

Consulting Report

**Wind Energy Study - Effect on Real Estate Values  
in the Municipality of Chatham-Kent, Ontario**



Prepared for:

**CANADIAN WIND ENERGY ASSOCIATION**

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February 2010

February 4, 2010

**CanWEA,**  
170 Laurier Avenue West,  
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Ottawa Ontario  
K1P 5V5

Attention: Mr. Tom Levy, P. Eng., Manager of Technical and Utility Affairs

**Re: Wind Farm Study – Effect on Real Estate Values  
in the Municipality of Chatham-Kent, Ontario**

Further to your request, we have now completed our study analysing the effect on real estate values arising from the installation and operation of wind turbines. For the purpose of preparing this consulting report, the location selected for analysis comprised an area of South Western Ontario, south of the City of Chatham, along the north shore of Lake Erie near the community of Merlin.

The following consulting report was prepared in accordance with the *Canadian Uniform Standards of Professional Appraisal Practice* for the **APPRAISAL INSTITUTE OF CANADA**. The report was required to enable the addressee to consider the impacts on the market value of nearby residential properties and their marketability, on behalf of the Association members. The applicability of the study results to wind farm developments in other regions of Ontario and Canada is discussed herein. The report, if necessary, may also form the basis of testimony at subsequent hearings.

A more detailed description of the properties analysed, together with the reasoning leading to the conclusions reported herein, is contained in the body of this report.



# Wind Farm Study – Effect on Real Estate Values in the Municipality of Chatham-Kent, Ontario

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This report demonstrates the following:

*In the study area, where wind farms were clearly visible, there was no empirical evidence to indicate that rural residential properties realized lower sale prices than similar residential properties within the same area that were outside of the viewshed of a wind turbine.*

The opinions reported herein are subject to the extraordinary assumptions, qualifications, limiting conditions and underlying assumptions as set out herein. This report contains 85 pages including Addendums, and is not valid unless it contains original signatures.

The authors reserve the right to revise the opinions set out herein, in light of any facts and conditions that become known subsequent to the date of the report, which have an impact on the conclusions reached.

A special note of thanks is extended to Paul Puopolo of the IBI Group in Kitchener for his help in providing background material etc. An outline of their most recent experience in the Electrical Energy related field has been included in Addendum “B”.

Thank you for choosing our firms to conduct this important study on wind farms.

Respectfully submitted,

**John Simmons Realty Services Ltd.**

**Canning Consultants Inc**



L. John Simmons, AACI, FRI, CMR, PLE



George Canning, AACI, P.App, PLE

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## **EXECUTIVE SUMMARY**

- STUDY PURPOSE:** Execute a market-based empirical study into the effect of wind turbines on local residential real estate values. This study focuses only on the Municipality of Chatham-Kent.
- FUNCTION OF REPORT:** Provide an independent, objective and reproducible analysis of market evidence into the effect of wind turbines on real estate values in the Municipality of Chatham-Kent.
- BACKGROUND:** Wind energy development has occurred in many countries around the world for decades. While some real estate value studies have been undertaken, there have been a limited number executed in Canada. Most studies have their basis in subjective analysis, relying on anecdotal evidence and survey responses to form a basis for conclusions. This report considers only market based evidence, and applies a widely recognized and accepted approach to statistical evaluation of data sets in order to evaluate the effect on real estate values.
- SCOPE OF ANALYSIS:** Due to the number of existing wind energy projects in the Province of Ontario, it was necessary to select a study area wherein:
- there have been a sufficient volume of sales of properties that have taken place in close proximity to a wind farm following its completion;
  - there have been a sufficient volume of sales of similar properties in the same general area but not in proximity to a wind farm (beyond the viewshed); and
  - there is sufficient access to registry office sales records, and local area real estate board listing information.

**STUDY AREA SELECTION:** The Chatham-Kent Region of Ontario was selected as a suitable study area as it met the primary selection criteria listed above, and a sufficient volume of property sale transactions for which MLS® and registry office details were available.

**IMPACTS CONSIDERED:** Data was analyzed to determine the effect on real estate values as a result of proximity to wind turbines and, more specifically, on properties within the viewshed and those not within the viewshed of wind turbines. Some concerns expressed by those near proposed or existing wind farms include:

aesthetics;  
shadow flicker; and  
sound, audible and low frequency.

None of the above influences on price were measured independently. If there is an effect on real estate values from any or all of these influences, it will be measurable from market data. Recommendations for future studies are presented within the body of the report.

**DATE OF INSPECTIONS:** The study area was visited on several occasions between May 18, 2009 and June 31, 2009 in order to view all properties within the viewshed as well as the control group of properties. This is known as a “ground-truthing” exercise.

**EFFECTIVE TIME FRAME:** Primary research material was obtained during the month of May 2009, while additional data was obtained during the month of June 2009.

**STUDY METHODOLOGY:** A Multiple Regression Analysis (MRA) statistical technique formed the basis for evaluating market data for this study. The MRA procedure is the most definitive tool to segregate data in a numerical format for further analysis and interpretation. Within the MRA framework data was divided into those characteristics that best explain the variance in selling prices of comparable real estate. The focus of this study is the measurement of the effect on real estate values due to the presence of wind farms; therefore, the data was further assigned a viewshed and a control group value.

MRA is used to determine the causal effect between variables by assigning a coefficient to each variable and determining its standard error as a function of sample size relative to population size. The “T score” is defined as the relationship between the coefficient of every variable and its respective standard error.

Data sampling did not return as large a volume of sale data as expected. Accordingly, other evaluation techniques were employed to aid in the evaluation of the data through improved matching of datasets. Within the report, Optimal and Coarsened Exact Matching (CEM) techniques were relied upon as additional data matching tools to further enhance the ability to analyze data by obtaining more closely matched pairs of data from the original dataset.

The study was not limited to MRA itself, nor was it limited to data filtering systems; rather, the study also explored the raw data that formed 14 pairs of identical property sales that were sold within and beyond the viewshed of a wind turbine. This is the more traditional approach to evaluating effects on real estate, and it was considered useful to compare merits of various options of data analysis available.

**STUDY CONCLUSIONS**

No statistical inference to demonstrate that wind farms negatively affect rural residential market values in Chatham-Kent was apparent in this analysis. Furthermore, this study did not find any consistent evidence from the analyzed data that such a negative correlation exists in the Municipality of Chatham-Kent. During the course of gathering data, there were no unusual quantities of rural residential properties listed for sale in the study area. Four unrelated data processes were used in studying the property sales information for Chatham-Kent. The only consistency was that each evaluation methodology found that it was highly unlikely that any type of a causal relationship exists between wind farms and the market values of rural residential real estate.

## **BACKGROUND AND STUDY PURPOSE**

Wind farm developers have out of necessity been required to address some concerns from local property owners adjacent and nearby to proposed development locations that their real estate values could decline due to the presence of a wind farm within their viewshed. Some segments of the population feel that wind turbines can intrude on viewsheds. Opposition has, in some cases been based on a belief that real estate values will diminish. While it is understandable that some property owners do not like change in their communities that they deem to be undesirable, it becomes difficult for wind farm developers to address objectors in a subjective manner.

In North America, some studies have attempted to evaluate the relationship between residential real estate values and proximity to a wind turbine. While some of these studies have found a negative effect on nearby real estate value that has been attributed to the proximity of a wind farm, others have not found such a correlation.

This study has focused entirely on tangible market-based data obtained through recognized means such as MLS®. In addition, some research has been conducted into similar studies in other jurisdictions. Although exhaustive research was not conducted, studies conducted in the U.S.A., Australia, England and one in Ontario were reviewed. Some of these were based on anecdotal evidence and some on the basis of survey responses. To the best of our knowledge, no reports have been produced within Canada presenting a comprehensive analysis of market data, such as that presented herein.



## **CLIENT AND FUNCTION**

This report has been prepared for the Canadian Wind Energy Association (CanWEA) to assess the effect of wind turbines on the market value of local residential real estate in the Municipality of Chatham-Kent, Ontario.

## **PROPERTY RIGHTS ANALYSED**

The ownership rights of those properties analysed in this report are those of the “**Fee Simple Interest**”, subject to the four powers of government: taxation, expropriation, police power and escheat. A “**Fee Simple Interest**” may be defined as “*the ownership of real property rights unencumbered by any other interest.*”<sup>1</sup>

## **DATE OF INSPECTION**

Properties adjacent and near to various existing wind energy developments were identified, researched and inspected by the authors during the months of May and June 2009. The initial site inspection was conducted on May 18, 2009.

## **EFFECTIVE DATE OF REPORT**

July 1, 2009 has been selected as the effective date of this report as it encompassed the time frame of inspections and data research.

## **DEFINITION OF MARKET VALUE**

“Market Value” is defined<sup>2</sup> as:

*The most probable price which a property should bring in a competitive and open market as of the specified date under all conditions requisite to a fair sale, the buyer and seller each acting prudently and knowledgeably, and assuming that the price is not affected by undue stimulus.*

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<sup>1</sup> The Appraisal of Real Estate, (Canada Edition, 1992), 12

<sup>2</sup> Canadian Uniform Standards of Professional Appraisal Conduct 04/15/2008

Implicit in this definition are the consummation of a sale as of the specified date and the passing of title from seller to buyer under conditions whereby:

- 1) buyer and seller are typically motivated;*
- 2) both parties are well informed or well advised, and acting in what they consider their best interests;*
- 3) a reasonable time is allowed for exposure in the open market*
- 4) payment is made in terms of cash in Canadian Dollars or in terms of financial arrangements comparable thereto; and*
- 5) the price represents the normal consideration for the property sold unaffected by special or creative financing or sales concessions granted by anyone associated with the sale.*

The foregoing definition of Market Value assumes a competitive scenario with more than one potential buyer, and a seller who is willing to sell in accordance with the Highest and Best Use of the property. This inherently assumes that the seller no longer needs or wants the property and wishes to convert the asset to cash.

The intent of this study is to evaluate the effect of wind farms on the market value of nearby residential properties.

**EXPOSURE TIME:**

With respect to Item 3 above in the Market Value definition, exposure time is the estimated length of time the property interest being appraised would have been offered in the market prior to its hypothetical sale at the estimated market value on the effective date of the appraisal. Reasonable exposure encompasses not only adequate, sufficient and reasonable time, but also adequate, sufficient and reasonable effort. In addition to price, exposure time is also a function of use and type of real estate.

As this study does not estimate market value of a specific property, consideration of the exposure time as a specific undertaking is unnecessary. The relationship of exposure time to selling price was considered in general terms relative to the impact of nearby wind farms.

Some studies attempting to reflect or measure a loss in market value due to the proximity to a wind farm have suggested that the influence has resulted in increased marketing times. In order to address this possibility, a review of MLS® listings in the area was undertaken to ascertain if the exposure to a view or proximity to a wind turbine contributed to the length of time a property was listed on the market before a sale was recorded. While many properties were listed on a 90 day listing basis, some listings sold within that time frame, and some expired unsold. Some were relisted for sale and others not, while others were relisted at reduced prices, and still others not. There are a number of variables that can influence the length of time that a property is listed for sale, including:

- asking price was too high;
- condition of the property less than desirable;
- poor curb appeal;
- location relative to employment;
- undesirable neighbouring properties;
- regional economic conditions/unemployment levels;
- time of year;
- volume of competing listings; and
- inadequate marketing/agency representation.

These are the primary reasons, within which there are subcategories of more specific issues that may explain the length of time a property is listed for sale. A study incorporating a detailed analysis of these factors and isolating any specific influence of proximity to a wind turbine is beyond the scope of this report. Further, a greater volume of sales data would be required over an extended period of time. Reliance on anecdotal opinions as a basis for a credible indication of value influence or loss is not evidentiary, nor is it reproducible.

Even though the review of the evidence conducted for this study did not disclose any probative evidence to suggest that proximity to a wind turbine had an influence on the length of listing time, this issue would require a more comprehensive (and independent) study to reach a firm conclusion.

