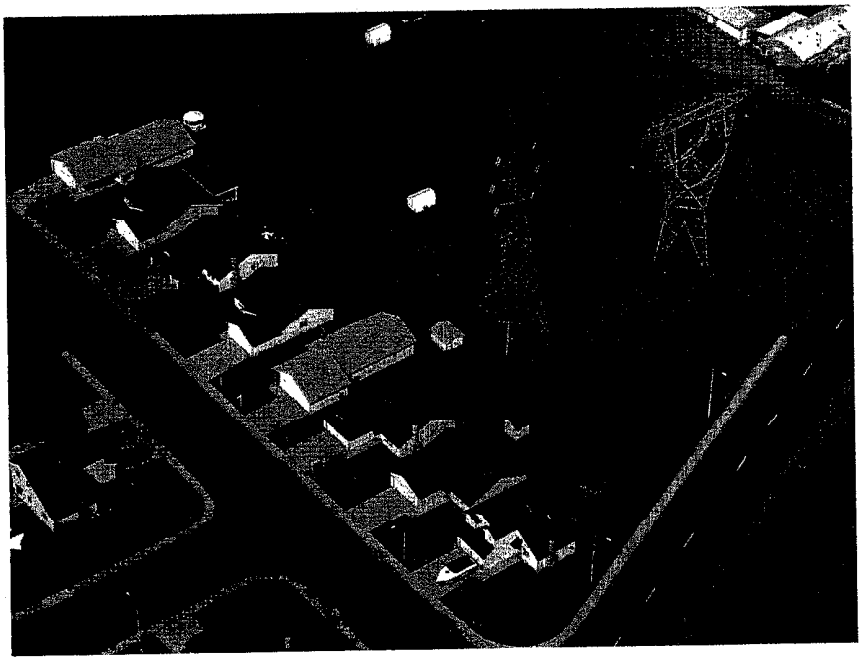
Transmission Line Impact on Residential Property Values

A Study of Three Pacific Northwest Metropolitan Areas

J R. Cowger, Steven C. Bottemiller, MAI, and James M. Cahill



How are property values affected by the proximity of electric transmission lines? Electric utilities, utility regulators, tax assessors, property owners, real estate professionals, and the courts are all looking for the answer. Such information is needed to adequately plan routes for rights of way and to determine proper levels of compensation for property owners. A market-based study was recently conducted by the Bonneville Power Administration (BPA), the Pacific Northwest regions, federal power marketing agency, in three large metropolitan areas located in Seattle and Vancouver, Wash., and Portland, Ore. The study compared the value of improved residential properties bordering overhead, high-voltage transmission lines to similar properties located away from the lines.

BPA markets wholesale power from 29 dams and one non-federal nuclear plant and operates about 15,000 circuit miles of transmission lines primarily located in Washington, Oregon, Idaho, and western Montana. Even though BPA enjoys a relatively neutral position as a nonprofit power and transmission provider, extra efforts were made to offset the natural skepticism of a study conducted by an electric utility. Initially, many of BPA's staff, especially those who receive phone calls from concerned property owners, expected a substantial impact from the overhead transmission lines. Others, particularly staff helping real estate developers and builders with new subdivisions abutting transmission lines, expected a negligible impact. This study added significantly to BPA staff's understanding of this issue, providing objective information to share with the public. A brief literature review follows, along with a description of study methods and results.

BACKGROUND LITERATURE

Research on the impact of overhead transmission lines on property values has greatly expanded in the past 15 years. Since 1975, researchers at a variety of institutions have established an extensive body of knowledge on this subject. A recent literature review by Kroll and Priestly[1] contains a thorough list of the relevant information in the field.

Generally, the research addresses the central question of how overhead, high-voltage transmission lines affect proper-

ty values. Studies have also determined factors (voltage, tower height, etc.) that increase or decrease the effects, and identified types of property that are most vulnerable. A common technique used to measure the impact of overhead transmission lines is to compare the sale price of properties sold along transmission lines to Comparables (Comps) sold elsewhere. A Comp is often defined as a sale that has a similar land-use classification (residential, agricultural, commercial), improvements (home, commercial structures, landscaping, etc.), and sale conditions (arm's-length, foreclosure, etc.).

