from those of the experts.

Given the public concerns about the potential risks arising from being located nearby a CPBS, it is important for future studies to focus more attention on the kinds of 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 CPBS design, size, and surrounding landscape would help CPBSs to be more publicly acceptable? What social, economic, educational, and other demographic variables influence how people perceive the risks from CPBSs? Do residents that are heavy users of cell phones have a different perception of CPBSs than residents who make little use of this technology? 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 among researchers and made public, could lead to the development of a global database to assist appraisers in determining the perceived level of risk associated with CPBSs and other similar structures.[59] Knowledge of the extent that 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 CPBSs and other similar structures.

Summary and Conclusions

Focusing on four case study neighborhoods in Christchurch, New Zealand, this article presents the results from both an opinion survey and market sales analysis undertaken in 2003 to determine residents' perceptions towards living near a CPBS and how this may impact property prices. From the results, it appears that people who live close to CPBSs perceive the sites less negatively than those who live farther away.

The issue of greatest concern for survey respondents in both the case study and control areas is the impact of proximity to CPBSs on future property values. Overall, respondents would pay from 10%–19% less to over 20% less for a property if it were in close proximity to a CPBS.

The opinion survey results were generally confirmed by the market sales analysis using a hedonic house price approach. The results of the sales analysis show prices of properties were reduced by around 21% after a CPBS was built in the neighborhood. How-

59. For example, high-voltage overhead transmission lines.

ever, this result varies between neighborhoods, with a positive impact on price being recorded in one neighborhood, possibly due to the CPBS being built in that suburb before any adverse media publicity about CPBSs appeared in the local Christchurch press.

Research to date reports no clearly established health effects from radio frequency emissions of CPBSs operated at or below the current safety standards, yet recent media reports indicate that people still perceive that CPBSs have harmful effects. Thus, whether or not CPBSs are proven to be free from health risks is only relevant to the extent that buyers of properties near CPBSs perceive this to be true. Even buyers who believe that there are no adverse health effects from CPBSs, knowing that other potential buyers might think the reverse, will probably seek a price discount for a property located near a CPBS.

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

Sandy Bond, PhD, MBS, ANZIV, SNZPI, is a senior member of the New Zealand Property Institute (NZPI), a director on the Board of the International Real Estate Society, and a past president of the Pacific Rim Real Estate Society (PRRES). She was awarded the PRRES Achievement Award in 2002 and the NZ Institute of Valuers' Presidential Citation in 1997. Before commencing her academic career in 1991, she worked as an appraiser in both New Zealand and London, UK.

Contact: dr_sandybond@yahoo.com

Ko-Kang (Kevin) Wang is a recent graduate from the University of Auckland and has been a tutor in the Statistics Department at the university. Wang has recently commenced doctoral studies in Australia.

Contact: Kevin.Wang@anu.edu.au

Acknowledgements

The authors thank Mark Dunbar of Telfer Young and Robert Albrecht of DTZ for sharing the results of their cell phone research on valuation impacts from proximity to CPBSs, and Maya Marshall, Project Administrator at Telecom NZ, and Rapheal Hilbron, Community Relations Manager at Vodafone NZ, for information about CPBS locations and environmental impacts from these.

Additional Reading

Appraisal Institute. *Proposed USPAP Statement on Appraisal Standards–First Exposure Draft: Utilization of Statistical and Market Survey Techniques in Real Estate Research, Appraising, Counselling, and Consulting Assignments.* Report of Task Group for the Development of Standards for Determining the Acceptability of Applications of Statistical and Market Survey Techniques to the Valuation of Real Property. Chicago: Appraisal Institute, 2000.

Burch, J. B., J. S. Reif, M. G. Yost, T. J. Keefe, and C.A. Pittrat. "Nocturnal Excretion of Urinary Melatonin Metabolite Among Utility Workers." *Scand J Work Environ Health* 24, no. 3 (1998): 183–189.

Christchurch City Council Web site, http://www.ccc.govt.nz/index.asp.

Fesenko, E. E., V. R. Makar, E. G. Novoselova, and V. B. Sadovnikov. "Microwaves and Cellular Immunity: Effect of Whole Body Microwave Irradiation on Tumour Necrosis Factor Production in Mouse Cells." *Bioelectrochem Bioenerg* 49, no. 1 (1999): 29–35.

Khudnitskii, S. S., E. A. Moshkarev, and T. V. Fomenko. "On the Evaluation of the Influence of Cellular Phones on Their Users." [In Russian] *Med Tr Prom Ekol* 9 (1999): 20–24.

International Commission on Non-Ionizing Radiation Protection. "Health Issues Related to the Use of Hand-Held Radio Telephone and Base Transmitters." *Health Physics* 70, no. 4 (April 1996): 587–593.

International Commission on Non-Ionizing Radiation Protection. "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 GHz)." *Health Physics* 74, no. 4 (April 1998): 494–522.

Priestley, T., and G. Evans. *Perception of a Transmission Line in a Residential Neighbourhood: Results of a Case Study in Vallejo, California.* San Francisco: Southern California Edison Environmental Affairs Division, December 1990.

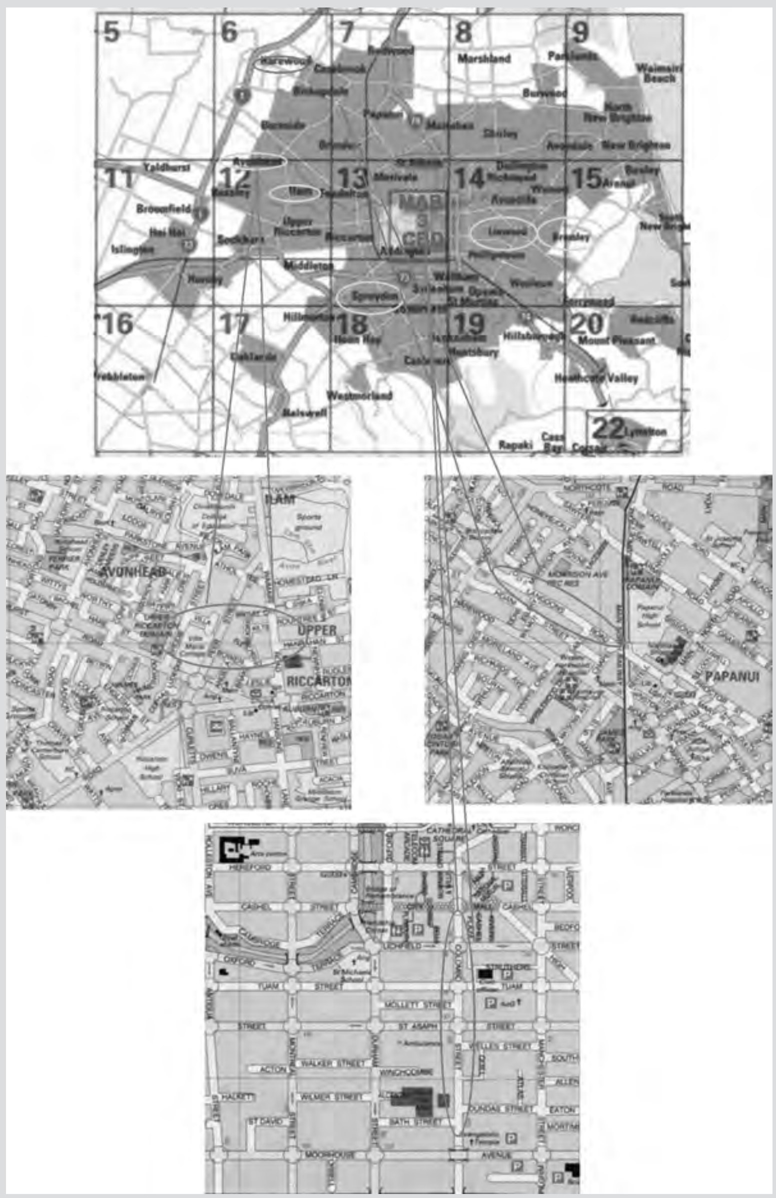
Priestley, T., and P. C. Ignelzi. *A Methodology for Assessing Transmission Line Impacts in Residential Communities.* Washington, DC: Edison Electric Institute, June 1989.

Repacholi, M. H., A. Basten, V. Gebski, D. Noonan, J. Finnie, and A. W. Harris. "Lymphomas in E mu-Pim1 Transgenic Mice Exposed to Pulsed 900 MHZ Electromagnetic Fields." *Radiat Res* 147, no. 5 (1997): 631-640.

Royal Society of Canada. *A Review of the Potential Health Risks of Radiofrequency Fields from Wireless Telecommunication Devices: An Expert Report Prepared at the Request of the Royal Society of Canada for Health Canada.* Ottawa, Ontario: Royal Society of Canada, March 1999. http://www.rsc.ca//files/publications/expert_panels/RF//RFreport-en.pdf.

World Health Organization. *Electromagnetic Fields (300 Hz to 300 GHz).* Environmental Health Criteria 137. Geneva: World Health Organization, 1993.

Appendix I Location Map



Areas circled in white at the top are without a cell phone tower, while areas circled in the bottom three maps have a cell phone tower.
Source: http://www.ccc.govt.nz/maps/Wises/

Appendix II Summary of the Survey Results

Variable	Responose	Valid Percent (%) Case Study	Control
Occupancy	Homeowner	78.5	94.2
	Tenant	21.5	5.8
How long have you lived there?	Less than 6 months	8.0	2.6
	6 months–1 year	8.6	4.5
	1–4 years	25.1	27.7
	More than 5 years	58.3	65.2
How would you rate the desirability of your neighborhood?	Superior	27.4	30.9
	Above Average	37.4	36.8
	Average	28.5	27.0
	Below Average	5.6	4.6
	Inferior	1.1	0.7
Would you be opposed to construction of a cell phone tower nearby?	Yes		72.1
	No		27.9
When you purchased/began renting was the cell phone tower already constructed?	Yes	39.3	
	No	60.7	
Was the proximity of the cell phone tower a concern to you?	Yes	20.0	
	No	80.0	
Would you have gone ahead with rental/purchase if you had known a cell phone site was to be constructed?	Yes	73.9	
	No	26.1	
Is location of a cell phone tower a factor you would consider when moving?	Yes		83.4
	No		16.6
Is the cell phone tower visible from your house?	Yes	45.7	
	No	54.3	
If yes, how much does it impact on your view?	Very obstructive	9.6	
	Mildly obstructive	24.5	
	Barely noticeable	66.0	
In what way does it impact on the enjoyment of living in your house?	Views	11.8	
	Aesthetics	20.6	
	Health concerns	36.8	
	Change in property value	19.9	
	Other	11.0	
Effect a nearby cell phone tower would have on the price/rent you would pay for the property	Tower wasn't constructed	53.1	
	Pay substantially more	0.0	0.0
	Pay a little more	2.3	0.0
	Pay a little less	2.8	37.6
	Pay substantially less	0.6	45.4
	Not influence price	51.4	17.0
% Effect a nearby cell phone tower would have on the price/rent you would pay for the property	20% higher or more	5	3.2
	10–19% more	10	1.6
	1–9% more	14	2.4
	1–9% less	33	19.2
	10–19% less	24	36.0
	20% or a greater reduction	14	37.6
Concern about the possibility of harmful health effects in the future	Does not worry me	50.3	19.9
	Worries me somewhat	38.0	38.4
	Worries me a lot	11.7	41.7
Concern about the stigma associated with houses near the cell phone sites	Does not worry me	54.6	20.8
	Worries me somewhat	33.9	45.0
	Worries me a lot	11.5	34.2
Concern about the affect on your properties value in the future	Does not worry me	61.3	15.4
	Worries me somewhat	25.4	37.2
	Worries me a lot	13.3	47.4
Concern about the aesthetic problems caused by the tower	Does not worry me	63.3	18.2
	Worries me somewhat	25.4	37.0
	Worries me a lot	11.3	44.8

Appendix III Variable Codes

Category of Dwelling

Code	Definition
D	Dwelling houses are of a fully detached or semi-detached style situated on their own clearly defined piece of land.
E	Converted dwelling houses that are now used as rental flat.
F	Ownership home units which may be single storey or multi-storey and which do not have the appearance of dwelling houses.
H	Home and income. The dwelling is the predominant use, and there is an additional unit of use attached to or associated with the dwelling house that can be used to produce income.
R	Rental flats that have been purpose built.