## DEFINITIONS

In this report certain words and terms have been used that require defining for those readers unfamiliar with this type of report. As considered by the authors, these are as follows:

<b>Algorithm:</b>	A step by step method of solving a problem using numbers in computations.
<b>Avg:</b>	This is the short form for Average being the number of observations divided by their total.
<b>Bins:</b>	Bins are used in statistical graphing or displaying of items of a similar value or characteristic.
<b>CEM:</b>	Coarsened Exact Matching is the name of another matching data program used in the study.
<b>Coefficient:</b>	The coefficient is the returned number allocated to a specific property variable from using regression analysis.
<b>Control Group:</b>	That group of properties not affected by the alleged impacts of a wind turbine.
<b>Histogram:</b>	A bar chart that represents a frequency distribution of data.
<b>Log:</b>	The log is the power that a base number is raised to.
<b>Mean(s):</b>	A mean, or arithmetic mean, is the total of a list of numbers divided by the number. It is an average. It reflects a central tendency.
<b>MW:</b>	Short form of “megawatt”, which equals 1,000 kilowatts or 1,000,000 watts.
<b>Optimal:</b>	This is the name of a matching data program used in the study.
<b>Rated Capacity:</b>	Manufacturer specified maximum power output of a wind turbine. Typical large wind turbines have rated capacities of 1.5 megawatts or more.

<b>Regression:</b>	The relationship between the mean value of a random variable and the corresponding values of one or more independent variables.
<b>Scatterplot:</b>	This is a graph that shows any variable on the “X” axis plotted against any variables on the “Y” axis.
<b>Viewshed:</b>	A point within the study area whereby a sale property had a view of one or more wind turbines.
<b>Viz:</b>	Short form for visible.
<b>No Viz:</b>	Short form for not being Visible
<b>Wind Farm:</b>	A project containing more than one wind turbine, each electrically connected to each other, for the purpose of selling electricity to the electrical grid.
<b>Wind Turbine:</b>	A structure that uses airfoils (commonly referred to as a blade) to extract kinetic energy from the wind, and converts this to electrical energy. Each wind turbine typically contains three blades. In this study area, typical wind turbines have hub heights of 80 m, blade lengths of 41m, for a total max height of 121 meters.

### **CRITICAL AND EXTRAORDINARY ASSUMPTIONS**

For every hypothetical condition, an Extraordinary Assumption is required. According to the *Canadian Uniform Standards of Professional Appraisal Practice* (CUSPAP 04/15/2008), an Extraordinary Assumption “*refers to a hypothesis – either supposed or unconfirmed – which, if not true, could alter the appraiser’s opinions and conclusions.*”

In order to achieve this objective, the following specific critical assumptions were made in the preparation of this study:

1. That comparable sale transactions negotiated at or after the issuance of building permits for tower and turbine installations would have reflected any and all concerns in the purchase price.
  
2. That none of the comparable sale transactions relied upon in this report are the subject of legal actions resulting from non-disclosure of information regarding the towers or turbines by any agents or vendors involved in the property sales.
  
3. That any and all adverse effects on market value as perceived by market participants would be reflected in the market evidence of nearby real estate transactions.
  
4. All estimates and projections are based upon circumstances and economic conditions prevailing as of the effective date, and that the critical assumptions above have been made.

**SCOPE OF VALUATION AND REPORTING PROCESS:**

The findings and conclusions outlined in this study are based on:

Identification of wind farms wherein nearby residential property sales have taken place;

Exterior inspection of properties sold in close proximity to wind farms, and those properties outside the viewshed;

Research conducted for comparable property sales through MLS® records, GeoWarehouse®, MPAC (Municipal Property Assessment Corporation) and the records of the Land Registry Office. Photostatic copies of this data are available in the appraiser's file.

Analysis and inspection of comparative data, confirmation of sale details and ownership/title transfer;

Determination that the Highest and Best Use of target property and comparative sales properties are as categorized;

A review of published statistical data as relating to economic indicators, and where necessary, a discussion in some detail;

Research and selection of appropriate study references;

Confirmation of data relied upon in the analytical process

## **VALUATION PROBLEM**

The purpose of this study is to consider the effect on the market value of residential properties due to the presence of a wind farm. Based on the background research, it is evident that some members of the general public hold negative opinions with respect to the desirability of wind farms and perceptions of their effect on real estate value. This report considers a variety of perceived influences, and provides an estimate of their effect on local real estate values.

The most frequently identified factors perceived to have an adverse effect on the market value of residential real estate are:

- aesthetics;
- shadow flicker;
- vibration; and,
- audible sound (low frequency waves);

Measuring the extent of these perceptions and how they affect local real estate values requires the analysis of a wide range of variables associated with any given property.

The thesis is that when an identified study property is valued both with and without the identified impact, the difference represents the change in market value attributable to that impact. This study considers the impacts identified above on residential properties adjacent to an existing wind farm on a collective basis, not individually.

Real estate types considered in this study are rural residential properties.

During the course of conducting research and assembling the data for analysis, the following was undertaken:

- review of real estate effect studies prepared by others in Canada, USA, Great Britain, Australia and Europe (see Addendum C);
- review of fact sheets, guidelines and other relevant publications prepared by the Ministry of the Environment, Ontario (See Addendum D);
- attendance at a public meeting on the proposed regulations to implement the new Green Energy and Green Economy Act, 2009;



discussions with a number of property owners in attendance;

discussions with real estate developers, real estate brokers and other market participants; and

discussions with several consultants involved in the development of wind farms.

During the course of research it was noted that although building permits are issued for construction of wind turbines, there could be a time delay of as much as 1 year from when the permits are issued to when work begins. These delays were attributed to a variety of reasons such as a shortage of cranes or ground conditions for preparing access routes tower sites.

While some of the nearby residential sale transactions may have been completed at or after the issuance of a building permits for the wind turbines, the towers may not have been in place or in operation. In such instances, due to a public information meeting regarding the approval process, combined with ongoing news media coverage of the projects, an assumption was made that purchasers of a particular property would have made a conscious decision as to whether or not the proximity of wind turbines influenced their purchase price. Only one owner, who purchased a vacant lot for a future house, expressed disappointment that he had not been aware of the nearby wind farm approval. He had not decided whether to build or not.

## **STUDY AREA SELECTION**

Initially a number of areas containing wind farm developments were investigated to locate a suitable location for study. The criteria for selection included:

- A reasonable number of wind farm developments within a region, each having similar economic influences;

- Availability of MLS® data and registry office records for data confirmation;

- A base of residential properties that have potential for being influenced by exposure to wind farm developments;

- A sufficient volume of transactions of similar property transactions within that region that would provide an adequate base for analysis; and

- A reasonable travelling distance for conducting research since several property and area inspections would be required.

The Chatham-Kent area was ultimately selected as it met the above criteria. At present there are understood to be 64 operating wind turbines in the area. Chatham-Kent is attempting to position itself as a leader in Ontario's renewable energy sector. Wind turbines erected in the study area had rated capacities of 1.5 MW, and turbine blade lengths of 41m metres. According to the Chatham-Kent web site, February 2009, the Ontario Power Authority recently awarded three additional wind power projects. These approved wind farm development projects are expected result in the addition of a further 165 wind turbines for a total of 229 turbines within this region.

## GENERAL OVERVIEW OF THE STUDY AREA

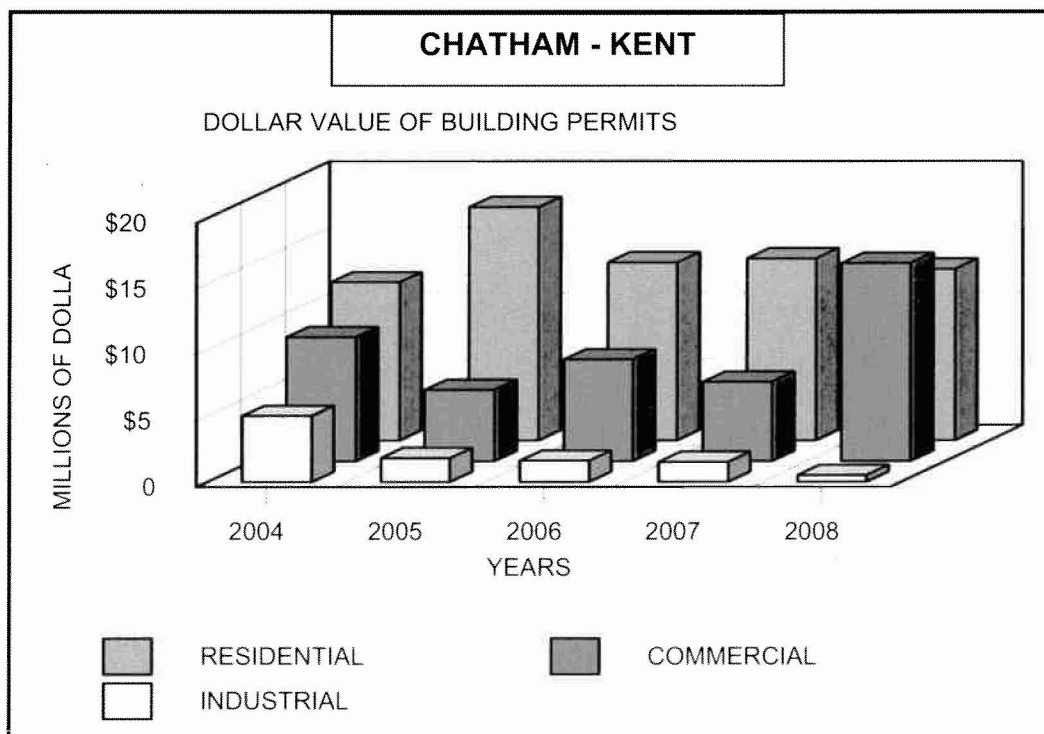
The study area in which the sale properties were located is known as the Municipality of Chatham-Kent. This Municipality is composed of 9 major communities and the surrounding rural areas that were amalgamated on January 1, 1998. The location of Chatham-Kent relative to major cities is shown below.

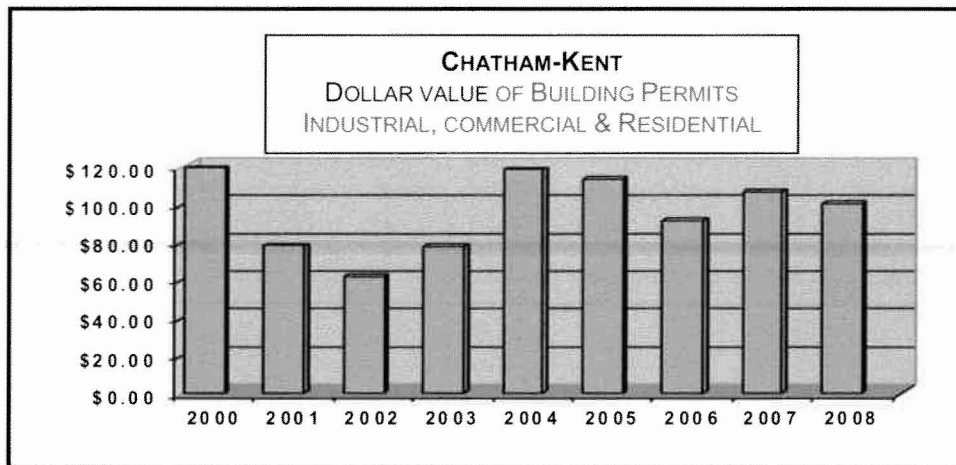


The population of Chatham-Kent as of 2006 was 108,177 compared to a population of 107,341 as of 2001(last census).

The total workforce within Chatham-Kent is 58,860 persons. The occupation by industry that has the highest number of workers is Manufacturing and Construction, followed by Wholesale and Retail Trade, Business and Other Services. Agriculture and Other Resource based industries employ 10% of the labour force. If the work force was divided by Occupations, the highest percentage would go to Sales and Service Occupations followed by Trades, Transport and Equipment Operator and related Occupations. A strong tertiary occupation would be unique to processing, manufacturing and utilities.