Several statistical techniques (regression, analysis of variance, comparison of means) have been used to formally compare the value of property along transmission lines to Comps located elsewhere. Generalized findings from several studies are listed below:

- Overhead transmission lines can reduce the value of residential and agricultural property. The impact is usually small (0-10 percent) for single-family residential properties. The greatest impacts have been measured in intensively managed agricultural property (irrigators, etc.) and in rural, second (vacation) home developments.
- Other factors such as location, improvements, and lot size are more likely to be major determinants of sale price.
- Impacts on sales are most likely to occur on property crossed or immediately adjacent to the lines.
- In areas where the right of way has been landscaped or developed for recreational use, positive impacts have been measured.
- Impacts may be greater for smaller properties than for larger properties.
- Impacts are more pronounced immediately after construction of a new line and diminish over time.

METHODS

Data Collection

Four counties in the vicinities of Portland, Ore. (Washington, Clackamas), Vancouver Wash. (Clark), and Seattle (King) were chosen as the geographical areas most likely to yield sufficient sample sizes for this study. Data collection began in January 1992 by identifying all 1990 and 1991 residential home sales that abutted BPA high-voltage transmission lines in the four counties. Sample homes along the transmission lines are referred to as Subjects in this report.

Subject homes were selected adjoining 16 different transmission lines, varying in voltage from 115 kV to 500 kV. Transmission structures included one line with concrete poles, one line with two-pole H-frame wood structures, and 14 lines with lattice steel towers. Either the structures or the wires were clearly visible from the Subjects. Transmission lines were located on a variety of right of way, from 60-foot-wide single rights of way to 750-foot-wide multiple rights-of-way. Some rights of way were covered with brush, while others contained linear walkways surrounded by well-maintained lawn-like grass. The Subject home sales were then paired with Comparable home sales that would be unaffected by proximity to transmission lines.

Comparables were selected in much the same way as they are in a typical residential home appraisal. Each Comparable was carefully chosen to be a close match with its respective Subject. The following data was gathered and compared for each pair:

Information Collected on the Matched Subjects and Comps

Owner name	***Number of bedrooms***
Property address	***Number of bathrooms***
Sale date	Unfinished space
Sale terms	***Car storage size/type***
Sale price	***Landscaping quality***
Time on market	Other improvements
Lot size	Residence to conductor distance
Topography	Residence to structure
distance	
Viewshed	Transmission visibility from residence
Residence size	***Zoning***
Residence condition	Parcel number
Residence age	Deed reference
Number of rooms	

The attributes above in bold italics were required to be highly similar when matching a Comparable with its Subject. The Comparable sale date was to be within nine months before or after the Subject sale date. In addition, the sales were to be arm's length, functionally equivalent, located in similar neighborhoods, and capable of contributing to a comparable style of living. Matching a large number of pairs in this manner allowed comparison of the properties without a typical appraisal adjustment process.

The primary data source utilized for information concerning the Subject and Comparable properties was County Assessor's records. These records differed slightly from jurisdiction to jurisdiction; however, the basic housing components i.e., the number of bedrooms and bathrooms, age of residence, size and style, and vehicle storage, were required to be similar for each pair. Assessment maps were also utilized in comparing Comparable properties to their respective Subjects. Sale information and legal documentation for all Subject and Comparable pairs were taken from local county assessor's records and treasurer's offices. All sales involved legally recorded transactions.

Land and building data for Subject and Comparable pairs was verified through field inspections, reviews of listings (when available), and personal contact with owners, face-to-face, by telephone and/or through the mail. Confidentiality of data provided by grantors or grantees was promised to encourage as much cooperation as possible. A confirmation rate of 57 percent for Subject properties and 50 percent for Comparables through grantor/grantee, realtor, attorney, or related third parties knowledgeable in the sale transaction was achieved.

A two-stage process was used to assure accuracy. In the first stage, data was gathered, files were created for each pair, and each Subject and Comparable was field inspected. The second stage included an independent field review of two-thirds of the sales, and an independent office review of all sales. When discrepancies between county records and physical inspections occurred, physical inspection data was given stronger consideration.

A total of 296 Subject sales, all of the arms-length sales that could be found adjacent to BPA transmission corridors in the four counties, were identified for the study. 'Unique" Comps were found

for 281 of the Subjects. Unique, in this sense, matches a Comp to a single Subject judged to be most similar in land and home characteristics. To create pairs for the entire sample (296 Subjects), a small number of Comps were used twice; however, data analysis was primarily restricted to the unique pair sample.