Quality of the Principal Structure

Code	Definition
A	Superior design and quality of fixtures and fittings is first class.
B	The design is typical of its era and the quality of the fixtures and fittings is average to good.
C	The design is below the level generally expected for the era, or the level of fixtures and fittings is barely adequate and possibly of below average quality.

Building Materials: Walls and Roof

Code	Definition
W	Wood
B	Brick
C	Concrete
S	Stone
R	Roughcast
F	Fibrolite
M	Malthoid
P	Plastic
I	Iron
A	Aluminium
G	Glass
T	Tiles
X	*

Appendix IV Descriptive Statistics

Variable	Mean	Std. dev.	Median	Minimum	Maximum	Range
St Albans:						
Sale Price ($)	221,957	110,761	200,000	42,000	839,000	797,000
Land Area (ha)	0.0658	0.0331	0.0579	0.0261*	0.3794	0.3533
Floor Area (m^2)	161	70.40	150	50	450	400
Beckenham:						
Sale Price ($)	116,012	50,037	111,000	21,500	385,000	363,500
Land Area (ha)	0.0601	0.0234	0.0553	0.0164*	0.2140	0.1976
Floor Area (m^2)	115	32.50	110	40	340	300
Papanui:						
Sale Price ($)	127,661	51,114	119,000	43,000	375,000	332,000
Land Area (ha)	0.0685	0.0289	0.0675	0.0310	0.3169	0.2859
Floor Area (m^2)	122	34.60	110	56	290	234
Bishopdale:						
Sale Price ($)	136,786	41,390	134,500	56,000	342,000	286,000
Land Area (ha)	0.0679	0.0163	0.0653	0.0400	0.2028	0.1628
Floor Area (m^2)	125	31.20	118	64	290	226

* These small land areas are related to apartments or units in a block of apartments/units that have the land area apportioned on a pro rata basis.

Appendix V Regression Model: St Albans

log(*SLNETX*) = *TOWER* + *CATGYX2* + *CATGYX4* + *TIMESOLD.Q* + *AGE* + log(*LANDAX*) + *MATFAX* + *SITSTX*

Residuals:	**Min**	**1Q**	**Median**	**3Q**	**Max**
	-0.72855	-0.15032	0.01593	0.14263	0.72047

Coefficients:	**Estimate**	**Std. Error**	***t*-value**	**Pr(> |*t*|)**
(Intercept)	9.1781868	0.6769096	13.559	< 2e-16 ***
TOWER	**0.1133186**	0.0318188	**3.561**	0.000395 ***
CATGYX2D	0.1846417	0.0702520	2.628	0.008776 **
CATGYX2O	0.0334663	0.1008594	0.332	0.740134
CATGYX4B	-0.1551409	0.0245485	-6.320	4.75e-10 ***
CATGYX4C	-0.1483169	0.0722959	-2.052	0.040600 *
TIMESOLD.Q	**0.0136663**	**0.0008208**	**16.650**	< 2e-16 ***
AGE	0.0016408	0.0003521	4.660	3.81e-06 ***
log(LANDAX)	**0.3285367**	**0.0283610**	**11.584**	< 2e-16 ***
MATFAX	**0.0022314**	**0.0001962**	**11.373**	< 2e-16 ***
SITSTXAIKMANS RD	0.4029259	0.0533671	7.550	1.41e-13 ***
SITSTXBEVERLEY ST	0.2330787	0.0803137	2.902	0.003827 **
SITSTXBRISTOL ST	0.1706840	0.0521716	3.272	0.001124 **
SITSTXBROWNS RD	0.2492536	0.0720854	3.458	0.000579 ***
SITSTXCOX ST	0.3055798	0.0581672	5.253	2.00e-07 ***
SITSTXGORDON AVE	0.0823422	0.0679833	1.211	0.226236
SITSTXKNOWLES ST	0.1690979	0.0558911	3.025	0.002576 **
SITSTXMANSFIELD AVE	0.2954242	0.0652983	4.524	7.16e-06 ***
SITSTXMCDOUGALL AVE	0.3303105	0.0623720	5.296	1.60e-07 ***
SITSTXMURRAY PL	0.3613773	0.0629166	5.744	1.40e-08 ***
SITSTXOFFICE RD	0.3681146	0.0543368	6.775	2.71e-11 ***
SITSTX Other	0.0618491	0.0736629	0.840	0.401416
SITSTXPAPANUI RD	0.1940369	0.0560474	3.462	0.000570 ***
SITSTXRANFURLY ST	0.1701716	0.0617504	2.756	0.006012 **
SITSTXST ALBANS ST	0.1458665	0.0571172	2.554	0.010873 *
SITSTXWEBB ST	0.1895432	0.0725061	2.614	0.009143 **
SITSTXWESTON RD	0.2084419	0.0527555	3.951	8.60e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.2175 on 677 degrees of freedom
Multiple *R*-Squared: 0.8253, Adjusted *R*-squared: 0.8186
F-statistic: 123 on 26 and 677 DF, *p*-value: < 2.2e-16

Appendix VI Regression Model: Papanui

ln(formula = log(*SLNETX*) ~ *TOWER* + *SITSTX* + *TIMESOLD.Q* + *AGE* + log(*LANDAX*) + *MATFAX* + *WALLCNX* + *ROOFCNX* + *CATGYX4*, data = *Papanui.final*)

Residuals:	**Min**	**1Q**	**Median**	**3Q**	**Max**
	-0.484987	-0.098006	0.003859	0.106253	0.563126

Coefficients:	**Estimate**	**Std. Error**	***t*-value**	**Pr(> |*t*|)**
(Intercept)	5.9482316	0.6998186	8.500	< 2e-16 ***
TOWER	**-0.2339640**	0.0240908	**-9.712**	< 2e-16 ***
SITSTXHOANI ST	-0.1966982	0.0265429	-7.411	4.26e-13 ***
SITSTXLANGDONS RD	-0.1192547	0.0281242	-4.240	2.58e-05 ***
SITSTXLEANDER ST	0.0305555	0.0449437	0.680	0.496853
SITSTXMATSONS AVE	0.0949636	0.0292461	3.247	0.001231 **
SITSTXMORELAND AVE	-0.0892332	0.0397622	-2.244	0.025183 *
SITSTXMORRISON AVE	-0.1984492	0.0289772	-6.848	1.84e-11 ***
SITSTXOther	-0.1543194	0.0337436	-4.573	5.83e-06 ***
SITSTXSAILS ST	-0.0761412	0.0433455	-1.757	0.079490 .
SITSTXSAWTELL PL	0.1840793	0.0393904	4.673	3.66e-06 ***
SITSTXSAWYERS ARMS RD	0.0872393	0.0201388	4.332	1.73e-05 ***
SITSTXST JAMES AVE	0.2497688	0.0289940	8.615	< 2e-16 ***
TIMESOLD.Q	**0.0138914**	0.0004137	**33.575**	< 2e-16 ***
AGE	0.0029307	0.0003512	8.345	4.85e-16 ***
log(LANDAX)	0.0904764	0.0270812	3.341	0.000886 ***
MATFAX	**0.0042576**	0.0002410	**17.664**	< 2e-16 ***
WALLCNXC	0.0054100	0.0200666	0.270	0.787558
WALLCNXF	-0.0980851	0.0464442	-2.112	0.035106 *
WALLCNXO	-0.1158407	0.0468334	-2.473	0.013655 *
WALLCNXR	-0.0670051	0.0244382	-2.742	0.006291 **
WALLCNXW	-0.0679166	0.0192628	-3.526	0.000454 ***
WALLCNXX	-0.0571365	0.0358369	-1.594	0.111381
ROOFCNXI	0.1502973	0.1139845	1.319	0.187810
ROOFCNXO	0.0870092	0.1164152	0.747	0.455111
ROOFCNXT	0.0954874	0.1138506	0.839	0.401965
CATGYX4B	-0.0623758	0.0343487	-1.816	0.069872 .
CATGYX4C	-0.3669901	0.0905659	-4.052	5.74e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.1579 on 604 degrees of freedom
Multiple *R*-Squared: 0.8718, Adjusted *R*-squared: 0.8661
F-statistic: 152.2 on 27 and 604 DF, *p*-value: < 2.2e-16

Appendix VII Regression Model: Beckenham

ln(formula = log(*SLNETX*) ~ TOWER + *SITSTX* + *CATGYX4* + *TIMESOLD.Q* + *AGE* + log(*LANDAX*) + *MATFAX* + *WALLCNX* + *CATGYX2*, data = *Beckenham.final)*