International Truck and Engine Corp is the largest manufacturer in Chatham-Kent with 1,150 employees as of 2004. They are now down to 200 and there is a potential total plant layoff as of June 30<sup>th</sup> of this year. Union Gas Limited has 679 employees as of 2004 and this has not changed. Autolive Canada with 600 employees as of 2004 are now reduced to 50 employees, while YA Canada Fas Track Mail Processing Facility has 500 employees as of 2003 and are now reduced to 450 employees. Many of the smaller industries have between 200 to 300 employees. The following is a graph of the dollar value of building permits issued between 2000 and 2008 for the Chatham-Kent expressed in millions of dollars.

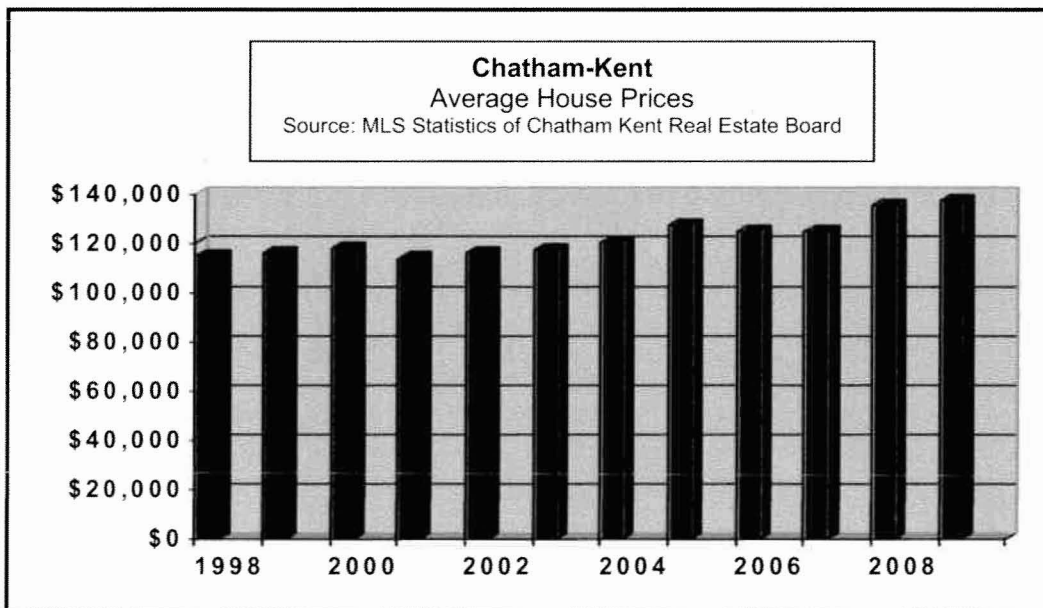




A surge in overall construction activity was seen at the turn of the millennium following the severe recessionary period during the early 1990's. Construction activity then slowed during a period of absorption followed by improvement during 2003. Since that time construction activity has been largely stable.

The impetus of growth in new residential construction resulted from low interest rates and the pent up demand for new housing following the recession in the early 1990's. The major focus of new residential construction has been within the urban areas of the City of Chatham.

A review of Multiple Listing Service (MLS®) statistics for Chatham-Kent show the average selling house prices for a given year. The following graph plots these average house prices between 1998 and 2008.



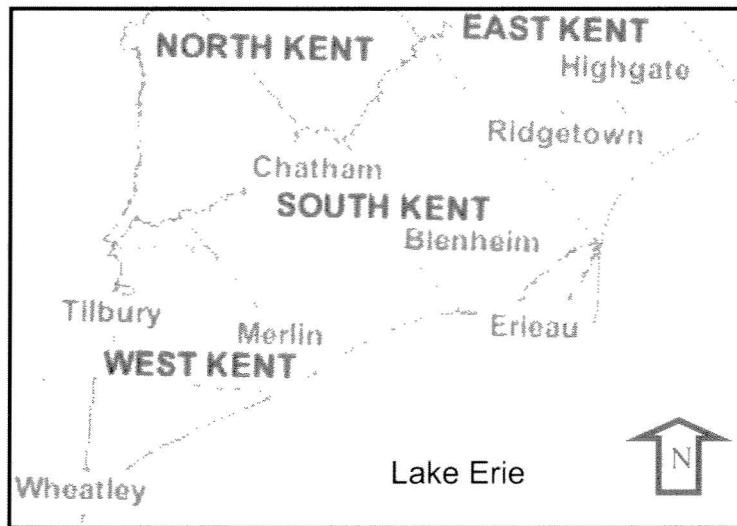
The previous chart of average house prices indicates a general increasing trend in average property sale price within Chatham-Kent. This graph shows prices that include a large volume of house prices from the urban area in the City of Chatham which are believed to have an impact on the overall annual average price. The MRA used in this study demonstrates that within the data set analysed, general price levels in the rural areas were not a significant factor in explaining the variances of sale prices.

### **STUDY AREA**

The study area has a rural character, implying that the primary economic driver is agriculture or agriculture-related. In 2008, Chatham-Kent was the third highest producer in the entire Southwestern Ontario region for Winter Wheat, Grain Corn and Soybeans. In 2007(most recent) Chatham-Kent was the highest producer of tomatoes in Southwestern Ontario.

Transportation through Chatham-Kent is via Highway 401 which bisects Chatham-Kent traverses the full width of the municipality. Highway 401 extends from Windsor/Detroit to the easterly boundary of Ontario. Chatham-Kent is bounded to the south by Lake Erie. The study area is located between Lake Erie and Highway 401.

The rural housing type throughout Chatham-Kent is diverse and ranges from turn of the century homes (built between 1850 and 1900) to modern homes less than a year old. Typical structures include wood frame construction with brick veneer or wood siding, and 1 to 2 storey, including a single or double garage and an outbuilding that could serve as a workshop or as exterior storage. There are no single rural areas of Chatham-Kent that contain a higher concentration of rural properties. These property types are homogeneous throughout the Municipality of Chatham-Kent, and are commonly found throughout Southwestern Ontario. A general map of Chatham-Kent is provided below.



## **SUMMARY**

### **Municipality of Chatham Kent**

The Municipality of Chatham-Kent is dependant to a significant degree upon agriculture, manufacturing, and vehicle related industries. The City of Chatham has recently experienced an economic downturn of the auto and truck manufacturing sector due to its proximity to Windsor and Detroit, while the agricultural sector has been largely unaffected.

The Municipality comprises of the former City of Chatham with a population of approximately 44,000 people, with another eight communities within its borders with a total population between 1,000 and 12,000 people. Chatham-Kent has not grown substantially over the last five to ten years. It has remained fairly stable. Very little growth is expected within this region of South Western Ontario over the next decade. This is typical of other regions.

### **Study Area**

The study area has been dominated by the agricultural industry for well over 100 years. Its success is due to fertile soils and fairly high heat units. Heat units in the Chatham-Kent region range from 3,340 and 3,560, in contrast to just north east in the London to Guelph area where the heat units range between 2,680 and 2,890. In other respects, the Chatham-Kent region is fairly typical to rural areas throughout other parts of South Western Ontario. Land uses within the study area are heavily dependent on cash crop farming. There is also a good mixture of rural housing that offers a wide range of amenities and locations.



## **ANALYSIS METHODOLOGY**

The market for rural residential real estate consists of those individuals or families typically seeking property that provide a location, utility and area features consistent with their individual needs, and accordingly, are willing and prepared to pay a competitive price. In a competitive market, an informed purchaser will pay no more for a particular property than the cost of acquiring a satisfactory substitute that provides equal expected accommodations without undue delay. Those properties having undesirable features, either within the property itself, or nearby, often require a longer market exposure or tend to sell at lower prices. Wind farms are perceived by some to be such a nearby adverse external influence. Market value is typically estimated through the analysis of similar properties that have sold proximate to the date of valuation. If the market demonstrates that wind farms are indeed a negative influence, then an observable trend in lower selling prices should be apparent. The primary focus of this analysis is to assess the presence (or lack of) trend, and to quantify the extent of the price differential.

The identification and measurement process firstly requires the careful selection of properties that have sold proximate to a wind farm development. The properties must have been sold on the open market, with the vendor and purchaser being at arms length, both parties being fully aware of the neighbouring land uses, and neither being unduly motivated to complete the transaction. The selling prices of those properties are then compared to sales at or about the same time period that are distant from the wind farm project, yet are similar in nature and utility to the study properties.

There are basically two techniques for measuring the effect of a feature on the value of real estate, namely a “Paired Sales” analysis and by MRA.

A “Paired Sales” analysis has been used over the last few decades as the “default” solution for extracting variables that influence price. A “Paired Sale” would be a sale of a property that is identical to some other property under study with the exception that it is not subject to a specific variable (whatever that might be). In studying the two different index groups, the real estate analyst would extract a difference in price levels. The conclusion that would be reached is that the differences in the price levels of the comparable sales would be due to the influence of the variable in question.



Unfortunately, this “Paired Sales” methodology contains inherent limitations and is often considered to be flawed. Many academics and real estate practitioners have therefore stopped using this approach to evaluating effects from externalities on local real estate values. The difficulties and flaws with this procedure include:

- (1) Insufficient quantities of “Paired Sales”. Ideal paired sales rarely, if ever, exist in the market place.
- (2) Variations between the “Paired Sales” and the influencing factor under review require a substantial volume of “Paired Sales” to hold constant the other property differences or variables within the group.

The analysis is often undertaken by an application of a Direct Comparison Approach through a process of adjustment. The comparable sale properties, when adjusted for differences in the site size, building features, zoning, municipal services, financing etc, are thought to provide a basis or benchmark for indicating the market value of a study property absent the perceived influencing factor. A weakness in its application is that the adjustments are mostly unsupported and contain unconscious bias that can invalidate the results.

In this study a “Paired Sales” was prepared by using analytical tools such as CEM and Optimal which selects “Paired Sales” through a process of utility scores and bins. Since the selection process is not the sale price, these “Paired Sales” are drawn without bias.

The application of “Paired Sales” was enhanced by applying re-sales of properties within the main data set since a re-sale is closer in identity to what a “Paired Sale” should be.

Although considered in this study, it is recognised that it is an imperfect methodology applied to measure influences in an already imperfect market place.

### **MULTIPLE REGRESSION ANALYSIS (MRA)**

The MRA technique has the ability to study large quantities of transacted sales data that are influenced by numerous variables over a specific time period. It is also known as a Multivariate Linear Regression Analysis.

Single Linear Regression analysis is a means for building models that describe how variation in one set of measurements affects variation in another set. The analyst forms a hypothesis that one variable is dependent on or responds to another variable (independent or predictor variable). In real estate value analysis, the dependent variable is often the sale price of a property in total or on a price per unit basis. The independent or predictor variable can be a characteristic of the property that is believed to have an influence on the dependent variable-sale price in this example. Aided by a computer with the ability to perform many calculations quickly, regression analysis provides a systematic method for building an equation that summarizes the relationship between the two variables. The resultant equation can then be used for the prediction of value.

Multiple Regression Analysis (MRA) extends the idea of a two variable linear regression model by allowing an analyst to include many explanatory factors to the regression equation. As in simple linear regression, a regression coefficient measures the impact of changes in each explanatory variable on the response variable. In MRA, the coefficient for each variable represents the effect of that variable on the dependent variable while holding the affect of all the other variables constant. In addition to its usefulness in prediction, this allows the use of MRA as an exploratory tool where the coefficients can be interpreted as a level of contribution of the predictor variable.

For this particular study, an MRA model can be specified that reduces the many characteristics of index properties into values for different variables. A regression run on a complete data base can then generate coefficients for the variables. The analyst's expertise in deciphering or interpreting these coefficients will lead to many conclusions of the market place.