Data Analysis

The pair-wise matches were used as the basic unit of analysis. Matching is a technique frequently used in observational studies to remove the effect of confounding variables on the response of interest. In this case, the confounding variables were the home, lot, and location attributes used to match the Subject and Comp sales; the response variable was the difference in sale price. The pairing was maintained throughout the analysis because the process used to develop the pairs was rigorous, conformed to typical practices in the industry, and was verified by professional appraisers.

Analysis of data collected on matched pairs is straightforward; the difference between the pairs is computed, and simple descriptive statistics (averages, confidence intervals, etc.) are computed on the differences. The difference between pairs was expressed as a percentage of the Subject sale price; these percentages were used as the dependent variable in the analysis. Converting the dollar differences to percentages should better fit the actual impact of overhead lines on property values because more expensive lots and homes probably experience a greater absolute dollar loss than less expensive properties. The formula used to compute the percentages is shown below.

$$\% \text{ difference} = \frac{\text{Subject sale price} - \text{Comp sale price}}{\text{Subject sale price}} \times 100$$

The response variable can be either negative or positive; a negative percent indicates Comps were lower in price than Subjects; a positive percentage has the opposite interpretation. Confidence intervals (95 percent) were computed around the means to reflect the variability in the differences and to test whether or not they were statistically different from zero. Inclusion of zero in the intervals implies that the average was not statistically different from zero at the 95 percent confidence level.

Because the sale of the Comps was within nine months of the Subject sale date, no time adjustments were made to the data. Data from the four counties was pooled into three metropolitan areas (Portland, Vancouver, and Seattle) and analyzed separately. Summary statistics and confidence intervals were computed using only the unique pairs.

Correlations between the percent differences and several independent variables were also investigated. The intent was to examine whether value differences varied in predictable ways—did value loss, for instance, increase as the distance to the line decreased? The independent variables investigated were home size (square feet averaged for the Subject and Comp), sale price (dollars averaged for the Subject and Comp), distance (feet) from the line and supporting structure, and number of days between sale of the Subject and Comp. Visual inspections of data scatters and regression analysis were used to detect the presence, magnitude, and direction of underlying trends in the data.

Table 1. Sale Time an Home Characteristics for Subjects and Comps

Metro Area	Number of Pairs	Sale Diff. (days	Size (sq. ft.) Subj.	Comp.	Year Built Subj.	Comp.	Bedrooms Subj.	Comp	Bathrooms Subj.	Comp.
Portland	97	21	1725	1725	1983	1983	3.1	3.1	2.3	2.2
Vancouver	39	-11	1711	1776	1978	1978	3.2	3.3	2.2	2.2
Seattle	145	3	1980	1959	1984	1984	3.3	3.3	2.5	2.5
All Areas	281	8	1855	1852	1983	1983	3.2	3.2	2.4	2.3

Table 2. * Average Sale Price, Difference in Sale Price, and Percent Difference for Subject and Comp Homes

Metro Area	Average Sale Price—Subjects ($)	Average Sale Price—Comps ($)	Average Dollar Difference ($)	Percent Difference (%)
Portland	111,801	109,648	+2153	+1.46
Vancouver	107,310	108,113	-803	-1.05
Seattle	147,279	148,581	-1302	-1.00
All Areas	129,485	129,525	-40	-0.16

* Data based on unique pairs only (N=281)

Table 3.* Descriptive Statistics for the Difference Between Subjects and Comps

Metro Area	Average % Difference	Minimum %	Maximum %	Standard Deviation	95% Confidence Intervals (lower)	(upper)
Portland	+1.46	-26	24	7.7	-0.10	+3.01
Vancouver	-1.05	-19	11	6.3	-3.01	+0.98
Seattle	-1.00	-25	26	7.4	-2.22	+0.21
All Areas	-0.16	-26	26	7.4	-1.03	+0.71

* Dollar differences are expressed as a percent of the subject sale price. Data based on unique pairs only (N=281).

RESULTS

First, how closely matched were the Subjects and Comps? Table 1 presents some relevant home characteristics averaged for the Subjects and Comps. Also shown is the average number of days between sale of the Subject and Comp (referred to as 'sale time" in the table). The arithmetic sign of the difference in sale time indicates whether, on the average, the Comps sold before or after the Subjects. A negative sign indicates the Comp was sold after the Subject; a positive sign indicates the opposite.

Table 1 shows, in the aggregate, minor differences between the Subject and Comp sample homes. Square footage, year built, and number of bedrooms and bathrooms were almost identical for Subjects and Comps. The average number of days between the Subject and Comp sale date was also closely matched; by design, Subjects and Comps were required to be sold within nine months of one another. The average difference ranged from -11 days for the Vancouver homes to 21 days for the Portland sample.