Residuals:	Min	1Q	Median	3Q	Max
	-0.64490	-0.09026	0.01142	0.10112	0.40993

Coefficients:	Estimate	Std. Error	*t*-value	Pr(> |*t*|)
(Intercept)	9.2062865	0.4725194	19.483	< 2e-16 ***
TOWER1	**-0.2301918**	0.0182774	**-12.594**	< 2e-16 ***
SITSTXBECKENHAM ST	0.1648069	0.0515406	3.198	0.001436 **
SITSTXBOON ST	-0.0616738	0.0484966	-1.272	0.203817
SITSTXBRADFORD AVE	0.0923843	0.0494942	1.867	0.062300 .
SITSTXCOLOMBO ST	0.0623765	0.0467234	1.335	0.182223
SITSTXDEVON ST	-0.0959430	0.0457562	-2.097	0.036299 *
SITSTXDUNN ST	-0.0207886	0.0427676	-0.486	0.627031
SITSTXFISHER AVE	0.2271245	0.0400288	5.674	1.90e-08 ***
SITSTXLONGFELLOW ST	-0.0186953	0.0451597	-0.414	0.678990
SITSTXOTHER	-0.0222126	0.0467607	-0.475	0.634888
SITSTXPERCIVAL ST	-0.0347190	0.0517740	-0.671	0.502663
SITSTXROXBURGH ST	0.1029109	0.0466753	2.205	0.027729 *
SITSTXSOMERFIELD ST	0.0186495	0.0428968	0.435	0.663851
SITSTXSOUTHAMPTON ST	-0.0243265	0.0402926	-0.604	0.546171
SITSTXSOUTHEY ST	-0.0324513	0.0429880	-0.755	0.450520
SITSTXSTRICKLAND ST	-0.0819418	0.0407196	-2.012	0.044494 *
SITSTXTENNYSON ST	0.1165007	0.0393410	2.961	0.003147 **
SITSTXWEMBLEY ST	0.0648226	0.0458033	1.415	0.157359
CATGYX4B	0.0275481	0.0373405	0.738	0.460864
CATGYX4C	-0.1168640	0.0469787	-2.488	0.013049 *
TIMESOLD.Q	**0.0189904**	0.0003396	**55.928**	< 2e-16 ***
AGE	0.0010988	0.0002426	4.530	6.74e-06 ***
log(LANDAX)	0.1546535	0.0195655	7.904	8.19e-15 ***
MATFAX	**0.0042054**	0.0002138	**19.674**	< 2e-16 ***
WALLCNXC	-0.0208433	0.0378338	-0.551	0.581833
WALLCNXF	-0.1171637	0.0394091	-2.973	0.003031 **
WALLCNXO	-0.0445073	0.0399745	-1.113	0.265849
WALLCNXR	-0.1119164	0.0235736	-4.748	2.41e-06 ***
WALLCNXW	-0.0629968	0.0222366	-2.833	0.004718 **
WALLCNXX	-0.0992564	0.0398493	-2.491	0.012933 *
CATGYX2D	0.1445276	0.0399650	3.616	0.000316 ***
CATGYX2F	0.3069113	0.0744524	4.122	4.11e-05 ***
CATGYX2R	0.2927391	0.1222453	2.395	0.016847 *

Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.1515 on 864 degrees of freedom
Multiple *R*-Squared: 0.8911, Adjusted *R*-squared: 0.8869
F-statistic: 214.2 on 33 and 864 DF, *p*-value: < 2.2e-16

Appendix VIII Regression Model: Bishopdale

ln(formula = log(*SLNETX*) ~ *TOWER* + *TIMESOLD.Q* + *AGE* + log(*LANDAX*) + *MATFAX* + *WALLCNX* + *SITSTX*, data = *Bishopdale.final)*

Residuals:	Min	1Q	Median	3Q	Max
	-0.53633	-0.08893	0.01446	0.08850	0.49048

Coefficients:	Estimate	Std. Error	*t*-value	Pr(> |*t*|)
(Intercept)	9.0005033	0.6988891	12.878	< 2e-16 ***
TOWER	0.0262575	0.0182796	1.436	0.151259
TIMESOLD.Q	**0.0097887**	0.0004834	**20.251**	< 2e-16 ***
AGE	0.0013236	0.0003598	3.679	0.000249 ***
log(LANDAX)	0.1357753	0.0333622	4.070	5.16e-05 ***
MATFAX	**0.0039665**	0.0001855	**21.389**	< 2e-16 ***
WALLCNXC	-0.0169935	0.0108641	-1.564	0.118160
WALLCNXO	0.0785660	0.0336688	2.333	0.019863 *
WALLCNXR	-0.0693225	0.0300511	-2.307	0.021313 *
WALLCNXW	-0.0815023	0.0230110	-3.542	0.000420 ***
SITSTXCARDOME ST	0.0610536	0.0314227	1.943	0.052360 .
SITSTXCHEDWORTH AVE	0.0330487	0.0317738	1.040	0.298589
SITSTXCLOTILDA PL	**0.2252988**	0.0420078	**5.363**	1.06e-07 ***
SITSTXCOLESBURY ST	0.0528749	0.0302668	1.747	0.081018 .
SITSTXCOTSWOLD AVE	0.0604953	0.0286474	2.112	0.035012 *
SITSTXEASTLING ST	0.0551537	0.0319833	1.724	0.085003 .
SITSTXFARRINGTON AVE	-0.0001768	0.0238544	-0.007	0.994087
SITSTXHAREWOOD RD	0.0204412	0.0252674	0.809	0.418753
SITSTXHIGHSTED RD	0.0391760	0.0253953	1.543	0.123302
SITSTXKILBURN ST	-0.0176756	0.0366951	-0.482	0.630155
SITSTXKINGROVE ST	-0.0052772	0.0375965	-0.140	0.888406
SITSTXLEACROFT ST	0.1058243	0.0333633	3.172	0.001571 **
SITSTXMURMONT ST	0.1825316	0.0365287	4.997	7.12e-07 ***
SITSTXNEWMARK ST	-0.0342136	0.0272490	-1.256	0.209621
SITSTXOTHER	0.0525437	0.0253634	2.072	0.038612 *
SITSTXRALEIGH ST	0.0470151	0.0314032	1.497	0.134740
SITSTXSTACKHOUSE AVE	0.0235719	0.0278844	-0.845	0.398165

Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.137 on 821 degrees of freedom
Multiple *R*-Squared: 0.7946, Adjusted *R*-squared: 0.7881
F-statistic: 122.1 on 26 and 821 DF, *p*-value: < 2.2e-16

APPENDIX III

Dr. Sandy Bond's Research Taken as Gospel by Some

Dr. Jonathan Kramer — Uncategorized — June 11, 2016   0

It's always an amusing surprise to me when I see Dr. Sandy Bond's 2007 research on cell towers and property values quoted in public hearings. It happened again a few days ago during a hearing in which I participated, when a resident told the government leaders that cell towers lower property values by 21% (not 20%; not 22%, but 21%).

Here's the citation to Bond's 2007 report in case you'd like to read the source materials (most people don't):

Sandy Bond (2007) Cell Phone Tower Proximity Impacts on House Prices: A New Zealand Case Study, Pacific Rim Property Research Journal, 13:1, 63-91, DOI:10.1080/14445921.2007.11104223

I find it fascinating that the people who cite the number have no idea about what's in the report, or that Dr. Bond's research methodology has been roundly criticized by Filippova and Rehm (2011).

Here's the cite to Filipova and Rehm's research strongly challenging Bond's 2007 research:

> Filippova, O. and Rehm, M. (2011), "The impact of proximity to cell phone towers on residential property values", International Journal of Housing Markets and Analysis, Vol. 4 No. 3, pp. 244-267.

Go ahead and read both documents, and then make an informed decision as to whether you would want to be associated with the 21% number. I certainly don't.

Finally, in about 90 days I'll be publishing my findings on hedonic price modeling to assess the dis-amenity value of a cell site near a home, this time a bit closer to the U.S., specifically in Calabasas, California. My research discloses that hedonic price modeling–if it ever had a valid place in research–is no longer any sort of useful tool in this line of research for reasons discussed in my thesis that could not have been known to Bond, Filippova, or Rehm, or to the few researchers to who followed down the same rabbit hole.

Living 5G Large, baby!

Court Cases Galore and Hedonic Price Modeling

Dr. Jonathan Kramer — Uncategorized — June 3, 2016   0

I've been reviewing about 170 court cases touching on or dealing with perceptions of resident home value reduction due to the installation of a nearby cell site. The court cases, which date back to about 1988, provide some very illuminating facts about what the courts consider to be reliable evidence, and what is not.

The information I've collected is going into my law and policy chapter, which is turning out to be quite interesting.

Sneak peak: Direct references to hedonic price modeling and a Dr. Sandy Bond paper are found in exactly one federal case. The outcome of that case turned on other considerations.

Jonathan

Search

sandy bond   Search

Huh? What?

Who am I? Why this Blog?

I'm Dr. Jonathan L. Kramer.

In August 2016 I completed my Doctor of Law and Policy (LP.D) degree at Northeastern University in Boston. I received my doctoral hood in September 2016. I was a member in the 8th Cohort of that unique program.

I set up this blog at the suggestion of one of the LP.D program leaders whom I truly respect, Professor Neenah Estrella-Luna, Ph.D. Early in the LP.D program she strongly recommended that each Cohort member track their progress and stand up to the scrutiny of peers, just as we do when we publish or present papers.

I took Professor Estrella-Luna's suggestion to heart, and this blog allowed me to chart my personal journey from a highly-educated lawyer and masters-level blob to highly-educated lawyer and doctoral-level researcher blob.

At least that was my initial goal...

In real life, I'm a practicing telecom law attorney licensed in California and New Mexico, as well as a radio frequency engineer. My law firm has five attorneys, four staff, and two dogs working in offices in Los Angeles, San Diego, Seattle, and in our covert office on a Southwest Airlines jet (minus the dogs).

I have earned the following academic degrees:

Associate of Science (AS) degree (honors) Los Angeles Trade Tech College. Los Angeles, California.

Juris Doctor (JD) degree (cum laude) Abraham Lincoln University School of Law. Los Angeles, California.

Masters of Law (LL.M) degree (with distinction) Strathclyde University. Glasgow, Scotland.

Doctor of Law and Policy (LP.D) Northeastern University. Boston, Massachusetts.

Having completed my Doctor of Law and Policy degree, just for fun I might go after a few more professional licenses.

~~My current goal is to become licensed as a Real Estate Broker in California.~~ Done that!

Who knows?

Accountability

I am personally accountable for my education and the work I put in to that education. Because of that, I've decided to be transparent about my grades, whether good or bad (but better good than bad).

Q1 – Summer 2014:
Law and Legal Reasoning 1
(LWP 6120) Grade: A
Law and Policy Concepts 1
(LWP 6401) Grade: A
Research Methods
(LWP 6424) Grade: A-

Q2 – Fall 2014:
Law and Legal Reasoning 2
(LWP 6121) Grade: A
Law and Policy Concepts 2
(LWP 6402) Grade: A-
Qualitative Methods
(LWP 6423) Grade: A

Q3 – Winter 2015:
Law and Legal Reasoning 3
(LWP 6122) Grade: A
Law and Policy Concepts 3
(LWP 6403) Grade: A
Quantitative Methods
(LWP 6420) Grade: A

Q4 – Spring 2015:
Law and Legal Reasoning 4
(LWP 6123) Grade: A
Evaluation Research
(LWP 6404) Grade: A
Economics for Policy Analysis
(LAW 6410) Grade: A-

Q5 – Summer 2015:
Methods & Theory Appl Research
(LWP6425) Grade: A
Political/Moral/Ethical Dilemmas
(LWP6431) Grade: A
Doctoral Research Design 1
(LWP6500) Grade: A

Q6 – Fall 2015:
Public Policy Theory & Practice 1
(LWP6450) Grade: A
Doctoral Research Design 2
(LWP 6501) Grade: A

Q7 – Winter 2016:
Public Policy Theory & Practice 2
(LWP6451) Grade: A
Doctoral Research Design 3
(LWP 6502) Grade: A

Q8 – Spring 2016:
Public Policy Theory & Practice 3
(LWP6452) Grade: A
Doctoral Research Design 4
(LWP 6503) Grade: A

July 2016: My final GPA after all program coursework is 3.958 on a 4 point scale. I can live with that.

Links

Doctor of Law and Policy Program (Boston Section)

Doctor of Law and Policy Program (Seattle Section)

Telecom Law Firm PC

Telecom Realty Corp.