Regression analysis is based on a number of assumptions as to the nature of the underlying data. The use of mathematical statistics allows the analyst to perform many diagnostic tests on the specified model to assess the level to which the assumptions are met. This allows the analyst to explicitly state the level of confidence that can be given to the results of

regression modeling. The recipients of the findings of such analysis can then make better informed decisions.

### **IMPLEMENTATION OF MRA**

By using MRA, a “Model” of behaviour is developed that explains the variation in the prices of the comparables found in the market place. The comparables are sampled from a total potential number of sales within the array. The comparative data gathering process has the potential to gather a very high percentage of all possible sales. When using MRA, more sales data are better.

Once the data is placed into the MRA model, a “regression” run plots the results. MRA models are “smoothed” out to improve accuracy and functionality when deciphering the large quantities of data. Statistic tests are performed that assess the overall reliability of the model.

Once efficiency is established, the MRA produces a number of statistical reports. The ones of interest to this study are the coefficients. Graphics within the report demonstrate the possible relationships between variables.

The MRA indicates how much or how little wind farms have on real property, positive or negative. The MRA also provides a confidence interval. Statistically, the accepted confidence interval is established at the 95% to the 99% level. (The goal is to determine how statistically confident we are of the results and to demonstrate what the results mean.)

Like most types of analysis, MRA requires large quantities of data that particularly demonstrate the differences between properties. We are hopeful that there is a sufficient quantity of data that can be gathered for this type of study. MRA is the only known process that can effectively absorb and examine numerous interactive factors that influence real estate prices, all at the same time. It accomplishes this task by building all the factors of influence into the regression equation. As the model studies the influence of say, distance, it holds all the other factors (age, site size, building size, etc) constant. It continually repeats this individual process. That is why MRA is ideal for isolating the coefficients (expressed in dollars) to a given variable. Interpretation of the results is a key. It is not prudent to simply accept the results of the MRA blindly. The analyst must “step back” from the MRA outcomes to see if the results coincide with our appraisal knowledge of the problem at hand.

#### **VALIDATION OF THE USE OF REGRESSION ANALYSIS**

Regression analysis is a statistical modelling tool that has been employed very successfully in “Data Mining” and is used frequently at the corporate and government levels.

The Province of Ontario has adopted MRA in the assessment of residential properties for their new base of 1996. They also have test projects underway to extend MRA to other property sectors (vacant commercial land, industrial buildings, bank buildings and commercial plazas).

The Province of British Columbia has been using MRA in assessment for many years and has been a major consultant to the Province of Ontario on the implementation of their system.

Regression analysis is used by Statistics Canada in determining the Gross National Product for Canada and for the analysis of national data.

Regression Analysis was used in the USA by a large accounting firm to justify to the IRS the existence of “economic obsolescence” in large industrial buildings.

In this report a Regression Analysis was adopted as the preferred technique, however, due to the availability of several paired sales, these were analysis as a method of confirmation.

## **APPLICATION OF MULTIPLE REGRESSION ANALYSIS (MRA)**

A total of 83 house sales within parts of Chatham-Kent that occurred over the last two years were analysed, proximate to wind farms, with the most recent sale in May 2009. This is a small sample relative to the size of data sets usually used in observational studies of this type. While a larger volume of sale would be preferred, this was a constraint attributable to the rural nature of the area where wind farms are placed. They are generally not developed in densely populated areas.

A ground qualitative view assessment technique was used to assign a sale property to either the viewshed group or the control group. For the purpose of this study, the viewshed is “a point within the study area whereby a sale property had a view of one or more wind turbines”. Any sale property found that did not have a view of a wind farm was deemed to be outside of the viewshed. Wind farms were not visible to all properties within the general area, as the view was sheltered either by bush lots or tree rows.

A simple difference in the means of sale prices between the viewshed group and the control group was employed to estimate the impact of a wind turbine(s). When these groups are different in characteristics relevant to the outcome of sale price, as they usually are in observational studies, the study is required to adjust for these differences. Regression modeling was the primary approach to make these adjustments. This approach was first used on the entire data sample and then on reduced data samples after the data was preprocessed through matching methods. These matching methods (Optimal and CEM) make the viewshed and control groups more comparable by pruning the least comparable sales from the full data set. Adjustments are then made on remaining differences in the reduced data sets by regression.

## **IDENTIFICATION OF COMPARABLE SALES**

In assembling the comparative sales data, research was conducted with local Real Estate Board MLS® records, GeoWarehouse®, MPAC (Municipal Property Assessment Corporation) and at the Land Registry Office, with a view to finding properties within the viewshed and outside of the view shed.

The assembly of data did not focus on specific target residential property types, only residences on small acreages or lots that were within the viewshed or not in the viewshed. Sales of residences within small hamlets or communities were omitted from the data set since the selling prices of these properties were influenced by the convenience municipal services and amenities. Furthermore, wind farms are not typically situated in proximity to these locales. Sales of farm acreages with buildings were not included in this analysis as there was an insufficient volume of transactions for an effective analysis.

All of the comparable sales were inspected from the roadway. The sales were then cross referenced chronologically to identify any type of a buying pattern related to the sale dates of the transactions used in the study. The property variables or characteristics that were identified as having a potential influence on the study results are as follows.

- Address:** The address of the sale property.
- Age of the House:** The chronological age of the house at the time of the sale.
- Basement:** The sales were identified as either having a full basement or not at the time of the sale.
- Basement Finishing:** The sales were identified as either having some basement finishing or not at the time of the sale.
- Condition of the House:** Each house is classified as being in Fair, Good or Very Good condition.

<b>Date of Sale:</b>	The date at which the sale property was determined to be the date whereby all conditions of the sale were met.
<b>Elapsed Months:</b>	The difference in time between the oldest dated sale and the next occurring sale in months.
<b>Garage:</b>	The sales were identified as having a garage or not.
<b>House Size:</b>	The exterior square footage of the house above grade.
<b>Lake Front:</b>	Signalling the difference between properties that were located on a river or lake front as opposed to not.
<b>Location:</b>	Considers the possible difference of the sale property (within and beyond the viewshed) relative to important amenities such as major highways and goods and services.
<b>Lot Size:</b>	The size of the lot of the sales expressed in square feet.
<b>Number of Storeys:</b>	The number of storeys of the house on a given sale property.
<b>Outbuildings:</b>	The sales were identified as having some type of a outbuildings such as a shed or barn.
<b>Selling Price:</b>	The price which was agreed upon by the buyer and the seller.
<b>Viewshed:</b>	Any sale that was located within a view of a wind turbine.
<b>Viewshed Within:</b>	<p>Any sale that was located in a viewshed was differentiated by a score that would separate the proximity of the wind farm to any sale within the view shed.</p> <p>The specific Viewshed Within variable ultimately eliminated and said either the property had an average view or a no view. This is identified by Viewshed3. The number 3 does not have any reference other that this is the third name in the selection process of variables that tried to consider distance.</p>



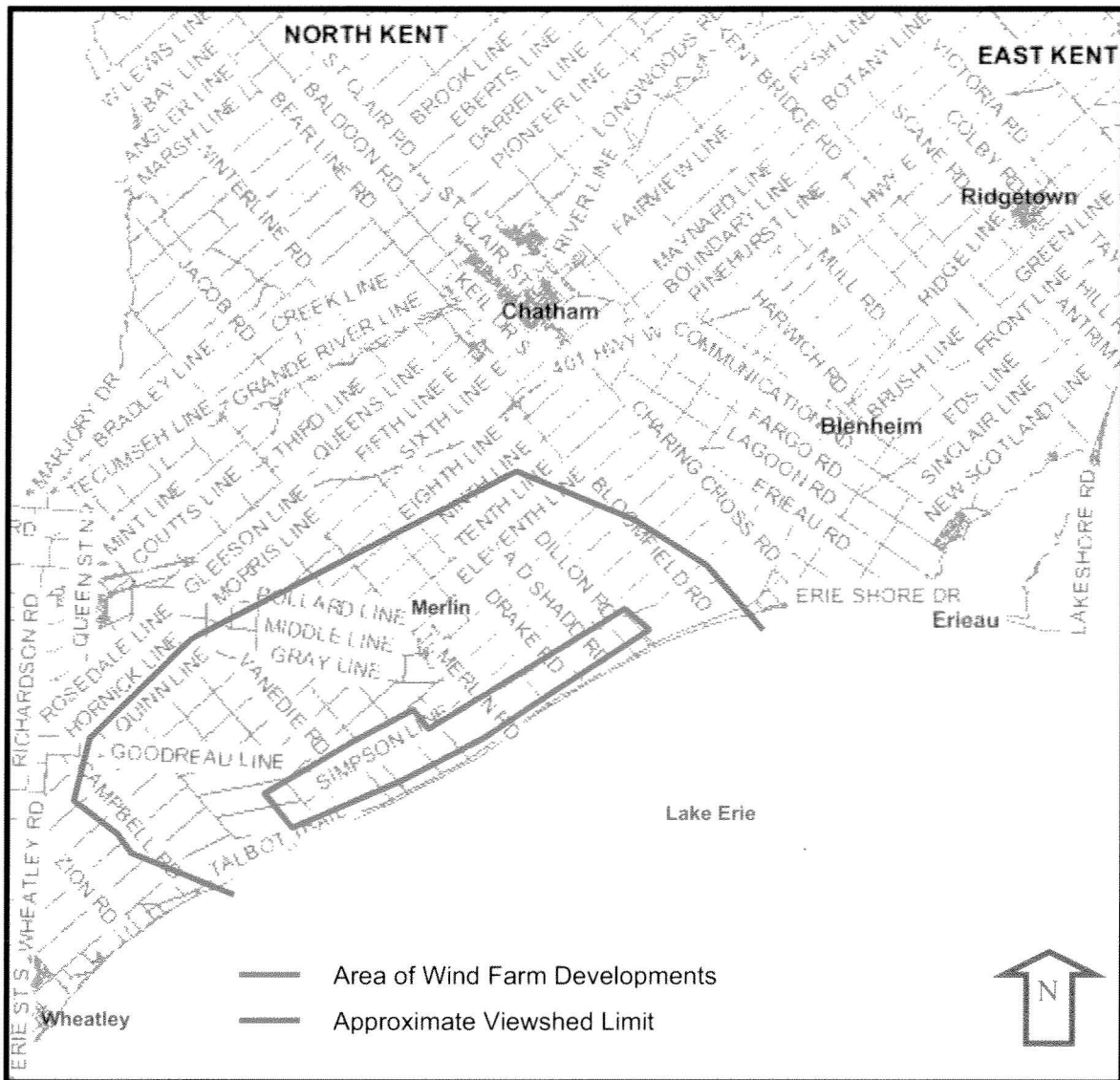
## **OVERVIEW OF THE PROBLEM AND THE TECHNICAL REPORTING ASPECTS OF THE STUDY**

### **Introduction**

Wind farms can be perceived by some nearby residential homeowners to be a source of nuisance, as a result of audible sound and aesthetics (visual appearance). Some claims have been made that suggest the presence of a wind turbine or wind farm could result in diminished real estate values for properties within the viewshed. Rural residential real estate is the principal target of this perceived association.

An analysis of sales of single family houses in south Chatham-Kent's rural area was undertaken to test this hypothesis. This study attempts to determine if residential properties located within a wind turbine's viewshed were or were not negatively influenced by reflecting lower sale prices in a statistically significant manner. By comparing properties that sold during the last several years, with a wind turbine(s) clearly visible and those farther away and outside the viewshed, but which are of similar age, lot size, and with similar amenities and economic influences, the differences in the selling prices of properties within the turbine's viewshed, on average, should be noticeably lower than the selling prices similar of similar properties outside a wind turbine's viewshed. The following is a map of the approximate area of the overall view shed. The red arc signifies the approximate location of the view shed. It should also be noted that some properties within this red arc were classified as being outside of the viewshed as the wind turbines were not visible due to tree lines or bush lots.





