THE IMPACT OF TRANSMISSION LINES ON RESIDENTIAL PROPERTY VALUES: RESULTS OF A CASE STUDY In a SUBURB OF WELLINGTON, NZ

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Abstract:

This article summarises the results of research consisting of two parallel studies: firstly, an analysis of residential property sales in a case study area to determine the effect of high voltage overhead transmission lines (HVOTLs) and supporting pylons on residential property values. Secondly, a study of the attitudes and reactions of property owners in the case study neighbourhood toward living close to HVOTLs and pylons. A comparison of the results helped determine the extent that these reactions are reflected in the prices paid for property close to HVOTLs and pylons The results of the sales analysis indicate the effect of having a 'pylon' close to a particular property is statistically significant. 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 sales price. 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 further away. It appears, however, from a comparison of the results, that the negative feelings expressed are often not reflected in the price paid for such property.

Keywords: *New Zealand, high voltage overhead transmission lines and pylons, residential property values, residents' attitudes*

1. INTRODUCTION

Understanding of the effects of HVOTLs and their supporting structures, the pylons, on property values is important to electricity companies in helping plan the routing of these and for determining fair compensation to property owners. The owners of affected properties also want to understand the magnitude of impacts, particularly if compensation claims are to be made against such property.

Media attention to the potential health hazards of HVOTLs has caused changes in public perception. Studies by Ahlbom (1987) Anna (1989) and Coghlan (1992) suggest a positive correlation between long-term exposure to the electromagnetic fields produced by HVOTLs and certain types of cancer. However, other studies, such as Consumer (1994), and The National Research Council (1997), report inconclusive results on health effects. Yet it appears the extent of opposition from property owners affected by the siting of HVOTLs is still strong. However, the extent to which such attitudes are reflected in lower property values affected by HVOTLs is not known in New Zealand.

The paper develops a case study approach to examine the effects of HVOTLs on residential property values. This follows the lines of similar research carried out by Priestley and Evans (1990) and the methodology developed by Priestley and Ignelzi (1989). Priestley and Ignelzi established a sound standardised methodology for assessing environmental impacts in residential communities using postal surveys and econometric modelling (regression analysis of sales transactions).

The case study area selected for this research was in the suburb of Newlands, Wellington. This suburb has two sets of HVOTLs crossing the suburb. The Khandallah - Takapau line erected in 1924 and upgraded in 1983 runs through the eastern side of the suburb, and the Khandallah - Haywards line erected in 1931 and upgraded in 1981 runs along the south east corner of Newlands. Both lines have 26 metre high pylon towers with lines carrying 110 KV.

The first part of the research used econometric analysis techniques to determine a suitable multiple regression equation to quantify the effect of the HVOTLs on property values. The second part of the study used a survey of residents' attitudes and perceptions of the HVOTLs to determine the specific concerns relating to these, and by comparison with the sales analysis results, to determine the extent that these reactions are reflected in price. The results can then be used to help resolve compensation issues in a quantitative way.

This paper provides a brief review of the relevant literature and describes the case study area selected for the research. It is then divided into two parts, describing the methodology and results from each of the parallel studies. The Statistical Analysis study is covered in Part I, and the Attitudinal Study in Part II. The paper concludes with a discussion of the results from both studies.

2. LITERATURE REVIEW

The only previously published study in New Zealand on HVOTLs effects was completed by Valuation New Zealand (1968). This study was carried out in Christchurch and Auckland (refer attached map). The results of that study showed that in Christchurch the HVOTLs did not appear to have any effect in the average[1] locality but they did have a negative effect in the superior[2] locality. The Auckland study was undertaken in an housing area comprising average to superior housing types (refer footnotes 1 and 2) and the results show that in a few cases HVOTLs did have an effect but that the majority of properties were not affected. This report concluded that although the transmission lines may not have a quantifiable effect on value, it was clear that power pylons either located on a property or situated in close proximity to a property do have an effect, with this effect being negative. The Valuation New Zealand study used an indexing system to compare changes in property values along the transmission line corridor, with those outside it. The basis for the indexing system was the most recent government valuation[3].

Few attitudinal studies, which give a qualitative feel for effects of HVOTLs, have been undertaken in New Zealand. An Environmental Impact Report (EIR) prepared by the Electricity Division of the Ministry of Energy in August 1986 arose as a result of environmental sensitivity and landowner reaction noted toward a new 220KV transmission line route. The EIR focused on the environmental impacts of six route options. Analysis of issues raised in submissions on the EIR indicated social and cultural concerns to be the most common concerns followed by visual impact, and then, effect on primary production. Of submissions received, 18.6% related to valuation concerns and 21% to compensation concerns. In particular, the extent of loss of property value resulting from the HVOTLs, and the inability of those affected by the HVOTLs to claim compensation where the HVOTLs were not directly on their land.