BillBoard Law PC

Dr. Kramer Secret Site for his students (don't tell anyone!)

APPENDIX IV

FEATURES

The Effect of Distance to Cell Phone Towers on House Prices in Florida

by Sandy Bond, PhD

ABSTRACT

This article outlines the results of a study carried out in Florida in 2004 regarding the effect that cell phone tower proximity has on residential property prices. The study involved an analysis of residential property sales transaction data. Both GIS and multiple regression analysis in a hedonic framework were used to determine the effect of linear distance of homes to towers on residential property prices. The results of the research show that prices of properties decreased by just over 2%, on average, after a tower was built. This effect generally diminished with distance from the tower and was almost negligible after about 656 feet.

The siting of cellular phone transmitting antennas, their base stations, and the towers that support them (towers) is a public concern due to fears of potential health hazards from the electromagnetic fields that these devices emit. Negative media attention to the potential health hazards has only fueled the perception of uncertainty over the health effects. Other regularly voiced concerns about the siting of these towers are the unsightliness of the structures and fear of lowered property values. However, the extent to which such attitudes are reflected in lower property values affected by tower proximity is controversial.

This article outlines the results of a cell phone tower study carried out in Florida in 2004 to show the effect that distance to a tower has on residential property prices. It follows on from several New Zealand (NZ) studies conducted in 2003.[1] The first of the NZ studies examined residents' perceptions toward living near towers, while the most recent NZ study adopted GIS to measure the impact that distance to a tower has on residential property prices using multiple regression analysis in a hedonic pricing framework. The study presented in this article was conducted to determine if homeowners in the United States make price adjustments that are similar to those of NZ homeowners when buying properties near towers, and hence, whether the results can be generally applied.

The article commences with a brief literature review of the previous NZ studies for the readers' convenience. The next section describes the research data and methodology used. The results are then discussed. The final section provides a summary and conclusion.

1. Sandy Bond and Ko-Kang Wang, "The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods," *The Appraisal Journal* (Summer 2005): 256–277; S. G. Bond, and K. Beamish, "Cellular Phone Towers: Perceived Impact on Residents and Property Values," *Pacific Rim Property Research Journal* 11, no. 2 (2005): 158–177; and S. G. Bond, and J. Xue, "Cell Phone Tower Proximity Impacts on House Prices: A New Zealand Case Study" (European Real Estate Society and International Real Estate Society Conference, Dublin, Ireland, June 15–18, 2005).

Literature Review

Property Value Effects

First, an opinion survey by Bond and Beamish[2] was used to investigate the current perceptions of residents towards living near towers in the case study city of Christchurch, New Zealand, and how this proximity might affect property values. Second, a study by Bond and Wang[3] that analyzed property sales transactions using multiple regression analysis was conducted to test the results of the initial opinion survey. It did this by measuring the impact of proximity to towers on residential property prices in four case study areas. The Bond and Xue[4] study refined the previous transaction-based study by including a more accurate variable to account for distance to a tower.

The city of Christchurch was selected as the case study area for all the NZ studies due to the large amount of media attention this area had received in recent years relating to the siting of towers. Two prominent court cases over the siting of towers were the main cause for this attention.[5] Dr. Neil Cherry, a prominent and vocal local professor, brought negative attention to towers by regularly publishing the possible health hazards relating to these structures.[6] This media attention had an impact on the results of the studies outlined next.

The Opinion Survey

The Bond and Beamish opinion survey study included residents in ten suburbs: five case study areas (within 100 feet of a cell phone tower) and five control areas (over 0.6 of a mile from a cell phone tower). Eighty questionnaires[7] were distributed in each of the ten suburbs in Christchurch (i.e., 800 surveys were delivered in total). An overall response rate of 46% was achieved.

The survey study results were mixed, with responses from residents ranging from having no concerns to being very concerned about proximity to a tower. In both the case study and control areas, the impact of proximity to towers on future property values is the issue of greatest concern for respondents. If purchasing or renting a property near a tower, over one-third (38%) of the control group respondents would reduce the price of their property by more than 20%. The perceptions of the case study respondents were less negative, with one-third of them saying they would reduce price by only 1%–9%, and 24% would reduce price by between 10% and 19%.

Transaction-Based Market Study

The Bond and Wang market transaction-based regression study included 4283 property sales, in four suburbs, that occurred between 1986 and 2002 (approximately 1000 sales per suburb). The sales data from before a tower was built was compared to sales data after a tower had been built to determine any variance in price, after accounting for all the relevant independent variables.

Interestingly, the effect of a tower on price (a decrease of between 20.7% and 21%) was very similar in the two suburbs where the towers were built in 2000, after the negative media publicity given to towers following the two legal cases outlined above. In the other two suburbs, the results indicated a tower was either insignificant or increased prices by around 12%, where the towers had been built in 1994, prior to the media publicity.

The main limitation affecting this study was that there was no accurate proximity measure included in the model. A subsequent study was performed using GIS analysis to determine the impact that distance to a tower has on residential property prices. The results from that study are outlined next.

Proximity Impact Study

The Bond and Xue study conducted in 2004 involved analysis of the residential transaction data using the same hedonic framework as the previous Bond and Wang study. It also included the same data as the previous study, but added six suburbs to give a total of ten suburbs: five suburbs with towers located in them and five control suburbs without towers. In addition, the geographical (x, y) coordinates that relate

2. Bond and Beamish, "Cellular Phone Towers: Perceived Impact on Residents and Property Values."
3. Bond and Wang, "The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods."
4. Bond and Xue, "Cell Phone Tower Proximity Impacts on House Prices: A New Zealand Case Study."
5. *McIntyre v. Christchurch City Council,* NZRMA 289 (1996), and *Shirley Primary School v. Telecom Mobile Communications Ltd.*, NZRMA 66 (1999).
6. For example see Neil Cherry, *Health Effects Associated with Mobil Base Stations in Communities: The Need for Health Studies*, Environmental Management and Design Division, Lincoln University (June 8, 2000); available at http://pages.britishlibrary.net/orange/cherryonbasestations.htm.
7. Approved by the University of Auckland Human Subjects Ethics Committee (reference 2002/185).

to each property's absolute location were included. A total of 9,514 geocoded property sales were used (approximately 1000 sales per suburb).

In terms of the effect that proximity to a tower has on price the overall results indicate that this is statistically significant and negative. Generally, the closer a property is to the tower, the greater the decrease in price. The effect of proximity to a tower reduces price by 15% on average. This effect is reduced with distance from the tower and is negligible after 1000 feet.

The study reported here, outlined next, adds to the growing body of evidence and knowledge from around the world on property value effects from cell phone towers.

Florida Market Study

The Data

Part of the selection process was to find case study areas where a tower had been built that had a sufficient number of property sales to provide statistically reliable and valid results. Sales were required both before and after the tower was built to study the effect of the existence the tower had on the surrounding property's sale prices.

Case study areas were selected using both GIS maps that showed the location of cellular phone towers, and sale price and descriptive data about each property located in Orange County. The maps and sales data were obtained from the Florida Geographic Data Library (FGDL).[8]

Approximately 60% of the towers located in Orange County were constructed between the years 1990 and 2000. Additionally, frequency distributions of properties sold during that period indicate that twenty of the towers have the greatest potential for impact on the price of residential properties, based on the greatest number of residential properties close to each tower. These twenty towers were selected to construct a data set for the study.

Parcel data recorded in the FGDL was collected from the Office of the Property Appraiser for Orange County, Florida.[9] Residential properties that sold between 1990 and 2000 (the years the towers were constructed) and that are closest to the twenty towers were selected. Areas close to Interstate 4 and limited access roads were avoided to ensure sale prices (i.e., home buyers' choices) were not affected by highway access or traffic noise variables. Similarly, properties south of Colonial Drive were avoided due to the lower socioeconomic nature of that location. The final areas were selected after site visits had been made to verify that each mapped tower existed, to confirm the location of the homes to the tower, and to ensure nonselected towers were not located near the homes that might impact on the study results. Overall, 5783 single-family, residential properties were selected from northeast Orange County (see the Location Map in the Appendix).

Variables

The study investigates the potential impact of proximity to a tower on the price of residential property, as indicated by the dependant variable *SALE_PRICE*.[10] The study controls for site and structural characteristics by assessing the impact of various independent variables. The independent data set was limited to those available in the data set and known to be related to property price, based on other well-tested models reported in the literature and from valuation theory. The independent variables selected include lot size in square feet (*LOT*), floor area of the dwelling in square feet (*SQFT*), age of the dwelling in years (*AGE*), the time of construction (*AFTER_TWR*), the closest distance of each home to the associated tower (*DISTANCE*), and the dwelling's absolute location is indicated by the Cartesian coordinates (*XCOORD*) and (*YCOORD*).[11]

The effect of construction of a tower on price is taken into account by the inclusion of the dummy, independent variable *AFTER_TWR*. By including *AFTER_TWR*, property prices prior to tower construction can be compared with prices after tower construction.[12] Frequency distributions indicate that

8. The FGDL is an assemblage of virtually every geographic data set for Florida that the GeoPlan Center of the University of Florida was able to obtain, this mostly from government sources, including the Federal Communications Commission.
9. As reported to the Florida Department of Revenue.
10. Model 1 and Model 2 estimate the log of the *SALE_PRICE*.
11. For further discussion of the significance of the absolute location in the form of {*x, y*} coordinates see Timothy J. Fik, David C. Ling, and Gordon F. Mulligan, "Modeling Spatial Variation in Housing Prices: A Variable Interaction Approach," *Real Estate Economics* 31 (Winter 2003): 647–670.
12. Dummy variables for each year of residential sales were also incorporated into both model specifications to control for the potential effects of time on the price of residential property.

among the residential properties sold between 1990 and 2000, approximately 80% of the residential properties were sold after tower construction.

Based on the parcel and tower data for Orange County, the mean sale price of single-family, residential property that sold between 1990 and 2000 is \$113,830. The mean square footage is 1535 square feet, the mean lot size is 8525 square feet, and the mean age is 14 years. The mean distance from a residential property to a tower is 1813 feet.[13] Descriptive statistics for select variables are presented in Table 1.

Research Objectives and Methodology

The study hypothesis is that in areas where a tower is constructed, it will be possible to observe discounts made to the selling prices of homes located near these structures. Such a discount will be observed where buyers of homes close to the towers perceive them in negative terms due to, for example, the risk of adverse health, or aesthetic and property value effects.

The literature dealing specifically with the measurement of the impact of environmental hazards on residential sale prices (including proximity to transmission lines, landfill sites, and groundwater contamination) indicates the popularity of hedonic pricing models, as introduced by Court[14] and later Griliches[15] and further developed by Freeman[16] and Rosen.[17] The standard hedonic methodology was used to quantify the effect of cellular phone towers on sale prices of homes located near these. GIS was also adopted to aid the analysis of distance to the towers.