Table 2 presents the average sale price, dollar difference, and percent difference for the three metropolitan area

samples based on the unique pairs. The average percent difference is the arithmetic mean of the individual percentages (average of ratios). Transmission lines had a small negative impact on the Vancouver and Seattle Subject homes, reducing their value by -1.05 and -1.00 percent respectively. Portland Subject homes were actually worth more (+1.46 percent) than their matched Comps. Virtually the same results were obtained when the percent difference was calculated using all (N=296 Subject data). Remember, that some Comps were initially matched against more than one Subject. The average percent differences using this data were Portland, +0.95 percent; Vancouver, -1.03 percent; and Seattle, -1.82 percent.

Table 3 presents additional descriptive statistics for the average percent difference—the minimum, maximum, standard deviation and the 95 percent confidence intervals. Readers should note that 'zero" is bounded by the lower and upper limits for all metropolitan areas and the combined data. This indicates that the average differences are not statistically different from zero.

The percent difference for each matched pair was plotted (Figures 1 & 2) over sale price and distance to the transmission line. Sale price is the average for the Subject and Comp. Figure 1 is a scatter plot for the Seattle area showing the relationship between percent difference and sale price. Figure 2 is a scatter plot for the Seattle area showing the relationship between percent difference and distance to transmission line. The percent differences are scattered above and below the 'zero-line" throughout the range of sale price and distance to the line. It appears, visually, that these characteristics did not affect the percent difference in price. The plots for Portland and Vancouver give similar results.

Multiple regression analysis was used to further investigate relationships between the percent difference and potential explanatory variables (listed below). Curvilinear expressions (2nd- and 3rd-degree polynomials) of these variables were also included in the analysis.

Potential Explanatory Variables

- Square feet of living space
- Sale price
- Distance to the transmission line
- Days between sale of Subject and Comp
- Year built

Stepwise forward regression was used to assess the ability of the variables listed above to account for variation in the percent difference. This process models the dependent variable one step at a time, starting with the most highly correlated independent variable. The regression analysis confirmed what was seen in the scatter plots (Figures 1 & 2)—that is, the percentages do not vary predictably with the potential explanatory variables. A slight trend was found between the percent difference and distance to the line in the Portland data; however, the relationship was only marginally significant (F=4.10, p=0.045), and too imprecise for predictive use (R**2=0.04), and the sign of the coefficient was in the wrong direction. No significant relationships (p=0.05) were found in either the Seattle or Vancouver data.

Figure 2. Percent differences plotted over distance to transmission line.

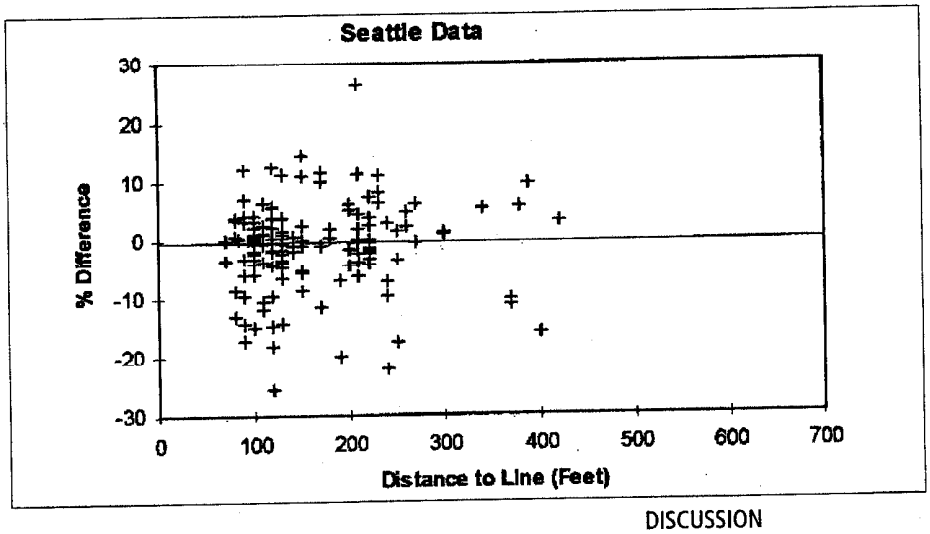
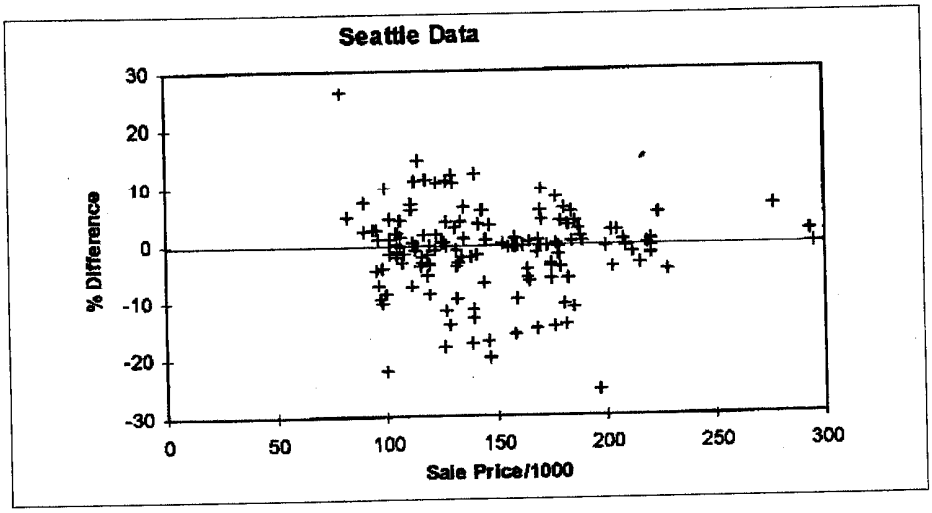