There have been a number of HVOTLs studies carried out in the United States and Canada. Kinnard (1967), and Priestley and Evans (1990) are worthy of note. A major review and analysis of the literature by Kroll and Priestley (1992) indicated that in about half the studies carried out, HVOTLs had not affected property values and in the rest of the studies there was a loss in property value between 2-10%. Kroll and Priestley were generally critical of most valuer type studies because of the small number of properties

[1] An "average" locality is defined as a locality comprising average price homes for the city. They are generally large subdivisions comprising mass produced standardised style homes ("group houses").

[2] A "superior" locality is defined as a locality comprising homes at the high end of the price range for homes in the city. Theses homes are generally purpose built to meet client requirements, have a more expansive layout, better quality of fixture and fittings, and are more aesthetically appealing than "average" homes.

[3] Government valuations are most commonly assessed for taxation rating purposes.

included and the failure to use econometric techniques such as multiple regression analysis. They found that the Colwell (1990) study was one of the more careful and systematic analysis of residential impacts. This study was carried out in Illinois and found that the strongest effect of the HVOTLs was within the first 15m but with this dissipating quickly further away, disappearing beyond 60m.

A Canadian study (Rosiers, 1998) based on a sample of 507 single-family house sales showed that although severe visual encumbrance due to a direct view of either a pylon or lines exerts a significantly negative impact on property values, a house located adjacent to a transmission corridor may increase values. This was particularly evident where the transmission corridor was on a well wooded 90m 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 (between, on average, 5-10% of mean house value) tends to be cancelled out by the increase in value from proximity to the easement.

The attitudinal studies conducted outside of New Zealand have been contradictory in their findings. Curiously, some of the research indicates that residents living near HVOTLs do not necessarily feel they have a negative impact on residential property value. The most common question posed in such studies is whether the respondent thought that the nearby transmission line affected the value of their property. In most of the surveys the implicit assumption was that the effect would be negative. Only a few surveys asked respondents to quantify the affect on property value of the HVOTLs.

The Priestley and Evans (1990) study is the most comprehensive in that it attempts to identify factors predicting how people will evaluate property value effects. It found that the perceived impacts of HVOTLs fall within three major areas. These were, in decreasing order of concern: health and safety, property values, and aesthetics.

The findings, to date, must be treated with caution as the development of hypotheses and research designs have not been standardised making comparisons difficult. The questions have been formulated in different ways and addressed to different kinds of samples living in different settings in widely dispersed geographic areas. Consequently, there is little opportunity to confirm the findings from one study with the results of another. To help address this Priestley and Ignelzi (1989) established a useful standardised methodology for assessing HVOTL impacts in residential communities.

Priestley and Ignelzi (1989) use an hedonic housing model to analyse the sales transactions. This involves first selecting a relevant case study area and time frame so there are sufficient sales data for analysis, and second, developing an appropriate explanatory model. The latter involves determining the property variables (characteristics) to include in the model and its appropriate functional form. For studying residents' perceptions they use a postal survey with an instrument designed to elicit responses from large numbers of people for statistical analysis.

The steps they suggest in the questionnaire development include: a review of the related literature together with interviews with key informants and area residents to identify the focus the study should take and the hypotheses to be tested. This information provides input for the development of a preliminary questionnaire that is reviewed by staff skilled in survey research and tested on a small sample of respondents. A final questionnaire is developed and posted to respondents. Using this approach the authors achieved a response rate of 60% after two follow-up reminders.

Priestley and Ignelzi (1989) suggest that if this standardised approach is followed it will allow comparisons to be made with their study and other similar studies. Hence, it was the approach adopted for the research reported here. However, New Zealand is somewhat unique in that the HVOTLs pass over the top of housing and not over an easement or right of way adjacent to the property, as is the case in the United States and Canada. In the Newlands area where the pylons are on privately owned land the electricity company Transpower has an existing use right under the Resource Management Act 1991. These legal access differences have made direct comparison between North America and New Zealand studies difficult. In North America the transmission line corridor effectively distances the lines and pylons from the homes, whereas in New Zealand, as mentioned,

pylons can be sited within metres of a house, with the lines transcending these.