Model Specification

In hedonic housing models the linear and log-linear models are most popular. The linear model implies constant partial effects between house prices and housing characteristics, while the log-linear model allows for nonlinear price effects and is shown in the following equation:

$$\ln P_i = b_0 + b_1 X_{1,i} + b_2 X_{2i} + b_3 X_{3i} \ldots + b_n X_{n+1} + a_o D_o + \ldots + a_m D_m + e_{0\ldots}$$

where:

$\ln P_i$ = the natural logarithm of sale price

b_0 = the intercept

$b_1 \ldots b_n; a_o \ldots a_m$ = the model parameter to be estimated, i.e., the implicit unit prices for increments in the property characteristics

$X_1 \ldots X_n$ = the continuous characteristics, such as land area

$D_o \ldots D_m$ = the categorical (dummy) variables, such as whether the sale occurred before (0) or after (1) the tower was built

Sometimes the natural logarithm of land area and floor area is also used. The parameters are estimated by regressing property sales on the property characteristics and are interpreted as the households' implicit valuations of different property

Table 1 Descriptive Statistics for Selected Variables, Orange County, Florida

Variable	Mean	Std. Dev.	Min.	Max.
SALE_PRICE	113830.6	58816.68	45000	961500
SQFT	1535.367	503.8962	672	5428
LOT	8525.193	4363.28	1638	107732
AGE	13.92755	10.03648	0	35
XCOORD	664108.9	6130.238	640460	671089
YCOORD	511489.4	2422.946	506361	531096
DISTANCE	1813.077	725.5693	133	6620

Notes: n = 5783. Polynomial expansions of the independent variables, identified by the $VARIABLE^2$ were included in the interactions in the two model specifications discussed in the methodology.

13. Initially, *HEIGHT* was also included among the explanatory variables. However, the *HEIGHT* variable provided no significant explanatory power.
14. A. T. Court, "Hedonic Price Indexes with Automotive Examples," in *The Dynamics of Automobile Demand* (New York: General Motors, 1939).
15. Zvi Griliches, ed., *Price Indexes and Quality Change* (Cambridge, Mass.: Harvard University Press, 1971).
16. A. Myrick Freeman, III, *The Benefits of Environmental Improvement: Theory and Practice* (Baltimore: Johns Hopkins University Press, 1979).
17. Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy* 82, no. 1 (Jan/Feb 1974): 34–55.

attributes. The null hypothesis states that the effect of being located near a tower does not explain any variation in property sale price.

To address the many difficulties in estimating the composite effects of externalities on property price an interactive approach is adopted.[18] To allow the composite effect of site, structure, and location attributes on the value of residential property to vary spatially, they are interacted with the Cartesian coordinates that are included in the model.[19]

Unless the hedonic pricing equation provides for interaction between aspatial and spatial characteristics, the effects of the explanatory variables on the dependant variable will likely be underestimated, misspecified, undervalued, or worse, overvalued. Including the Cartesian coordinates in the model is intended to increase the explanatory power of the estimated model and reduce the likelihood of model misspecification by allowing the explanatory variables to vary spatially and by removing the spatial dependence observed in the error terms of aspatial, noninteractive models.

Empirical Results

The model of choice is one that best represents the relationships between the variables, and has a small variance and unbiased parameters. Adhering to the methodology proposed by Fik, Ling, and Mulligan,[20] various empirical models were selected and progressively tested. The models were based on other well-tested hedonic housing price equations reported in the literature to derive a best-fit model.

To test the belief that the relationship between *SALE_PRICE* and other specific independent variables such as *SQFT*, *AGE*, and *DISTANCE* is not a linear function of *SALE_PRICE*, the variables were transformed to reflect the correct relationship. It was found that the best result was obtained from using the log of *SALE_PRICE* and the square of *SQFT*, *AGE*, and *DISTANCE*.

The methodology progresses from an interactive model specification, which controls for site and structural attributes of residential property as well as the effects of absolute location, to a model that incorporates the impact of explicit location to measure the effects of the proximity to towers (as indicated by *DISTANCE*) on the sale prices of residential property.

Preliminary tests of each model, proceeding from interactive aspatial and spatial estimates, were executed to identify an appropriate polynomial order, or a model that provided the greatest number of statistically significant coefficients and the highest adjusted R-squared value.[21] Like the study by Fik, Ling, and Mulligan, sensitivity analyses suggested the use of a fourth-order model, at most. Similarly, the following model specifications are estimated with a stepwise regression procedure to minimize the potential for model misspecification due to multicollinearity and to ensure that only the independent variables offering the greatest explanatory power are included in the second model. The study used Levene's test for equality of variances. The assumption of homoskedasticity, like the assumption of normality, has been satisfied.

Model 1 was utilized as a benchmark for the second model. The sale price (*SALE_PRICE*) is estimated using the following independent variables: lot size (*LOT*); square footage of the dwelling (*SQFT*); age of the dwelling in years (*AGE*); and the dwelling's absolute location (*XCOORD*) and (*YCOORD*). To investigate the effect of tower construction on the price of homes, the dummy variable (*AFTER_TWR*) was also included. Residential sale prices prior to tower construction (*AFTER_TWR* = 0) were compared to sale prices after tower construction (*AFTER_TWR* = 1). With the addition of the absolute location, Model 1 was used to provide a sound model specification, to maximize the explanatory value of the study and minimize the potential for misspecification in the estimated second model.

Model 2 includes distance-based measures indicating the property's explicit location, with respect to the closest tower. Both explicit distance and the distance squared were included. Model 2 integrated the base model (Model 1) with the distance from the tower to the property. The independent variable *DISTANCE* is introduced in the model and interacted

18. Externalities include influences external to the property such as school zoning, proximity to both amenities and disamenities, and the socioeconomic make-up of the resident population.

19. Model misspecifications could include inaccurate estimates of the regression coefficients, inflated standard errors of the regression coefficients, deflated partial t-tests for the regression coefficients, false nonsignificant p-values, and degradation of the model predictability.

20. Fik, Ling, and Mulligan.

21. Ibid., 633.

with the variables from Model 1. This model is used to assess the variation in sale price due to proximity to a tower.

Table 2 shows the development of a spatial and fully interactive model specification to estimate the effects of the proximity to towers on the price of residential property, according to Model 1, the base model.

In the semilogarithmic equation the interpretation of the dummy variable coefficients involves the use of the formula $100(e^{b_n}-1)$, where b_n is the dummy variable coefficient.[22] This formula derives the percentage effect on price of the presence of the factor represented by the dummy variable.

Results from Model 1 suggest that the price of residential properties sold after the construction of a tower increases by 1.47% (i.e., *AFTER_TWR* = 1.46E-02). Interactions with *AFTER_TWR* and other variables also suggest an increase in the price for single-family residential properties sold after tower construction. Among the control variables, *SQFT* increases price by 0.039% with each additional square foot of space (i.e., *SQFT* = 3.88E). *AGE* reduces price by 0.25% for each additional year of age. The *t*-statistics for the explanatory variables *SQFT, AGE, XCOORD,* and *YCOORD* suggest significant explanatory power within the specification (i.e., *SQFT* = 47, AGE^2 = 7, XCOORD = -7.105 and *YCOORD* = 6.799). Model 1 accounts for 82% of the variation in the *SALE_PRICE* (i.e., Adj. *R*-Squared = 0.8219987).

Model 2 introduces the independent variable *DISTANCE* to assess the variation in sale price due to the external effect of a tower. The Model 2 results are presented in Table 3; Table 4 provides a summary of the distance results.

The results clearly show that the price of residential property increases with the distance from a tower. The independent variable, *DISTANCE*, estimates a coefficient with a positive sign, which increases with increasing distance from the tower (i.e., *DISTANCE* = 5.69E-05). As distance from the tower increases by 10 feet, price of a residential property increases by 0.57%. Moreover, the *t*-statistic associated with the estimated coefficient indicates the significance of the explanatory power of this variable (i.e., *t*-statistic = 10.751).

DISTANCE presents significant interactions with the other independent variables. The *t*-statistics associated with these interactions provide strong evidence that the price of residential property, while highly associated with site and structural characteristics, may be significantly impacted by proximity to towers (i.e., *AFTER_TWR*DISTANCE* = 3.519; $DISTANCE^2$ = -12.258; *DISTANCE*AGE* = 4.829).

Further, although the estimated effect of the explanatory variable *AFTER_TWR* continues to suggest that the value of residential property increases with the distance from towers, the interactive nature of *AFTER_TWR* with $DISTANCE^2$ suggests that the effect of *AFTER_TWR* may vary due to varying distances from the tower. Indeed, the estimated coefficient for *AFTER_TWR* from Model 1 is diminished in Model 2 when the explicit, distance-based locational attribute is included in the model specification (i.e., Model 1, *AFTER_TWR* = 1.46E-02 (1.47%); Model 2, *AFTER_TWR* = 0.012722 (1.28%)).

Table 2 Model 1 Results

Variables	Est. Coefficient	Std. Error	Std. Coefficient	*t*-Stat	Significance
Constant	3.689244	0.257416		14.332	0.0000
AFTER_TWR	1.46E-02	5.08E-03	0.0353	2.867	0.0042
*AFTER_TWR*AGE*	5.99E-04	2.62E-04	0.0395	2.290	0.0221
*AFTER_TWR*LOT*	8.79E-07	2.91E-07	0.0272	3.018	0.0026
SQFT	3.88E-04	8.20E-06	1.2072	47.368	0.0000
$SQFT^2$	-3.02E-08	1.90E-09	-0.3779	-15.912	0.0000
*SQFT*AGE*	3.52E-07	1.78E-07	0.0429	1.982	0.0475
AGE	-2.81E-03	5.17E-04	-0.1739	-5.429	0.0000
AGE^2	7.12E-05	9.94E-06	0.1527	7.165	0.0000
XCOORD	-1.14E-06	1.61E-07	-0.0432	-7.105	0.0000
YCOORD	3.05E-06	4.48E-07	0.0456	6.799	0.0000

Notes: n = 5783. Adjusted R^2 = 0.8219987.

22. Robert Halvorsen and Raymond Palmquist, "The Interpretation of Dummy Variables in Semilogarithmic Equations," *American Economic Review* 70, no. 3 (June 1980): 474–475.

Table 3 Model 2 Results

Variable	Est. Coefficient	Std. Error	Std. Coefficient	*t*-Stat	Significance
Constant	3.097387	0.268028		11.556	0.0000
AFTER_TWR	0.012722	4.42E-03	0.0309	2.877	0.0040
*AFTER_TWR*AGE*					
*AFTER_TWR*LOT*	1.26E-06	2.86E-07	0.0389	4.400	0.0000
*AFTER_TWR*DISTANCE*^{2}	2.72E-09	7.73E-10	0.0550	3.519	0.0004
SQFT	4.01E-04	8.45E-06	1.2464	47.460	0.0000
SQFT^2	-3.04E-08	1.93E-09	-0.3797	-15.726	0.0000
*SQFT*AGE*					
AGE	-2.80E-03	3.95E-04	-0.1731	-7.077	0.0000
AGE^2	6.72E-05	9.70E-06	0.1442	6.931	0.0000
XCOORD	-1.61E-06	1.63E-07	-0.0610	-9.911	0.0000
YCOORD	4.70E-06	4.80E-07	0.0702	9.798	0.0000
DISTANCE	5.69E-05	5.29E-06	0.2548	10.751	0.0000
DISTANCE^2	-1.49E-08	1.22E-09	-0.2927	-12.258	0.0000
*DISTANCE*AGE*	6.20E-07	1.28E-07	0.0909	4.829	0.0000
*DISTANCE*SQFT*	-5.43E-09	2.71E-09	-0.0568	-2.002	0.0453

Notes: n = 5783. Adjusted R^2 = 0.8282641

Table 4 Summary of Model 2 Location Results

Variable	Estimated Coefficient (% Impact on Price)
DISTANCE	5.69E-05 (5.69-03%)
DISTANCE^2	-1.49E-08

Note: ADJ. R^2 = 0.8282641

Limitations

This study analyzed residential property sales from different but neighboring suburbs as an entire data set, i.e., the suburbs were grouped together and analyzed as a whole. The absolute location was included in the model to take into account composite externalities as well as to allow these and other independent variables in the model to vary spatially, and therefore preclude the need to analyse neighborhoods separately. However, it is possible that not all neighborhood differences were accounted for.