### Study Design

This study focused on the inferred effects of Chatham Kent wind turbines on property prices. Specifically, it examined how the local market prices residential properties located within the viewshed of wind turbines compared to a control group of property sales outside the viewshed. As the wind turbines of this study are in a rural area of the County, obtaining a sample of sufficient size required the collection of house sales over a period of 2 years.

As part of this study's design, an examination of other previously executed studies, undertaken to measure the effect of wind turbine views on property pricing was completed. Although there is substantial literature on measuring effects of undesirable land uses on residential properties, research on the actual market effects of wind farms is lacking. Wind farms as a large scale energy source are relatively new to Ontario, which may explain the thin inventory of available studies. Schedule "A" outlines the research literature referenced at the outset of this study.

In this study, the loss measured is the realized capitalized loss that occurs when a property is sold. This study does not look at the losses associated with a delayed sale or other issues that may affect the bundle of property rights infringed by the proximity of a wind turbine. It was noted that it was nearly impossible to determine the exact time when the wind farms were constructed. A considerable time lag was noted between the issuance date of the building permit to when the wind farm was actually physically constructed. The time lag was alleged to be due to weather, the availability of cranes to erect wind turbines, and road construction. However, it is known that considerable public awareness of the construction of wind farms was imminent since public meetings occurred and wind farm developers held barbeques and information meetings regarding the construction of wind farms in areas of Chatham-Kent.

This study presupposes the existence of two causal states, which are based on visual perception of a nearby wind turbine from a property or absence of such. For our purposes, they are labeled avg viz and no viz. They are not, however, well-defined states because of their qualitative nature and the observation made from one point on the ground. Although a wind turbine may be visible to an observer from an upper floor window of a house, it may not be visible to an observer on the ground. Any individual sale property in our data was assigned to one of two possible causal states and associated potential outcomes based on a view of a wind turbine(s) or not.

In this study, the effect of a wind turbine as the difference in the sample average of the observed sale price between the avg viz group and the no viz control group was estimated.

Excluding ID variables, these data were measured on 14 physical and location variables. Of these 14 predictor variables, only 8 variables were discovered to be important predictors of sale price based on initial regressions. These predictors and the binary variable viewshed3,

which is instrumental to measuring wind turbine visibility effect on price, were regressed on sale price in the final regression model on the full data sample. A random sample of 6 sales from the data set measured on these variables is in Table 1. Variable definitions are given in Table 2.

Figure 1 shows graphically the distribution of values for the variables in the data set employed for the final model of the regression analysis. As indicated by the plot for the binary viewshed3 variable of primary interest in this study, the control category has about 3 times the number of sales in the avg viz category. The distributions of sale price, house size and lot size are skewed to the higher values.

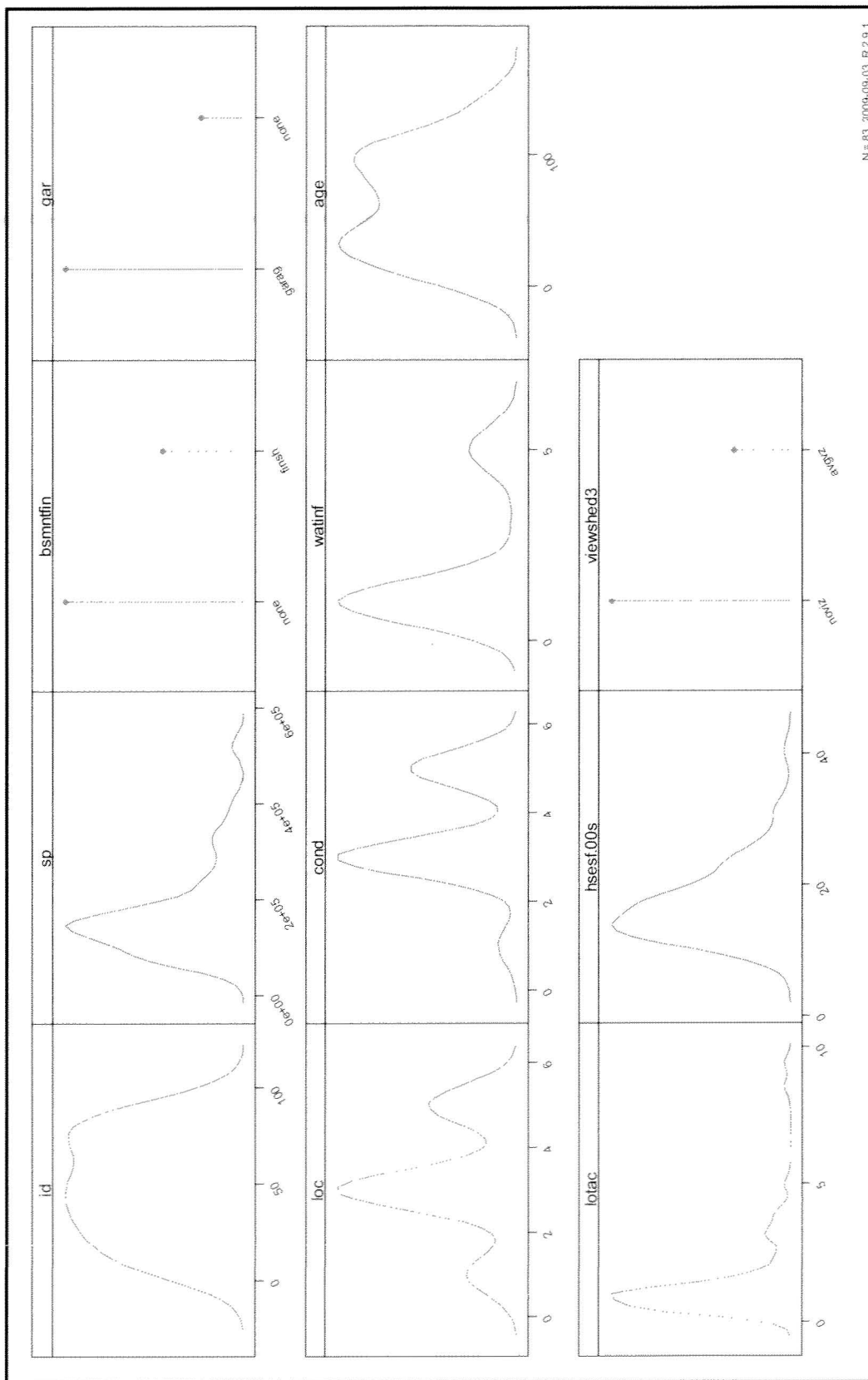
**Table 1**

id	sp	bsmntfin	gar	loc	cond	watinf	age	lotac	hsesf.00s	viewshed3
1	96000	none	garage	3	3	1	30	0.373	17.85	avg viz
3	124000	none	garage	1	3	1	49	0.744	10.73	avg viz
4	79000	none	garage	1	3	1	44	0.625	7.92	no viz
5	174000	none	garage	1	5	1	97	0.920	23.26	no viz
6	99500	none	garage	1	3	1	98	0.497	12.70	no viz
7	120000	none	none	1	3	1	82	1.311	15.14	no viz

**Table 2: Variable Definitions**

<b>id:</b> property sale identification	<b>cond:</b> qualitative assessment of house condition - 1=fair, 3=average, 5=good
<b>sp:</b> continuous variable - sale price	<b>gar:</b> binary variable indicating if a property has a garage or otherwise
<b>lotac:</b> continuous variable - site area in acres.	<b>waterinf:</b> qualitative assessment of linkage to a body of water - 1=none, 3=water view, 5=water front
<b>loc:</b> qualitative assessment of location variable – 1=remote, 3=typical, 5=near town	<b>hsesf.00s:</b> continuous variable - size of living area excluding basement in hundreds of square feet
<b>bsmntfin:</b> binary variable designating if a house has basement finish or otherwise	<b>age:</b> continuous variable – age of the house in years
<b>viewshed3:</b> binary variable designating if one or more wind turbines are visible from a property	

Figure 1



N = 83, 2009-09-03, R2, 9.1

## **Methodology**

The primary objective of this study is to compare the house sales identified as located within the viewshed of one or more wind turbines with the sales of houses without this influence as a comparison (control) group. As this is an observational study, property sales self-assign to either the viewshed group or the control group based on the observations taken from site visits. Randomized assignment to either group, the gold standard of a causal inference study design, is clearly not possible with property sales data. Without random assignment, it could well be the case that these two groups, viewshed and control, are different from the onset. Those differences, not the impact of a visible wind turbine, may cause the measured difference in sale price between the groups, if any.

Several approaches were employed in this study to control for these differences. As a basic strategy, regression analysis was employed as an adjustment technique. Sale price was transformed to its natural log for the regressions as this allowed the interpretation of the estimates as a percentage. A second approach was to obtain smaller but more comparable samples by first preprocessing the data through matching of sales in the viewshed group with sales in the control group on their attributes. Two matching algorithms were employed for the matching exercise.

## **Exploratory Analysis**

Figure 2 below is a graphic comparison of the distribution of sale prices before any adjustment by regression for differences between the viewshed group and control group. A comparison of the histograms of the two groups indicates the mean sale price of the viewshed group sale price distribution is less than that of the control group. The mean value of the viewshed group is approximately 7% lower than the mean value. Their distributions are similarly skewed to the right.

As indicated by the scatterplot (Figure 3) of sale price on the number of months that have elapsed (emths) for each sale between the date of sale and the date of the oldest sale, changes in market conditions is not an important price influencing variable for this data. As the smoother line on the plot clearly shows, there is no clear sale price trend.