3. THE CASE STUDY AREA

Newlands is a medium cost dormitory suburb situated approximately 14 kilometres north of Wellington city (see map). It is of a hilly terrain and the HVOTLs were built on hilltops within the suburb making them very prominent. The suburb has panoramic views of the Hutt Valley, downtown Wellington and the Wellington harbour. A major detracting feature of the area is its exposure to southerly winds that the city is renowned for. Although the suburb contains predominantly single family residential housing there are some multi-unit houses and a small commercial shopping centre.
A large section of the suburb has low voltage overhead power distribution and overhead telephone lines, a prominent feature in the local views. A limitation determined since concluding the research, was the presence of rumours amongst local residents and real estate agents that either one or both lines were to be removed in the near future. This may have influenced the purchaser's decision and purchase price. Subsequent to this study the section of the Khandallah - Haywards line through Newlands was in fact removed. Transpower has no reported plans to remove the Khandallah - Takapau line.

Part One: A Statistical Analysis.

4. ANALYSIS AND RESULTS

Based on the methodology developed by Priestley and Ignelzi (1989), multiple regression analysis was used to test the hypothesis that being located close to

HVOTLs has a negative impact on value. This involved an analysis of sales of residential properties in the case study area to determine the effect of HVOTLs on residential property values. Econometric analysis techniques were used to determine a suitable multiple regression equation to quantify the effect of the HVOTLs on property values.

Multiple regression analysis has been used for over twenty years to measure the impact of environmental hazards including the transmission lines, landfill sites and ground water contamination on residential sale prices (see, for example: Kinnard (1967); Zeiss and Attwater (1989 &1990); Colwell (1990); Priestley & Evans (1990); Hamilton & Schwann (1995); Smolen et. al.,(1992); Dotzour (1997); Simons and Sementelli (1997); and Reichert (1997)). Variables selected were similar to variables used in these other well-tested models.

4.1 Model Specification

The model used to analyse the impact on sale price of HVOTLs had three different types of variables:
Property specific variables
Real estate market factors

Transmission line and pylon distance effects
Due to the large number of variables that may come into a purchaser's decision, stepwise regression was used to select only those variables that have significant explanatory power.

4.2 Sources of Information

The prime source of information was the New Zealand Institute of Valuers' Valpak II software. Sales were extracted for the period 1 January 1983 - 31 January 1993. To eliminate large changes that might occur in the market over time, resulting from such factors as, for example, changing perceptions of HVOTL effects on health, the researchers adopted a five-year time frame. This time interval also provided sufficient sales (330) within 300 metres of HVOTLs to make the regression equation statistically reliable and to give confidence in results.

Measurements of distance from a sale property to the pylons, or lines, was taken from detailed maps obtained from the Department of Survey and Land Information. Field inspection revealed that 42% of the sales were directly under the HVOTLs, and 10% of sales were within 50 metres of the HVOTLs. The hilly terrain in the suburb meant that it was possible for a property to be only fifty metres from the line and yet have no visual impact, whereas a property located one hundred metres away, above the line may be looking directly at it. The affect of this is to render the results inconclusive in terms of distance from the line. Unfortunately, a line of sight variable was not included in this study.

4.3 Results

To determine the most appropriate model a number of models with different combinations of variables and functional forms were tested before the final model was selected. As it was suspected that the relationship between price and distance from the HVOTLs is not a linear function (as distance from the HVOTLs increases price increases but at a decreasing rate) this belief was tested by transforming the variable "distance" to reflect the correct relationship. Transformations included: the linear of all variables with distance shown in metres; the log of the distance; banding sales into 50 metre intervals; and the reciprocal of the distance. The best fit was found to be the reciprocal of the distance times one hundred to both the nearest lines and the nearest pylons. The variables in the final model found to be statistically significant are shown in Table 1, below.

TABLE 1: VARIABLES USED IN THE ANALYSIS

Sale Price:	Adjusted by Consumer Price Index to 31/12/93 basis
Property Features:	Land Area (m^2) Floor Area (to nearest 10 m^2) Exterior Construction (Brick, weather-boards etc.) Roof Construction (Tile, steel etc) Condition of Building (very good, average, poor etc) Year of Construction (decade built) Panoramic View or Not (Yes/No) Arterial Road (Yes/No)
Location:	Location 1 to 8 (suburb divided into 8 neighbourhoods)
Market:	Year of Purchase (split into 6 month periods)
Transmission Lines:	Reciprocal of Distance (1/distance x 100)

The non-HVOTL variables that were significant in this equation are similar to those appearing in the final equation for the control area.

Table 2 shows the statistical results of the analysis. Again, only those variables found to be statistically significant are shown.