For example, when comparing these results to those from the NZ study by Bond and Xue, it appears the results from both studies based on an analysis of the whole data set were similar. Towers have a statistically significant, but minimal, effect on the prices of proximate properties. However, what the NZ study showed by analyzing the suburbs separately was that substantive differences exist in the effect that towers have on property prices between suburbs, since the distribution of the property sale prices is quite different in each. It is possible that if the current study had analyzed suburbs separately that similar differences would have been found.

Summary and Conclusions

This article presents the results of a study carried out in Florida in 2004. The study involved the analysis of market transaction data of single-family homes that sold in Orange County between 1990 and 2000 to investigate the effect on prices of property in close proximity to a tower. The results showed that while a tower has a statistically significant effect on prices of property located near a tower, this effect is minimal.

Each geographical location is unique. Residents' perceptions and assessments of risk vary according to a wide range of processes including psychological, social, institutional, and cultural. The results of this study may vary with the NZ results not only due to the differences in study design (for example, this study excluded an analysis at a neighborhood level), but also due to differences in the landscape. In New Zealand, there are fewer structures such as high voltage overhead transmission lines, cell phone towers, and billboards than there are in the United States. As a result, it is possible that U.S. residents simply have become accustomed to these features and so notice them less.

The value effects from towers may vary over time as market participants' perceptions change due to increased public awareness regarding the potential (or lack of) adverse health and other effects of living near a towers. Further research into factors that impact on the degree of negative reaction from residents living near these structures could provide useful insights that help explain the effects on property price. Such factors might include, for example, the kinds of health and other risks residents associate with towers; the height, style, and appearance of the towers; how visible the towers are to residents and how they perceive such views; and the distance from the towers residents feel they have to be to be free of concerns.

As the results reported here are from a case study conducted in 2004 in a specific geographic area (Orange County, Florida) the results should not be generally applied. As Wolverton and Bottemiller explain,

> The limits on generalizations are a universal problem for real property sale data because analysis is constrained to properties that sell and sold properties are never a randomly drawn representative sample. Hence, generalizations must rely on the weight of evidence from numerous studies, samples, and locations.[23]

Thus, many similar studies in different geographic locations would need to be conducted to determine if the results are consistent across time and space. Such studies would need to be of similar design, however, to allow valid comparison between them. As suggested by Bond and Wang, the sharing of results from similar studies would aid in the development of a global database to assist appraisers in determining the perceived level of risk associated with towers and other similar structures from geographically and socioeconomically diverse areas.

Sandy Bond, PhD, MBS, DipBusAdmin, SPINZ, is a senior member of the Property Institute of New Zealand (PINZ) and a past president of the Pacific Rim Real Estate Society (PRRES). She was awarded the PRRES Achievement Award in 2002 and the New Zealand Institute of Valuers' Presidential Citation in 1997. Before commencing her academic career in 1991 she worked as an appraiser in both New Zealand and the United Kingdom.

Bond is currently a senior lecturer at Curtin University of Technology. Her doctoral research was on the assessment of stigma relating to remediated contaminated property. Her current areas of research interest include the valuation of contaminated land, the impact of cell phone towers and high voltage transmission lines on residential property values, and public sector asset valuation. She has published numerous articles in journals in New Zealand, Australia, Malaysia, the United Kingdom, and the United States, and was responsible for drafting the NZPI Practice Standard on the Valuation of Contaminated Sites. **Contact: dr_sandybond@yahoo.com**

Additional Reading

Christchurch City Council Web site at http://www.ccc.govt.nz/index.asp

Crecine, J. P., O. Davis, and J. E. Jackson. "Urban Property Markets: Some Empirical Results and Their Implications for Municipal Zoning." *Journal of Law and Economics* 10 (1967): 79–99.

Crone, Theodore M. "Elements of an Economic Justification for Municipal Zoning." *Journal of Urban Economics* 14 (September 1983): 168–183.

Fisher, Walter D. "Econometric Estimation with Spatial Dependence." *Regional and Urban Economics* 1, no. 1 (1971): 19–40.

Gillen, K., T. G. Thibodeau, and S. Wachter. "Anisotropic Autocorrelation in House Prices." *Journal of Real Estate Finance and Economics* 23, no. 1 (2001): 5–30.

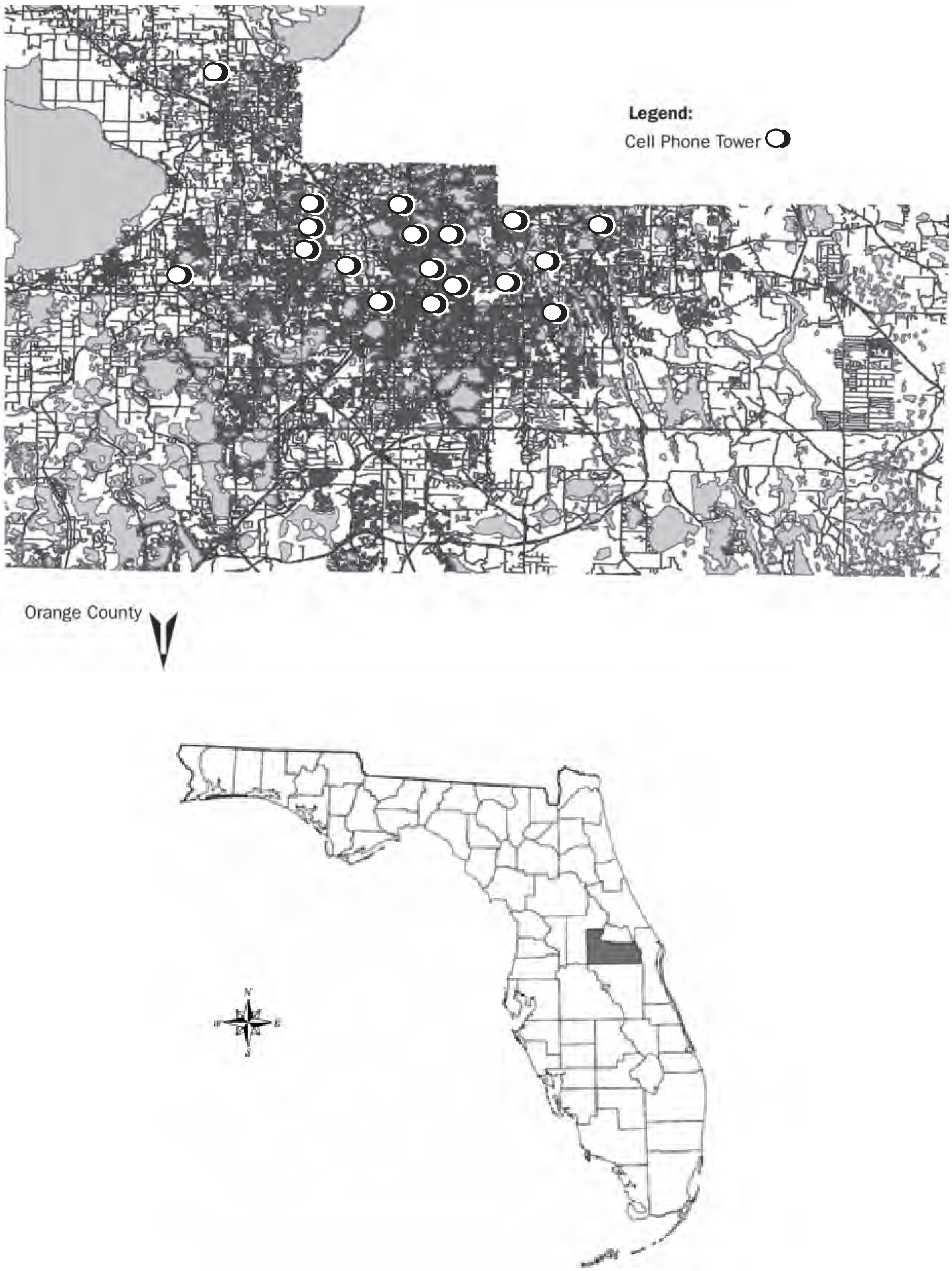
Kohlase, J. E. "The Impact of Toxic Waste Sites on Housing Values." *Journal of Urban Economics* 30, no. 1 (1991): 1–26.

Li, M. M., and H. J. Brown. "Micro-Neighborhood Externalities and Hedonic Housing Prices." *Land Economics* 56, no. 2 (1980): 125–141.

23. Marvin L. Wolverton and Steven C. Bottemiller, "Further Analysis of Transmission Line Impact on Residential Property Values," *The Appraisal Journal* (July 2003): 252.

Appendix

Location Map, Orange County, Florida



APPENDIX V

EMF Real Estate Survey Results: "Neighborhood Cell Towers & Antennas—Do They Impact a Property's Desirability?"

The National Institute for Science, Law and Public Policy's survey **"Neighborhood Cell Towers & Antennas—Do They Impact a Property's Desirability?"** initiated June 2, 2014, has now been completed by 1,000 respondents as of June 28, 2014. The survey, which circulated online through email and social networking sites, in both the U.S. and abroad, sought to determine if nearby cell towers and antennas, or wireless antennas placed on top of or on the side of a building, would impact a home buyer's or renter's interest in a real estate property.

The overwhelming majority of respondents (94%) reported that cell towers and antennas in a neighborhood or on a building would impact interest in a property and the price they would be willing to pay for it. And 79% said under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antenna.

- **94% said a nearby cell tower or group of antennas would negatively impact interest in a property or the price they would be willing to pay for it.**
- **94% said a cell tower or group of antennas on top of, or attached to, an apartment building would negatively impact interest in the apartment building or the price they would be willing to pay for it.**
- **95% said they would opt to buy or rent a property that had zero antennas on the building over a comparable property that had several antennas on the building.**
- **79% said under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas.**
- **88% said that under no circumstances would they ever purchase or rent a property with a cell tower or group of antennas on top of, or attached to, the apartment building.**
- **89% said they were generally concerned about the increasing number of cell towers and antennas in their residential neighborhood.**

The National Institute for Science, Law and Public Policy (NISLAPP) was curious if respondents had previous experience with physical or cognitive effects of wireless radiation, or if their concern about neighborhood antennas was unrelated to personal experience with the radiation. **Of the 1,000 respondents, 57% had previously experienced cognitive effects from radiation emitted by a cell phone, wireless router, portable phone, utility smart meter, or neighborhood antenna or cell tower, and 43% had not experienced cognitive effects. 63% of respondents had previously experienced physical effects from these devices or neighborhood towers and antennas and 37% had not experienced physical effects.**

The majority of respondents provided contact information indicating they would like to receive the results of this survey or news related to the possible connection between neighborhood cell towers and antennas and real estate decisions.