Figure 1. Percent difference plotted over sale price. Sale price is the average of the Subject and Comp.



DISCUSSION AND CONCLUSIONS

Analyses of this data show that overhead, high-voltage transmission lines had minimal impacts on residential property values in these metropolitan areas. Seattle and Vancouver Subjects averaged small decreases in property values (-1.00 percent, and -1.05 percent, respectively). Portland Subjects were, on the average, worth slightly more (+1.46 percent) than the matched Comps. None of these differences were statistically different from zero at the 95 percent probability level.

This magnitude of difference is consistent with findings from other, similar studies—that impacts, when detected,

are generally small. Other studies attempting to measure impacts during periods of change, such as transmission line rebuilds, have shown greater short-term impacts. However, most studies have concluded that other factors such as location of the property, type and condition of improvements, and the level of real estate activity are far more important than the presence of transmission lines in determining the value of residential property.

Regression analysis showed that the percent differences were not well correlated with home and sale characteristics measured in this study. Also, distance from the Subject residence to the line and to the nearest structure did not generate differences in sale price. This was not totally surprising since this effect has not been consistently associated with negative impacts on property values in other studies. Readers are reminded that homes in this study adjoined the right of way; the lines and a varying number of support structures could be clearly seen from all Subject properties.

One caution about the data: Readers should be aware that the sample of Subjects comprised all known arm's-length sales of properties adjacent to BPA overhead lines in the four surveyed counties. Comps were restricted to the same geographic area. County data was loosely aggregated into three metropolitan areas; however, no claims are made that this data represents the entire population of residential real estate adjacent to overhead transmission lines in the Portland, Vancouver, and Seattle markets.

Finally, this data should be helpful to both the public and electric utilities in objectively characterizing property value impacts from overhead transmission lines. BPA will continue to monitor real estate activities along its transmission corridors with a long-term objective of fully understanding the potential impacts on property values. ❑

NOTE

1. Cynthia A. Kroll and Thomas Priestley, *The Effects of Overhead Transmission Lines on Property Values, A Review and Analysis of the Literature*, Edison Electric Institute Siting & Environmental Planning Task Force, 701 Pennsylvania Avenue NW, Washington D.C. 20004-2696 (1992).

John R. Cowger is th Manager for Real Estate at the Bonneville Power Administration headquarters located in Portland, Ore. A graduate of Portland State University, he recently served as president of the Oregon and Southwest Washington Chapter of the International Right of Way Association.

Steven C. Bottemiller, MAI, is the Manager for Appraisal at the Bonneville Power Administration. A graduate of Seattle Pacific University, he has extensive experience in appraising and reviewing elderly care housing properties throughout the United States and electrical transmission lines/substations in Bonneville's region.

James M. Cahill is a Public Utility Specialist with the Bonneville Power Administration. A graduate of both Colorado State University and Oregon State University, he has published a number of papers resulting from statistical studies in the field of forestry.