TABLE 2: Statistical Results

Variable	Coefficient	$T_{observed}$	$T_{critical}$	Beta
Constant -(Intercept)	$46985			6.152
Floor Area	$371	22.2	.0000	0.679118
Land Area	$16	3.5	.0005	0.128069
Sale in first half of 1989	$23915	12.3	.0000	0.399677
Sale in second half of 1989	$23189	11.3	.0000	0.364857
Sale in first half of 1990	$18670	8.5	.0000	0.269518
Sale in second half of 1990	$15385	6.3	.0000	0.198773
Sale in first half of 1991	$8715	4.0	.0001	0.127532
Very good, Above average condition	$23341	3.6	.0004	0.499100
Average Condition	$18444	2.8	.0056	0.390230
Location four	$(4783)	-3.5	.0006	- 0.11077
Non panoramic view	$(4058)		.0033	- 0.09207
Constructed in 1950s	$(7496)	-3.0	.0033	- 0.105162
Proximity to Pylon	$(3551)	-5.0	.0000	- 0.137888

Number of Observations	=	330 sales
Adjusted R^2	=	0.74
Standard error as % of Sales Price	=	8.5
F Statistic	=	64.22

Transmission Line - Related Variables

Experimenting with the data gave an inconsistent result for the distance effects of transmission lines but a negative result was always obtained on the distance to nearest Pylons. In the final model a negative effect of -$3,551 times the reciprocal distance was obtained on the Khandallah - Haywards line. Table 3, below, shows that distance from the HVOTLs has a diminishing effect on property value that reduces to a minimal amount at around one hundred metres.

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TABLE 3: REDUCTION OF AVERAGE PRICE

Distance	Dollar Amount	Percentage
At 100 metres	-$3,551	-2.7%
50 metres	-$7,102	-5.4%
30 metres	-$11,836	-9.1%
20 metres	-$17,755	-13.6%
15 metres	-$23,673	-18.2%
10 metres	-$35,510	-27.3%

In summary, the results show that the effect of having a 'pylon' close to a particular property is significant and has a negative effect of around twenty percent at ten to fifteen metres from the pylon, decreasing to five percent at fifty metres. This effect diminishes to a negligible amount after one hundred metres. The presence of HVOTLs in the Newlands area has a minimal effect of less than negative one percent for those properties directly under the line, and is not a statistically significant factor in the sales price.

Part Two: An Attitudinal Study of Residents' Perceptions of HVOTLs

5. INTRODUCTION

This part of the article summarises the results of research carried out to answer the question of how those who live near HVOTLs evaluate their impact. Further, by comparing the results with those from the sales analysis study outlined in Part I, they

help to determine the extent that these reactions are reflected in price. It is pointed out that this attitudinal study serves to demonstrate current perceptions of the effect of HVOTLs upon residential property values. As in Part I of this research, the research design adopted followed the lines of similar research carried out by Priestley and Evans (1990) and the methodology developed by Priestly and Ignelzi (1989).

For purpose of analysis, sites in the chosen suburb were divided into two categories according to their distance from the pylons. Those sites that were within 50 metres of a pylon and/or the HVOTLs were termed "close", and sites within 50-300 metres from a pylon and/or the HVOTLs were classified as "distant". As mentioned in Part I, despite having reasonably homogeneous housing units various complicating factors emerged on closer inspection, such as the topography that permits some properties to obtain a harbour view and/or to screen the view of the lines.

5.1 Summary of Case Study Findings

Of the 796 questionnaires mailed to homeowners and tenants in the study area, 58% were completed and returned.

5.1.1 Feelings toward Transmission Lines as an element of the neighbourhood

When asked about a variety of factors that could affect their neighbourhood's attractiveness 78.5% of those responding indicated that they think high voltage HVOTLs have negative effects, and over 80% indicated they would rate the HVOTLs and/or the pylons appearance as either "somewhat" or "very negative".

Despite the negative feelings about the HVOTLs and pylons, over 66% of the respondents rated their neighbourhood as somewhat more or much more desirable in comparison to others in the Newlands area. This would suggest that there are many

features in Newlands such as proximity to the city, and harbour views that mitigate the negative effect of living near HVOTLs and pylons.

5.1.2 Concerns About Transmission Lines and Pylons

Residents evaluate the HVOTLs and pylons that run through their neighbourhood in negative terms because of their perceived impact on noise, health and safety, aesthetics and resale value. Of those respondents living "close" to the lines, 87% hear "buzzing" or "crackling" either sometimes or often. Of these, 78.3% are bothered to one degree or another by this noise.

The most important concerns are related to the health effects and lines breaking during earthquakes. In terms of health effects 62.5% of the respondents indicated that they worry "somewhat" to "a lot" and 52.3% indicated that they worry to the same extent about lines breaking during an earthquake.

Factors that over 60% of respondents considered to be most negatively affected by HVOTLs and pylons were: attractiveness of their home, attractiveness of views from their home, and the resale value of their property.