Comments from real estate brokers who completed the NISLAPP survey:

"I am a real estate broker in NYC. I sold a townhouse that had a cell tower attached. Many potential buyers chose to avoid purchasing the property because of it. There was a long lease."

"I own several properties in Santa Fe, NM and believe me, I have taken care not to buy near cell towers. Most of these are rental properties and I think I would have a harder time renting those units… were a cell tower or antenna nearby. Though I have not noticed any negative health effects myself, I know many people are affected. And in addition, these antennas and towers are often extremely ugly–despite the attempt in our town of hiding them as chimneys or fake trees."

"We are home owners and real estate investors in Marin County and have been for the last 25 years. We own homes and apartment building here in Marin. We would not think of investing in real estate that would harm our tenants. All our properties are free of smart meters. Thank you for all of your work."

"I'm a realtor. I've never had a single complaint about cell phone antennae. Electric poles, on the other hand, are a huge problem for buyers."

Concern was expressed in the comments section by respondents about potential property valuation declines near antennas and cell towers. While the NISLAPP survey did not evaluate property price declines, a study on this subject by Sandy Bond, PhD of the New Zealand Property Institute, and Past President of the Pacific Rim Real Estate Society (PRRES), The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods (http://snurl.com/2922m58), was published in *The Appraisal Journal* of the Appraisal Institute in 2006. The Appraisal Institute is the largest global professional organization for appraisers with 91 chapters. The study indicated that **homebuyers would pay from 10%–19% less to over 20% less for a property if it were in close proximity to a cell phone base station.** The 'opinion' survey results were then confirmed by a market sales analysis. **The results of the sales analysis showed prices of properties were reduced by around 21% after a cell phone base station was built in the neighborhood."**

The Appraisal Journal study added,

"Even buyers who believe that there are no adverse health effects from cell phone base stations, knowing that other potential buyers might think the reverse, will probably seek a price discount for a property located near a cell phone base station."

James S. Turner, Esq., Chairman of the National Institute for Science, Law & Public Policy and Partner, Swankin & Turner in Washington, D.C., says,

"The recent NISLAPP survey suggests there is now a high level of awareness about potential risks from cell towers and antennas. In addition, the survey indicates respondents believe they have personally experienced cognitive (57%) or physical (63%) effects from radiofrequency radiation from towers, antennas or other radiating devices, such as cell phones, routers, smart meters and other consumer electronics. Almost 90% are concerned about the increasing number of cell towers and antennas generally. A study of real estate sales prices would be beneficial at this time in the Unites States to determine what discounts homebuyers are currently placing on properties near cell towers and antennas. Americans deserve to know."

Betsy Lehrfeld, Esq., an attorney and Executive Director of NISLAPP, says,

“The proliferation of this irradiating infrastructure throughout our country would never have occurred in the first place had Section 704 of the Telecommunications Act of 1996 not prohibited state and local governments from regulating the placement of wireless facilities on health or environmental grounds. The federal preemption leaves us in a situation today where Americans are clearly concerned about risks from antennas and towers, some face cognitive and physical health consequences, yet they and their families increasingly have no choice but to endure these exposures, while watching their real property valuations decline.”

The National Institute for Science, Law, and Public Policy (NISLAPP) in Washington, D.C. was founded in 1978 to bridge the gap between scientific uncertainties and the need for laws protecting public health and safety. Its overriding objective is to bring practitioners of science and law together to develop intelligent policy that best serves all interested parties in a given controversy. Its focus is on the points at which these two disciplines converge.

NISLAPP contact:
James S. Turner, Esq.
(202) 462-8800 / jim@swankin-turner.com
Emily Roberson
er79000@yahoo.com

If you can support NISLAPP’s work, please donate here:
http://snurl.com/2922mso

Donate

PayPal

See Commentary by ElectromagneticHealth.org on NISLAPP EMF Real Estate Survey Results and Recommendations for Real Estate Agents and Homebuyers here:
http://electromagnetichealth.org/electromagnetic-health-blog/survey-commentary/

Wireless Communications Initiative Study

Wireless Facilities Impact on Property Values

November 2012

Background

Wireless technology has dramatically changed the way the world communicates. There are over 6 billion wireless phones being used worldwide. In the United States the number of wireless phones is greater than the population. Conversely, with the advent of smart phones and wireless devices, there is increasing strain being put our already stressed wireless infrastructure. The goal of the Wireless Communications Initiative (WCI) is to enable the deployment of a 21st century wireless infrastructure. Silicon Valley is clearly driving wireless innovation and the region has consistently been an early adopter of these products.

However, compared to feature phones, smartphones place 24 times the demand on wireless networks, and smart devices such as tablets command 120 times as much. Carriers are trying to respond to this revolution in technology by deploying what is called Next Generation technology. Carriers tout the capacity of their 4G or LTE (Long Term Evolution) networks as significantly more efficient in managing the burgeoning demand placed on networks by applications such as streaming video.

The significant challenge facing the next phase in technology deployment is the need to place wireless facilities in residential neighborhoods. These facilities need to be closer to consumers to allow signals to be accessible within homes. This is increasingly important given that about 30 percent of homes rely solely on wireless phone service. In addition, almost 400,000 calls to 911 are made each day using wireless phones. Access to a wireless network has now become a public safety imperative.

Carriers are working with cities to identify neighborhood sites for wireless facilities. However, this task has been made more difficult in some cases when a few residents raise concerns about the placement of wireless towers. These residents oppose carrier applications because of trepidations related to Radio Frequency (RF) emissions or suspicions about a negative impact on property values. The anxiety that wireless towers impact property values has been a powerful argument used by opponents to carrier applications. Oftentimes, anecdotal evidence is used to bolster these arguments, absent any factual evidence regarding the veracity of these claims.

Carrier and city attempts to address these concerns can lead to long delays in deploying and upgrading wireless facilities. It isn't unusual for a single application to be delayed for a year or more while community concerns are being addressed.

This study has been designed to assess the actual effects of wireless facilities on property values. We have the capability to consider wireless facilities that have been in place for several years. We can look at hundreds of recent real estate transactions to determine what effects are present.

The Study Partners

The Santa Clara County Association of REALTORS® and the Silicon Valley Association of REALTORS® (SILVAR) partnered with WCI to produce the study. The members of these two organizations are involved with most transactions involving single family residences in Silicon Valley. The Associations are over 100 years old and have a rich history paralleling the growth of the region. The organizations represent thousands of real estate agents who have a deep commitment to furthering the professionalism of the industry.

In addition, WCI partnered with MLS Listings to perform the actual data analysis. MLSListings, Inc. was founded in 2007 by a collaboration between several established regional multiple listing services, notably Silicon Valley's RE InfoLink and California's Central Valley MLS. The company created by this merger, MLSListings Inc. serves nearly 16,000 subscribers and 6,000 firms. MLSListings typically handles listings totaling nearly $70 billion annually.

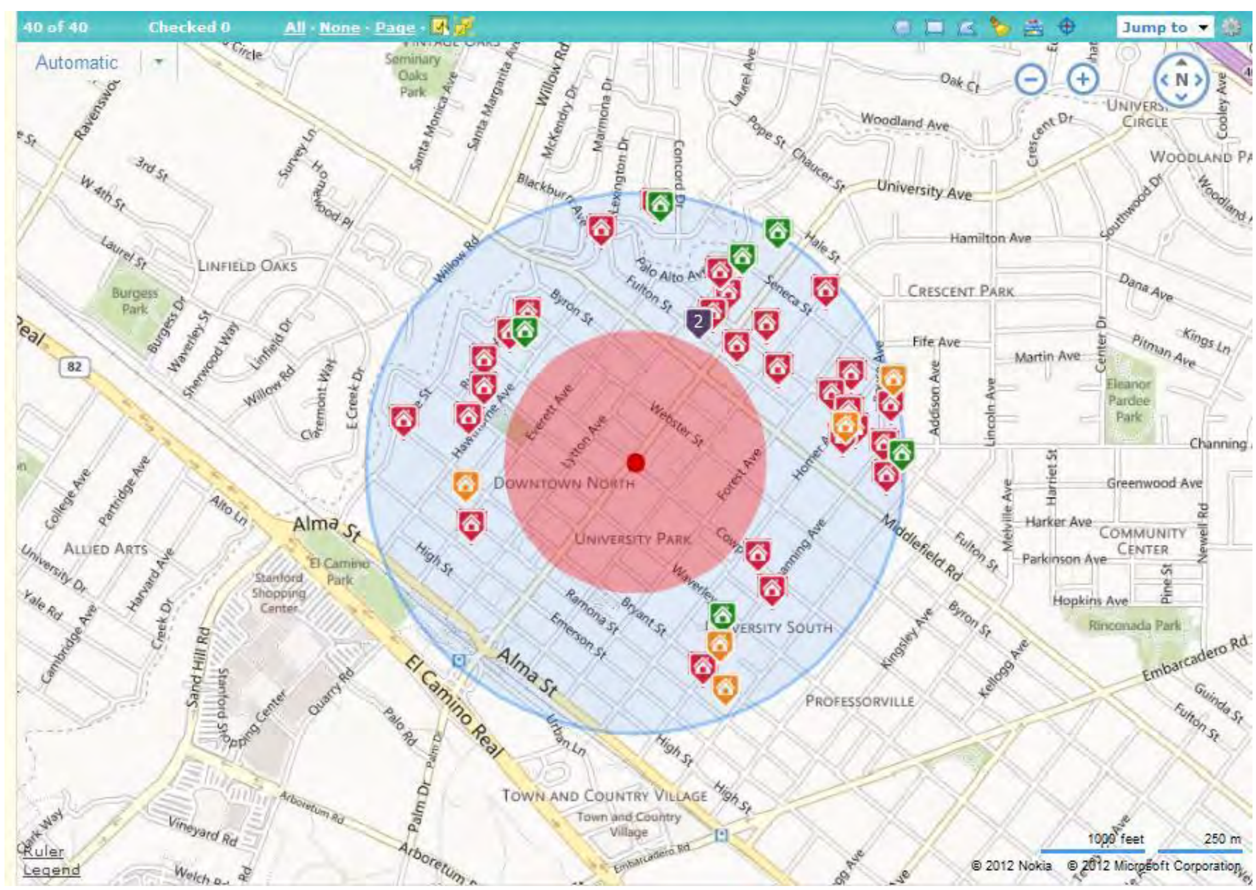
See Appendix B for more information about these organizations.

The Methodology

The data was compiled using over 1600 single-family home transactions from January to September 2012. A total of 70 wireless sites were selected in Palo Alto, Redwood City, Saratoga and San Jose. The survey compared the "list" and "sale" price for transactions based on the distant from the wireless facility. The transactions were grouped by those 1) within 1/8th of a mile, 2) 1/8 to a quarter mile and 3) a quarter to one-half mile.