5.1.3 Effect on Decision to Purchase or Rent

For over two thirds (68.1) of the respondents, the presence of the lines and
pylons did not influence their decision one way or another, for 29.5% their presence created mild to strong reservations about buying or renting the house. Similar results were obtained for the ways in which the presence of the lines and pylons affected their price decision with 79.6% of the respondents not being influenced by this one way or another.

In general terms, the residents who notice the transmission lines and pylons the most and who evaluate them most negatively are those who live within 50 metres of either the HVOTLs or the pylons termed *"close"*.

Evaluation of the responses to the questionnaire's background questions revealed that 72.8% of the respondents were male and 27.2% were female. The average age was 30-49 years. 73.1% of the respondents were in full-time employment. Home-owners made up 97% of the sample with only 2.9% being tenants. Those situated within 50 metres of the HVOTLs and/or pylons made up 43.7% while those further than 50 metres made up 56.3%.

As no question was included to determine how many of the respondents had heard the rumour that a line was to be removed it is uncertain to what degree this information affected the results. Knowledge about the number of respondents that had heard the rumour and the degree to which it affected their response would have helped determine the impact, if any, on the results reported here.

Finally, it is possible that respondents biased their responses for fear that it may affect the value of their property, particularly for those located near a line or pylon. It was not possible to verify this possibility however, the questionnaire was designed to minimise such potential biases.

6. SUMMARY AND CONCLUSIONS

The only prior research in New Zealand to determine the impact of HVOTLs on property values was carried out by the Valuation Department in 1968, and was based on the analysis of government values in two cities: Auckland and Christchurch. The aim of the current project was to extend and update this research by using two parallel studies: a statistical analysis of sales
transactions and an attitudinal study of residents' perceptions, and by adopting a suburb in Wellington for the case study area. It is argued that sales transactions are a better proxy of buyer behaviour than government values. Further, the survey of buyers' perceptions served as a valuable check on the sales transaction analysis.

The results of Part I show that the effect of having a 'pylon' close to a particular property is significant and has a negative effect of twenty percent at ten to fifteen metres from the pylon, decreasing to five percent at fifty metres. This effect diminishes to a negligible amount after one hundred metres.

The presence of HVOTLs in the Newlands area has a minimal effect of less than negative one percent for those properties directly under the line, and is not a statistically significant factor in the sales price. Given the variable

nature of the terrain noted earlier this result is perhaps unsurprising. The topographical variances render the distance measures inaccurate predictors of degree of impact. As such it is likely that these results underestimate the true effects of the transmission lines. Further research is warranted to account for the terrain variance. This may involve the inclusion of a line of sight distance variable in the model to help determine the true effect of HVOTLs on property prices that allows for the variable terrain.

While the area near to the Khandallah - Haywards line showed a larger effect than the area near the Khandallah - Takapau line, this may be due to the lack of sales within twenty metres of a pylon on the Takapau line.

Part II results indicate that the respondents think of the HVOTLs in negative terms. The proximity to HVOTLs and/or pylons is an important aspect determining the degree of negativity with those closer to the HVOTLs having more strongly negative attitudes than those further away. Areas of concerns ranked in decreasing order included: property values, health effects and aesthetics.

It appears from these results that the negative attitudes, reported in Part II, toward HVOTLs are not necessarily
reflected in sale prices. Only the proximity to pylons affected sale price. This effect displays rapid distance decreases. This may be due to the positive attributes of Newlands, such as harbour views, affordable sale prices and close proximity to the city that may outweigh the negative aspects of living close to HVOTLs. Further, it may also be as a result of the topographical variances noted above causing the results of the sales analysis study to be underestimated.

While the research served to indicate the likely magnitude of the affect of proximity to HVOTLs on property values and the degree to which residents' perceptions may be reflected in lower prices, to provide more defensible results further research is warranted. Firstly, the degree to which the rumour reporting a line was to be removed affected the residents' responses needs investigating. Secondly, allowance for the nature of terrain to more accurately reflect distance measures is needed in the sales analysis model. Results from the current study together with those from the further research suggested will be useful to property owners, property valuers and power companies faced with compensation issues.

It is important to note, however, that these results are unique to the Newlands area and should not be generally applied. It is possible that a different result would be obtained in a flat area, without a view or where the housing is in the higher price range. Other studies have found there to be a varying effect according to the type of housing and topography. This may be due to more affluent buyers being able to afford to pay extra to have no detracting visual aesthetics. Also, HVOTLs may have more impact in suburbs where there are no other visual barriers, such as overhead telephone lines or views.

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