In addition, the study included all types of wireless facilities. These facilities may be A) a wireless tower, B) equipment placed on buildings (e.g. church, offices) or C) placed on a utility structure (e.g. pole, tower).

See Appendix D for sample photographs of the sites.



Sample MLS listing data query

The chart below displays the aggregated results for the study. The list and sale prices are an aggregate of the all of the transactions that occurred within the specified distance from the wireless site during January to September 2012. The fourth column is derived as a percentage of the sale price to the list price.

	Total List Price	Total Sale Price	%List to Sale
Palo Alto			
0-0.125 mile	$ 33,093,000	$ 34,243,125	**103%**
0.125-0.25	$ 219,641,507	$ 233,276,629	**106%**
0.25-0.5	$ 1,058,288,821	$ 1,094,507,081	**103%**
Redwood City			
0-0.125 mile	$ 9,111,888	$ 9,306,000	**102%**
0.125-0.25	$ 36,670,398	$ 36,738,500	**100%**
0.25-0.5	$ 91,938,794	$ 92,571,249	**101%**
Saratoga			
0-0.125 mile	$ 11,116,000	$ 11,168,000	**100%**
0.125-0.25	$ 77,914,560	$ 77,601,045	**100%**
0.25-0.5	$ 353,092,390	$ 350,550,126	**99%**
San Jose			
0-0.125 mile	$ 29,024,249	$ 28,695,250	**99%**
0.125-0.25	$ 57,135,400	$ 57,075,940	**100%**
0.25-0.5	$ 157,404,541	$ 158,404,215	**101%**

A listing of the addresses for the wireless sites is in Appendix A.

Conclusion

It is quite clear from the data that the distance from a wireless facility has no apparent impact on the value or sale price of a home. The relationship between the list and sale price remained the same no matter how close the property was to the wireless facility. In addition, we see that all the cities in the survey had similar results. The sites across all cities represent a variety of properties including those in neighborhoods with higher priced homes versus those in communities with more moderately priced homes.

Most real estate professionals believe there are multiple factors that affect property values. These professionals still believe in the old adage that there are three factors: location, location, location. However, it is quite obvious that the overall economic climate can have an overriding effect on the real estate market. This year has seen a significantly stronger market for home sales, both in the number of transactions and sellers' ability to obtain their asking price. Other factors that tend to impact property values include schools and access to transportation.

This study should provide a data-based explanation of the relationship between home values and the proximity to wireless facilities. The conclusions can be understood to suggest that communities and carriers have done well in considering the placement of the technology. The Wireless Communications Initiative believes this continued commitment to resolving deployment issues will benefit our region and its neighborhoods.

(Appendix A)

Wireless Facilities Included In Study

Palo Alto

1082 Coronado

101 Alma St

1985 Louis Road

3990 El Camino

305 N California

10950 Channing

1501 Page Mill Rd

200 Page Mill Rd

2047 bayshore

2300 Geng Rd

260 Sheridan

2666 E Bayshore Rd

2675 Hanover St

2701 Middlefield Rd

300 Pasteur Dr

3000 Alexis

3141 Maddux Dr

3401 & 3431 Hillview

345 Hamilton Ave

3475 Deer Creek Rd

3600 W Bayshore Rd

3600 Middlefied

3672 Middlefied

3862 Middleflied

4009 Miranda

4243 Manuela Ave

4249 El Camino Real

488 University Ave

525 University Ave

531 Stanford Ave

695 Arastradero

711 Colorado

724 Arastradero

850 Webster St

855 El Camino

900 Blake Wilbur Dr

799 Arastradero

760 Porter

3000 El Camino Real

675 El Camino Real

2595 E Bayshore

Junipero & Stanford

Page Mill & Foothill

Redwood City

3025 Jefferson Ave

468 Grand St

1175 Palomar

1251 Annette

2900 Whipple Ave

Saratoga

14407 Big Basin Way

14000 Fruitvale

13000 Glen Brae

13750 Prune Blossom

14091 Quito Rd

12770 Saratoga Ave

1777 Saratoga Ave

13601 Saratoga Ave

20508 Saratoga Los Gatos

19491 Saratoga Los Gatos

12393 Saratoga Sunnyvale

12413 Saratoga Sunnyvale

Hwy 9 & Quito

San Jose

2827 Flint Ave

930 Remillard Ct

3675 Payne Ave

144 S Jackson

366 Saint Julie Dr

1529 Newport Ave

1200 Fleming Ave

2110 Story Rd

1635 Park Ave

1700 Moffat St

Disclaimer: the data was pulled on 10/2/2012 pulling only single family residence (class 1 in MLSListings, Inc.) with a time frame of all sales from 1/1/2012 to 10/2/2012

Appendix B

Santa Clara County Association of REALTORS®

History

Santa Clara County Association of REALTORS®, established in 1896, has a long and rich history paralleling the history of Santa Clara Valley. SCCAOR, the first trade association in California, is the largest real estate board in Northern California, and was listed as one of the nation's top 20 associations by the Foundation of the American Society of Association Executives. It has come a long way since its first members took potential buyers to preview properties in horse-drawn buggies.

Over the years, its members have made very significant contributions, both in the real estate industry and to the quality of life in Santa Clara County, through their community service activities. Santa Clara County Association of REALTORS®'s history is one of recognizing changing needs in the real estate industry, economy, and technology, and leading the way in responding to those needs.

Santa Clara County Association of REALTORS® was the first real estate board in California to employ a Government Affairs Director to represent the interest of property owners, REALTORS® and the real estate industry, at all levels of government. Threats to property rights remain an increasingly "hot" item on legislative agendas.

The Board's educational activities for members and the public consistently win state and national awards for high quality and leadership, including the Real Estate Assistants Program, developed in 1994. Ongoing classes and seminars provide Members with the most current, professional education for the benefit of their clients and their careers.

In support of the many communities our members serve, SCC REALTORS® FOUNDATION, a nonprofit corporation designed to direct Member's monetary contributions to the most vital community needs, was formed in 1991.

Integrity, strength and innovation are the foundation of Santa Clara County Association of REALTORS®'s history. In the same tradition, established during the past century, we are committed to being an industry leader, bringing positive action and service to our Members and communities for the next 100 years.

The Silicon Valley Association of REALTORS®

The Silicon Valley Association of REALTORS® (SILVAR) is a professional trade organization representing over 4000 REALTORS® and Affiliate members engaged in the real estate business on the Peninsula and in the South Bay. SILVAR promotes the highest ethical standards of real estate practice, serves as an advocate for homeownership and homeowners, and represents the interests of property owners in Silicon Valley.

It is the duty and responsibility of every REALTOR® member of this Association to abide by the "Code of Ethics" of the National Association of REALTORS®. The term "REALTOR®" is a registered collective membership mark which identifies a real estate professional who is a member of the National Association of REALTORS® & who subscribes to its strict Code of Ethics.

MLSListings®
The Trusted Real Estate Data Source

MLSListings, Inc. was founded in 2007 as a collaboration between several established regional multiple listing services, notably Silicon Valley's RE InfoLink and California's Central Valley MLS. As the company created by this merger, MLSListings Inc. serves nearly 16,000 subscribers and 6,000 firms in Santa Clara, Santa Cruz, Monterey, San Mateo, San Benito, Merced, San Joaquin and Stanislaus Counties – an area of approximately 28,000 square miles, reaching from San Francisco to Big Sur, and including some of the most valuable real estate in the world. MLSListings typically handles listings totaling nearly $70 billion annually.

In April, 2008, MLSListings, Inc. joined with three other Northern California MLS services – San Francisco MLS, Bay Area Real Estate Services, and MetroList Services – in an unprecedented alliance to share multiple listing data throughout Northern California. This new alliance serves nearly 50,000 brokers in 19 Northern California Counties, a total population of nearly 9 million people.

Appendix C

Wireless Site Photographs (Sampling)

366 St. Julie Drive, San Jose

2110 Story Road, San Jose


3675 Payne, San Jose

12770 Saratoga Ave, Saratoga

14407 Big Basin Way

675 El Camino, Palo Alto

1082 Colorado St. Palo Alto

1985 Louis Road, Palo Alto

4009 Miranda, Palo Alto

4243 Manuela, Palo Alto, CA

2575 Hanover, Palo Alto

APPENDIX VII

Valbridge

NEWS 2018

How Does the Proximity to a Cell Tower Impact Home Values?

September 14, 2018

Valbridge Property Advisors conducts market studies to determine the impact of wireless communication towers on property values in four metropolitan U.S. cities

Valbridge Property Advisors recently completed market studies in Boston, Dallas, Phoenix, and Raleigh, to determine the impact of the presence of wireless communications towers on residential property values.

THE PROCESS

The studies were conducted in multiple sub-areas of each city, which were then compiled to produce measurable results. Home sale values demonstrated no measurable difference for those homes within a 0.25-mile radius sphere of influence of the cell tower and those homes in a 0.50-1.0 mile radius outside of the cell tower sphere of influence. In many of the sub-areas, home prices increased nominally. No measurable difference is defined as a less than 1% difference; nominal difference is defined as 1-3%.

To prepare the sub-area studies, the center points of each sub-area's primarily single-family residential areas or specific subdivisions were identified by latitude and longitude. Single-family residential sales with both a qualified buyer and a qualified seller from the first quarter 2015 through first quarter 2018 were located and verified to assess the transactions.

THE RESULTS ARE IN

BOSTON

The Boston study revealed 10 of 22 pairings of home sales with higher sale prices within the 0.25- mile sphere of influence, 11 of 22 pairings with lower home prices, and one pairing indicating no difference. The data indicates cell towers do not have a negative impact on property values within a .25-mile radius of cell towers. Overall, the measurable difference is less than 1% in both the increasing and decreasing home price indications.

DALLAS

In Dallas, for homes in the .25 to 1.00-mile radius, there was no measurable difference. Out of 33 paired sales in five sub-areas, 20 pairings indicated higher values for those sales within the 0.25- mile sphere of influence, while 12 pairings indicated lower values and one indicated no difference. Overall, Dallas shows no measurable difference. The data indicates cell towers do not have a negative impact on property values within a .25-mile radius of cell towers.

PHOENIX

There were 37 paired sales in the Phoenix market, and 20 of the pairings indicated increased home prices within the 0.25% sphere of influence while seventeen of the 37 pairings indicated decreased home prices. Four of the five sub-areas studied had no measurable difference and one sub-area had a nominal difference.

RALEIGH

In Raleigh, fourteen of 22 pairings indicated higher home prices within the 0.25-mile sphere of influence while eight of 22 indicated slightly decreased home prices. Overall, the average and median prices increased in four of the five sub-area and one sub-area indicated no measurable difference. The data indicates cell towers do not have a negative impact on property values within a .25-mile radius of cell towers. Overall, the measurable difference is less than 1% in both the increasing and decreasing home price indications.

DIG DEEPER

To request a copy of the study findings, visit Valbridge.com.

REQUEST A CONSULTATION

Find your local Valbridge office for more information or to receive a customized proposal for services.

FIND AN APPRAISER

National Coverage. Local Knowledge. True Valuation Independence.