Figure 2

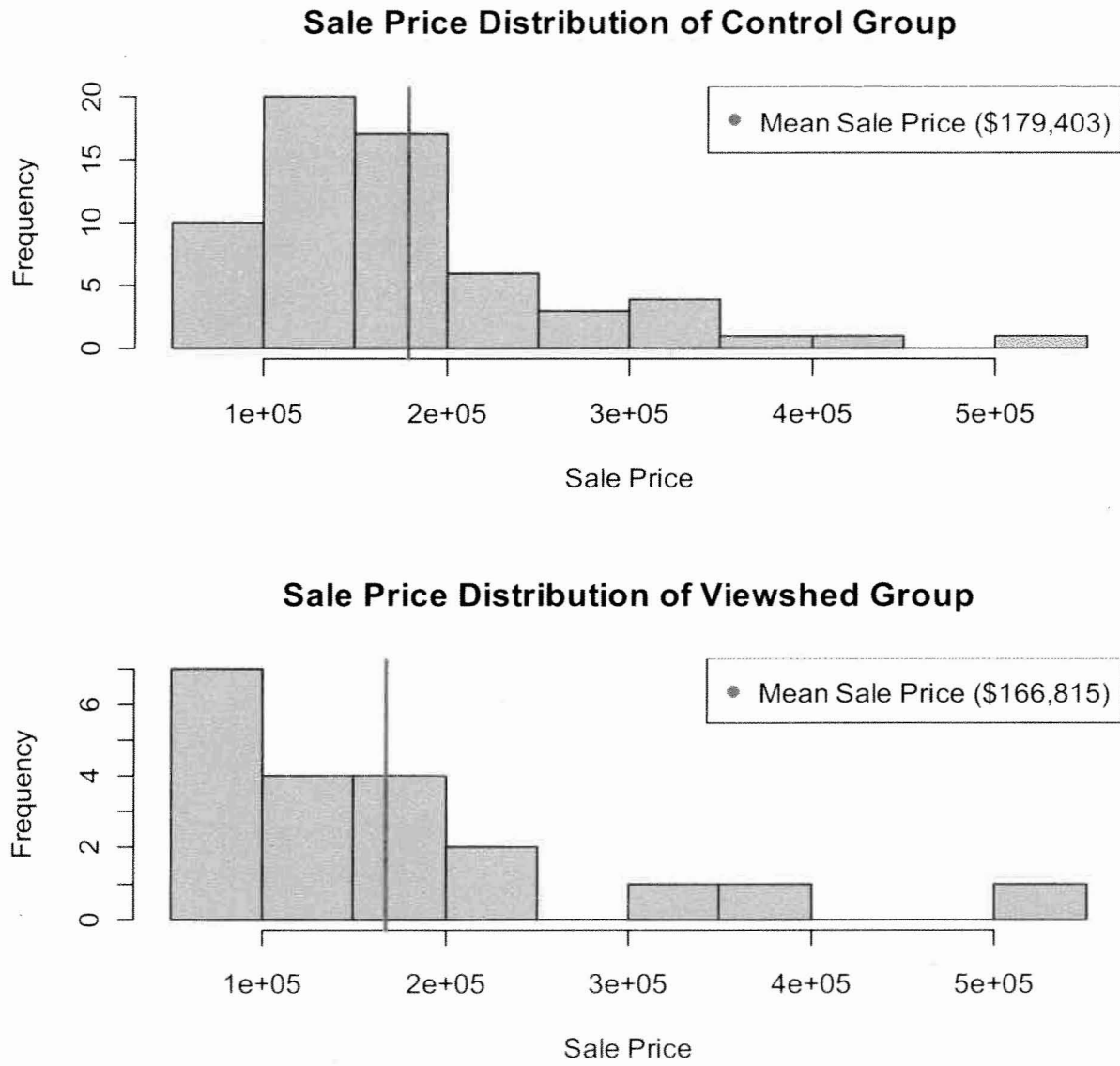
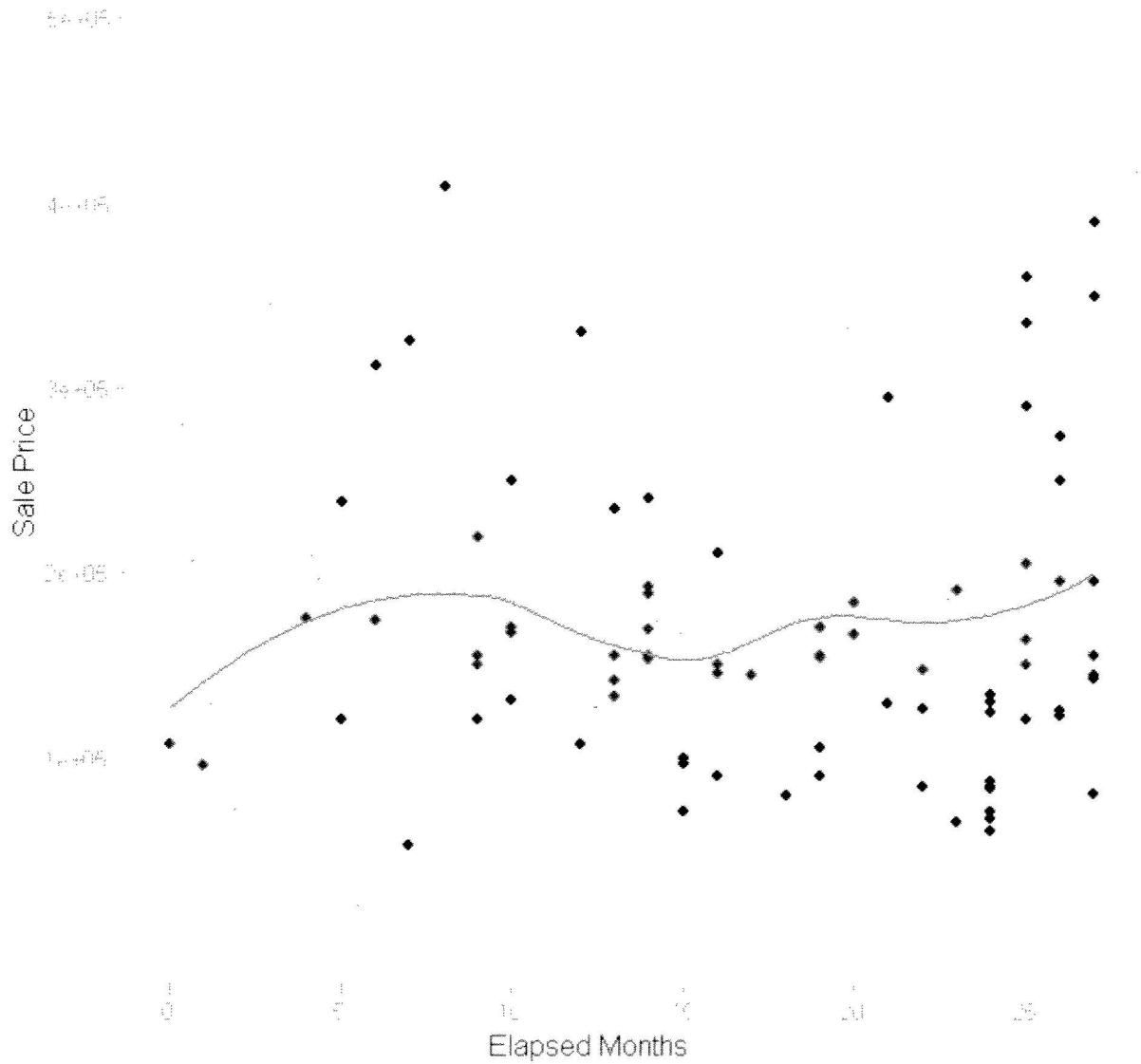


Figure 3



The exploratory analysis revealed that sale properties in the control group differ from the viewshed group on some characteristics; in other words they are not closely comparable. This imbalance must be addressed before a comparison of mean prices between the two groups of properties can be inferred to measure the effect of a wind turbine on the values of nearby properties from which a wind turbine or turbines are visible. Two strategies were used in this study to balance the comparability between the two groups of properties. They are regression modeling and pre analysis matching.

Altogether, three approaches to estimate wind turbine effect were conducted in this study. Matching was combined with regression in two of these analyses.

### **Regression Analysis**

The use of regression analysis to adjust the sale prices of individual properties in the sample for differences between them is common to studies of the type conducted here. After controlling for the differences in the measured characteristics of the sale properties, the difference in the sample means between the viewshed and Control groups is inferred to be the causal effect of wind turbines that are visible to the nearby properties.

As regression analysis is a statistical technique, it offers a measure of sampling error. It provides a measure of the confidence that can be placed in the estimate of turbine effect on price.

This study considered a sequence of regressions to arrive at the final model specification described here. All regression modeling was done with the log of sale price as the outcome variable, using various sets of predictor variables. The choice of variables selected for the final regression model depended on their predictive power for sale price.

The regression model results for the initial approach on the full data, presented in Table a.1, shows the adjustment variables are associated with sale price in an expected manner and with the correct signs. As none of these non-viewshed effect relationships is surprising, they are not discussed further in this report.



**Table A.1: Summary of Final Regression Model**

```
lm(formula = log(sp) ~ log(age) + bsmntfin + cond + gar +
log(hsesf.00s) +
lotac + watinf + viewshed3, data = wind.cln)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.467791	-0.093272	0.002240	0.132561	0.405398

Coefficients:

Estimate	Std. Error	t value	Pr(> t )
(Intercept)	9.92138	0.25967	38.208 < 2e-16 ***
log(age)	-0.12236	0.03080	-3.973 0.000163 ***
bsmntfin[T.finish]	0.12295	0.05537	2.220 0.029454 *
cond	0.14775	0.02467	5.989 7.04e-08 ***
gar[T.garage]	0.18784	0.06200	3.030 0.003369 **
log(hsesf.00s)	0.55485	0.08158	6.801 2.30e-09 ***
lotac	0.07977	0.01542	5.173 1.90e-06 ***
watinf	0.08210	0.01592	5.159 2.01e-06 ***
<b>viewshed3[T.avg viz]</b>	<b>-0.12879</b>	<b>0.05984</b>	<b>-2.152 0.034627 *</b>

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2054 on 74 degrees of freedom

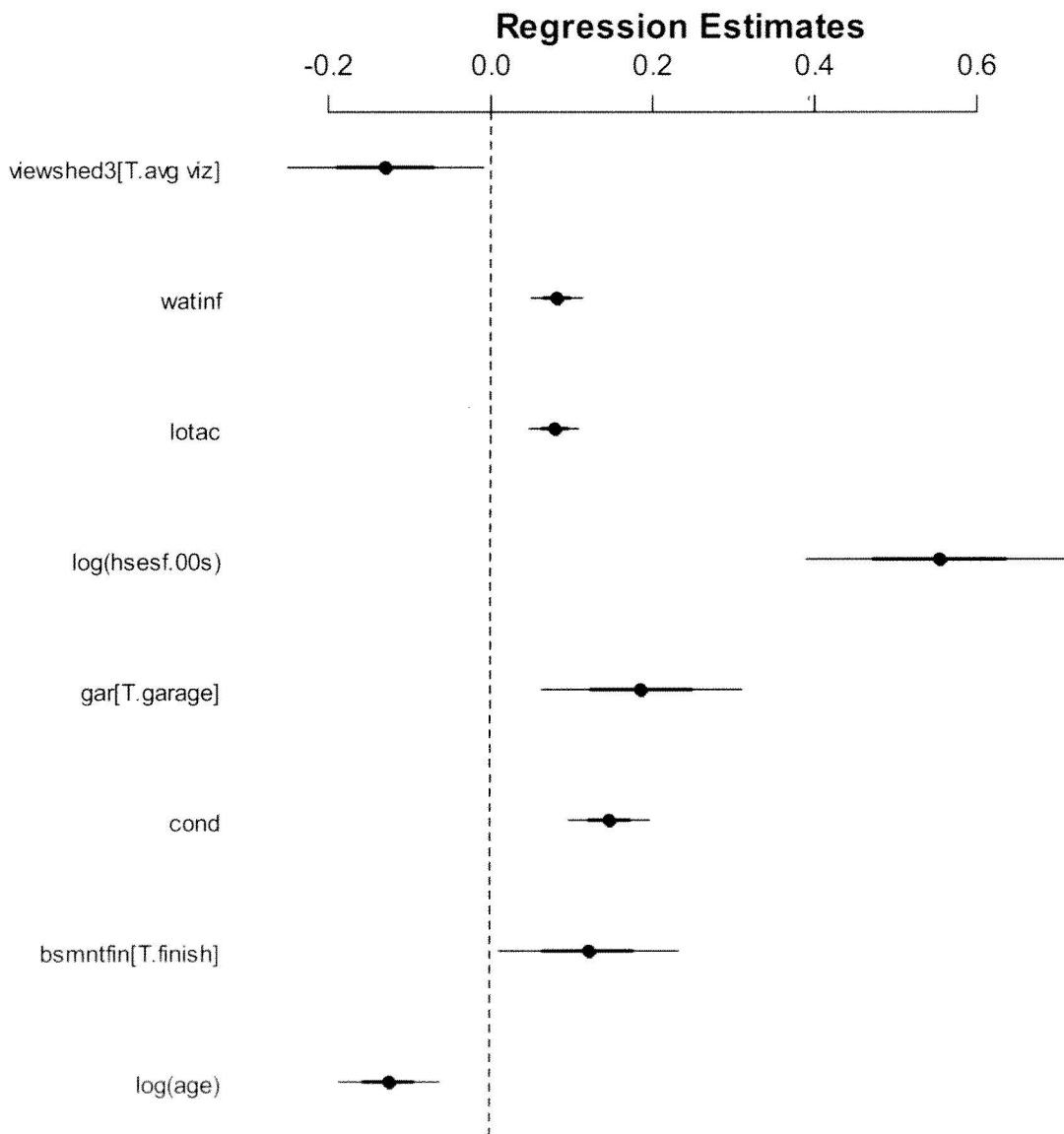
Multiple R-squared: 0.8476, Adjusted R-squared: 0.8312

F-statistic: 51.46 on 8 and 74 DF, p-value: < 2.2e-16

The regression summarized in Table A.1 has an adjusted R-squared measure of 83%, which indicates a considerable proportion of the variation of the log of sale price is explained by the eight predictors included in the final model. Viewshed3 is the variable of interest for this study, and it is presented within the Table in bold type. Because the untransformed predictors are regressed on sale price expressed on the logarithmic scale, their coefficients can be interpreted as proportional differences. Thus, with all else held constant, houses with basement finish (bsmntfin) have sale prices, on average, approximately **12% greater** than houses without basement finish, houses on a water body like a lake or river have, on average, sale prices about **8% higher** than others, and so forth.

These patterns, however, are not comparable in the strength of their signal. The plot below relates the estimates and their associated level of certainty.

Figure A.1: Plot of Regression Estimates and Confidence Intervals - Final Model



The plot above outlines the coefficients presented in Table A.1 and  $\pm 1$  standard error (thick line) and  $\pm 2$  standard error (thin line) intervals estimated from the final regression. Strongest patterns are associated with the shortest lines relative to the size of coefficient; thus we have the greatest certainty with effect on sale price estimates for condition (cond), water influence (watinf), and house (log(hsesf.00s)) and lot size (lotac). Noticeably, the estimate for houses with wind turbine visibility (viewshed3) displays a wide confidence interval relative to its affect size. For the -13% impact on sale price from wind turbine visibility estimate, this translates to a margin of error between -3% and -23%.

## Matched Samples

### Overview

In observational studies, the use of regression modeling alone presents a risk of estimate bias (not human) because of dependency on model specification and the underlying assumptions that premise such a model. One approach often used to reduce the potential of bias in observational studies is to mimic a randomized experiment through data preprocessing by matching the treatment (in the viewshed) and control (out of the viewshed) groups. By obtaining a sample of control sales that agrees as closely as possible with the viewshed group sales on an array of property characteristics that excludes their sale price, preprocessing the data by matching reduces dependence on the regression model and brings us closer to this goal. Matching the estimators for the two groups attempts to balance the characteristics between the groups so they are more alike than not, both in their distributions and coverage. The basis of this type of analysis is drawn from traditional appraisal methodology using “paired sales”. The differences are that specific programs are used to match the “Paired Sales” as opposed to human selection. It eliminates the problem of bias either conscious or unconscious and achieves better results. Two matching analyses were conducted.

### OPTIMAL

The “MatchIt” package<sup>3</sup> of the R statistical software program was used to obtain a sample of sales in the Control Group matched to the 20 sales in the viewshed group as closely as possible on house characteristics that are independent of the wind turbines, before adjusting for remaining differences with regression. This automated matching process is summarized in Panel B below.

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<sup>3</sup> Daniel Ho; Kosuke Imai; Gary King; and Elizabeth Stuart (2007), “Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference,” *Political Analysis* 15(3): 199-236, <http://gking.harvard.edu/files/abs/matchp-abs.shtml>.

Full and optimal matching are implemented via the `optmatch` package (Hansen, 2004).

## Using the Optimal Matching Sequence

### Panel B: Regression Model on Data Matched by MatchIt Package Using Optimal Method

Call:

```
matchit(formula = viewed ~ hsesf.00s + cond + loc + lotac + age + watinf, data = mwind, method = "optimal")
```

**Table B1: Summary Of Balance For All Data**

	Means Treated	Means Control	SD Control	Mean Diff	eQQ	Med eQQ	Mean eQQ	Max
distance	0.390	0.194	0.169	0.197	0.168	0.193	0.366	
hsesf.00s	16.727	17.352	6.038	-0.625	0.885	1.337	9.460	
cond	3.000	3.762	1.160	-0.762	0.000	0.700	2.000	
loc	3.500	3.159	1.208	0.341	0.000	0.600	2.000	
lotac	1.627	1.379	1.388	0.247	0.100	0.230	0.851	
age	63.600	64.905	36.474	-1.305	8.000	8.600	30.000	
watinf	2.700	1.603	1.420	1.097	0.000	1.100	4.000	

**Table B2: Summary Of Balance For Matched Data**

	Means Treated	Means Control	SD Control	Mean Diff	eQQ	Med eQQ	Mean eQQ	Max
distance	0.390	0.362	0.181	0.029	0.008	0.029	0.102	
hsesf.00s	16.726	17.630	5.572	-0.903	0.920	1.123	3.600	
cond	3.000	3.000	1.124	0.000	0.000	0.200	2.000	
loc	3.500	3.400	1.392	0.100	0.000	0.300	2.000	
lotac	1.627	1.401	1.855	0.226	0.146	0.257	0.851	
age	63.600	62.300	40.901	1.300	5.000	6.800	29.000	
watinf	2.700	2.400	1.957	0.300	0.000	0.300	4.000	

**Table B3: Percent Balance Improvement**

	Mean Diff.	eQQ	Med eQQ	Mean eQQ	Max
distance	85.457	95.384	84.98	72.119	
hsesf.00s	-44.423	-3.955	16.04	61.945	
cond	100.000	0.000	71.43	0.000	
loc	70.698	0.000	50.00	0.000	
lotac	8.684	-45.662	-11.76	0.000	
age	0.365	37.500	20.93	3.333	
watinf	72.648	0.000	72.73	0.000	

**Table B4: Matched Sample Size**

	Control	Treated
All	63	20
<b>Matched</b>	<b>20</b>	<b>20</b>
Unmatched	43	0
Discarded	0	0

Tables B1 to B4 are output from the matching process. Tables B1 and B2 outline the comparability of the two groups before and after matching, respectively. A summary of the improvement in comparability of the groups achieved by matching is in Table B3. Table B4 shows that matching has reduced the original sample of 83 sales to a smaller sample of 40 sales, consisting of 20 sales in the viewshed group (inside the view shed-Treated) and 20 sales in the control group(outside of the viewshed).

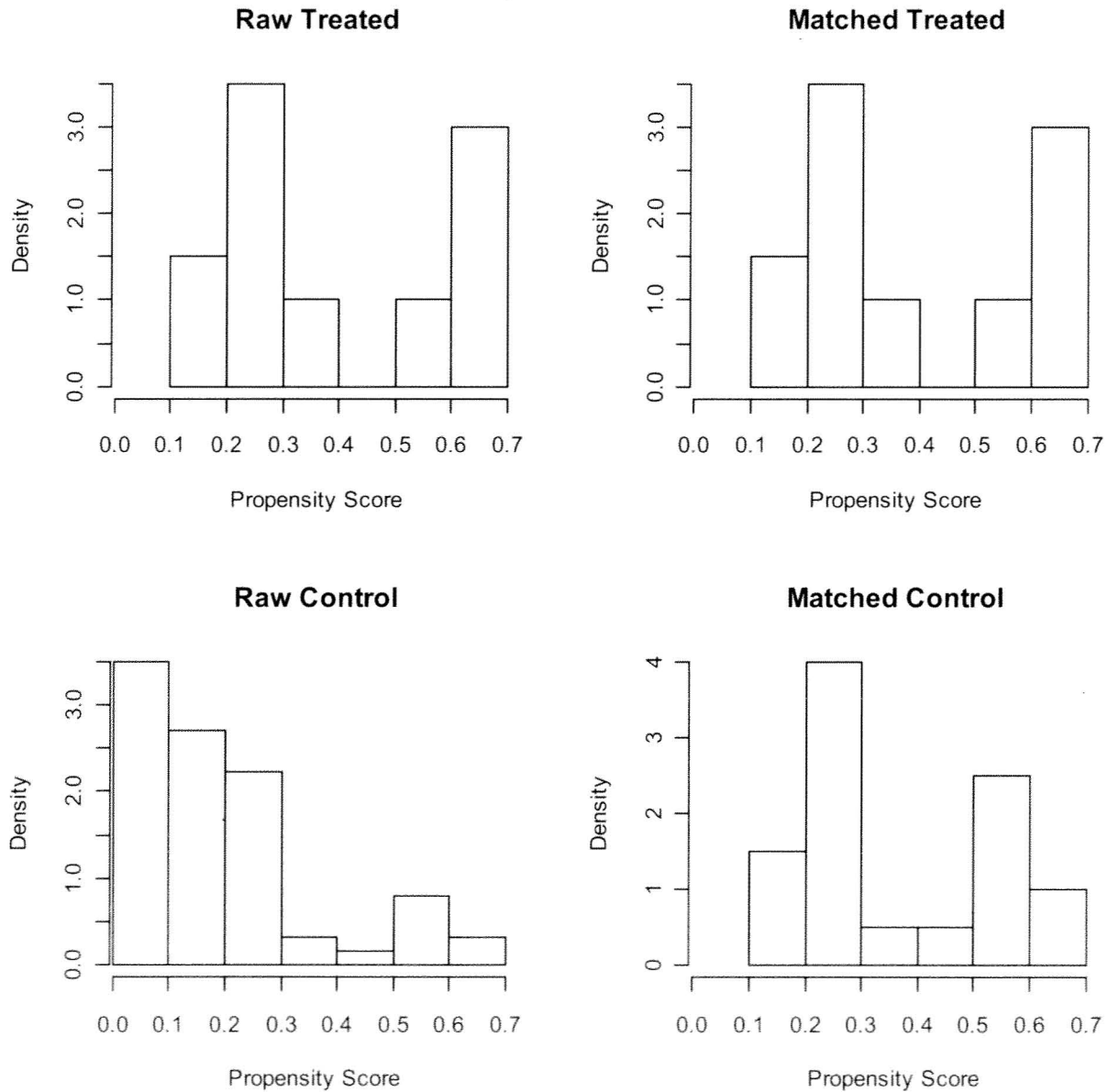
Figure B.1 is a visual display of the imbalance in the attributes between the two groups before matching (raw) and the improvement in the comparability of these attributes caused by the matching process (matched).

The comparison is made on the calculated propensity score for each sale. A propensity score of a property is its conditional probability of falling into the viewshed group given its attributes. It is a single value measure that summarizes all the attributes of any one property. Matching occurs on these propensity scores. It can be said that the propensity score is an overall utility score of the property similarly used in Qualitative and Quantitative analysis within the Direct Comparison Approach used by appraisers using Quality Point.

A comparison of the distributions of the propensity scores between the viewshed and control groups for both the raw and the matched data sets is offered by the histogram plots of Figure B.1. As the plots in the left column show, the distributions of the scores before matching are quite different. This difference disappears after matching, with the viewshed and control groups having similar propensity score distributions in the matched sample.

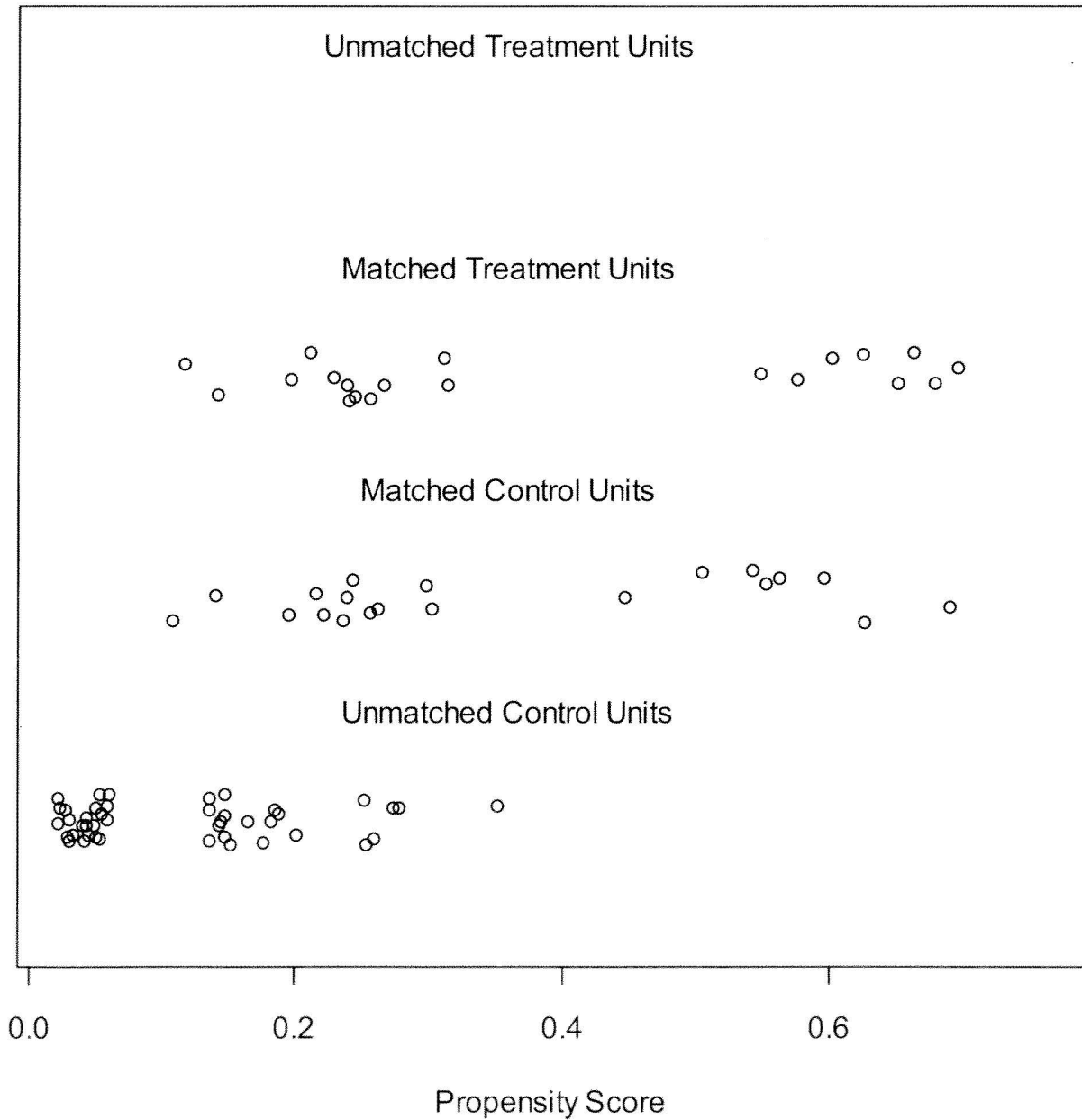
Figure B.2 below is a dot plot of these propensity scores. In addition to plotting the scores of the matched data set, it also shows the propensity scores of the discarded sales.

**Figure B.1: Histogram Plots Comparing Propensity Scores between Raw and Matched Data by Viewshed and Control Groups**



**Figure B.2: Plot Comparing Propensity Scores between Raw and Matched Data by Viewshed (Treatment) and Control Groups**

### Distribution of Propensity Scores





After matching, comparability between the groups has improved in the smaller matched data set (mdata). Overall, matching has made the two groups more alike than not.

Tables B.5 is the summary of the regression model built on the matched data set. Besides the viewshed variable, only three predictors were included in this model. These three predictors are helpful in explaining the variation in the log of sale price. The reason why only three predictors were used is because these were significant in explaining variation in the data set. Using too many variables against too small a sample would undermine the basic principles of regression analysis.

Table B:5 indicates that, contrary to the expectation of a statistically important negative coefficient for viewshed obtained from the regression on the full data set (outlined in Panel A), the regression on the smaller matched data sample of 40 sales shows viewshed has no clearly identifiable relationship with sale price. Although the viewshed coefficient has a value of -9%, the standard error is almost 12%. The output shows a probability of 45% of obtaining the coefficient value returned, even if the statement of a zero effect between sale price and viewshed were true. It can reasonably be concluded, therefore, that the model indicates there is no relationship between price and viewshed.

**Table B.5 Summary of Regression Model - Data Matched Optimal Method**

Call:

```
zelig(formula = log(sp) ~ viewshed + age + hsesf.00s + lotac,
model = "ls", data = mdata, weights = "weights")
```

Residuals:

Min	1Q	Median	3Q	Max
-0.6559	-0.2388	0.0293	0.2247	0.6321

Coefficients:

Estimate	Std. Error	t value	Pr(> t )
(Intercept)	11.27470	0.22463	50.19 < 2e-16 ***
<b>viewshed</b>	<b>-0.08945</b>	<b>0.11594</b>	<b>-0.77 0.44558</b>
age	-0.00626	0.00136	-4.61 5.1e-05 ***
hsesf.00s	0.05082	0.01097	4.63 4.9e-05 ***
lotac	0.11917	0.03048	3.91 0.00040 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.364 on 35 degrees of freedom

Multiple R-squared: 0.634, Adjusted R-squared: 0.593

F-statistic: 15.2 on 4 and 35 DF, p-value: 2.72e-07

## USING THE CEM MATCHING SEQUENCE

As a second matching approach, the CEM package<sup>4</sup> was employed in the R library of analytic functions. The CEM function was chosen from the available matching functions because of its similarity to the matching process traditionally used by property appraisers for variables with continuous values. The basic idea with CEM is to temporarily coarsen continuous variables such as house size so that substantively indistinguishable values are grouped and assigned the same numerical value. It is on these assigned values that matching occurs. Panel C of shows the matching analysis by CEM and final adjustment by regression.

### Panel C: Regression Model on Data Matched by MatchIt Package Using Coarsened Exact Matching (cem) Method

Cem Matching Call:

```
library(cem)
todrop <- c("sp", "bsmnt", "outbldgs", "gar", "bsmntfin", "id")

matcem <- cem(treatment = "viewshed", data = wind,
drop = todrop, cutpoints = list(age = 4, hsesf.00s = 3, lotac = 3))

est <- att(matcem, log(sp) ~ viewshed + age, data = wind)
summary(est)
```

#### Table C.1: Matched Sample Size

```
summary(est)

G0 G1
All      63 20
Matched 11 9
Unmatched 52 11
```

---

<sup>4</sup> The program implements the Coarsened Exact Matching (CEM) algorithm described in Stefano M. Iacus, Gary King, and Giuseppe Porro, "Matching for Causal Inference Without Balance Checking"

**Table C.2 Summary of Regression Model - Data Matched cem Method**

Treatment effect estimation for data:  
(Linear regression model estimated on matched data only)

Coefficients:

	Estimate	Std. Error	t value	p-value
(Intercept)	12.3485988	0.2324106	53.1327	< 2.2e-16 ***
<b>viewshed</b>	<b>-0.0702465</b>	<b>0.2142539</b>	<b>-0.3279</b>	<b>0.747017</b>
age	-0.0082206	0.0028356	-2.8991	0.009982 **

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

After matching by the CEM method, comparability between the groups has improved (output not shown) in the smaller matched data set of 20 sales. Overall, matching has made the two groups (G0=no viz, G1=avg viz) more alike than not.

Table C.2 is the summary of the regression model built on the matched data set. Besides the viewshed variable, only one predictor (age) is included in this model to explain remaining variation because of the small sample size of the matched data.

Similar to the regression estimate obtained on the matched data by the optimal method (outlined in Panel B), Table C:2 shows the regression on the smaller matched data sample of 20 sales has brought back a strong indication that viewshed has no clearly identifiable relationship with sale price. The viewshed coefficient has a value of -7%, with a very large standard error of 21%. With this large sampling error, it can reasonably be concluded that the matched data does not refute the hypothesis of no relationship between price and viewshed.

---

## PAIRED SALES ANALYSIS

A common method of analysis by real estate valuers and consultants is the “Paired Sales” or “re-sales”.

The “Paired Sales” method involves the pairing of IDENTICAL sales in every respect with the exception of characteristic under review. “Paired Sales” do not exist in the market place. The confusion by real estate analysts is the difference between the words “identical” and “similar”. Many consultants believe because they have similar sales that they are identical. Unfortunately that is not the case. How consultants analyze similar sales is to make ad hoc adjustments (based upon no evidence) to the data with respect to differences between the paired similar sales to the property characteristic in question. This is a common strategy when trying to group sales that are near or adjacent to wind farms and those that are not. The difficulty with this strategy is that it is subjective in nature, and often very difficult to reproduce.

A closer data match would be “re-sales” that have occurred over a period of time. Thus to measure the effect of wind turbines on real estate values, one should be able to decipher from the “re-sales” the difference in sale prices and the “re-sale” price.

Some “re-sales” of the same property were noted in the data compiled for this analysis. 14 examples of “re-sale” sales were identified for an independent analysis, as shown below. With a view to respecting the rights to privacy of the property owners, and to maintain the confidentiality of purchase price information, the specific property addresses have not been identified. Full details have been retained in the author’s files as required by the Appraisal Institute of Canada, and should they be required for court testimony.

ADDRESS	DATE OF SALE	SALE PRICE	IN THE VIEWSHED	PRICE DIFFERENTIAL
Property A	2008/05	96000	Yes	+\$7,000
Property A1	2003/08	89000		
Property B	2009/02	124000	Yes	+\$41,500
Property B1	2003/05	82500		
Property C	2008/08	79000	Yes	-\$6,000
Property C1	2006/10	85000		

# Wind Farm Study – Effect on Real Estate Values in the Municipality of Chatham-Kent, Ontario

Property D	2007/08	174000	Yes	+29,000
Property D1	2005/03	145000		
Property E	2008/05	99500	Yes	+\$9,500
Property E1	2004/05	90000		
Property F	2007/12	131000	Yes	-\$4,000
Property F1	2005/06	135000		
Property G	2008/04	152500	Yes	+\$12,500
Property G1	2007/11	140000		
Property H	2009/05	79900	Yes	-\$5,100
Property H1	2003/09	85000		
Property I	2009/05	70500	Yes	+\$6,500
Property I1	2007/01	64000		
Property J	2009/01	65000	Yes	-\$52,000
Property J1	2004/12	117000		
Property K	2007/03	95000	No	-\$15,000
Property K1	2005/04	110000		
Property L	2007/09	325000	Yes	+\$177,000
Property L1	2005/10	148000		
Property M	2007/05	200000	Yes	-\$95,000
Property M1	2005/04	295000		
Property N	2008/09	105000	Yes	+\$30,000
Property N1	2006/07	75000		

14 pairs of identical properties were found to have sold over the last 5 years. These were in fact re-sale of the same properties. Out of the 14 re-sales, 13 were re-sales that were in the viewshed and 1 re-sale outside of the viewshed. If the “re-sales” are taken at face value, there are 8 re-sales in which their values have increased over time and 6 that have shown a decrease in value. It is interesting to note that the sale that is not in the viewshed showed a decrease in value. Since the element of time is constant and had no effect on sale price, there had to be a reason for the differences in the sale prices within the “re-sales”. The interpretation of the “re-sales” has identified some of the reasons for the differences in the sale prices.

Property A sold in 2008 on the MLS®. At that time the home was in good condition and had some updates. There was no MLS® listing on the property when it sold in 2003. However, we did find a 2002 MLS® listing that indicated that the property had received some renovations. In other words, the change in the sale price levels between 2003 and 2005 was not due to a difference in the condition of the home. Everything else seemed identical. So what was the real cause of the increase in value?

Property B sold on the MLS® in 2003. It required updating and it was not in the same condition when it sold in 2009. This might explain the +\$41,500 increase between the sale dates 2003 and 2009.

Property C, when it sold in 2006 appeared to be in better condition then when it sold in 2008 at a loss. This could explain the price difference between the sale dates.

Property D revealed no MLS® listing when it sold in 2003. The 2008 MLS® sale indicated that the house was in good repair at the time of the sale. It is not known if there was any difference in the property between the two sale dates.

Property E sold in 2006 and 2008. On both MLS® listings of the property, it indicated that the property had not changed and was in good condition when sold each time. The cause for the property to increase in value by \$9,500 is not known.

Property F sold in 2005 and 2007. In both instances the home was in good repair yet it sold for a loss. The rationale for the loss is unknown.

Property G sold in 2007 and 2008. The 2007 sale indicated that the home needed some work. The 2008 sale reflected the improvements made to the property that is why it sold for a profit.

Property H sold in 2003 and in then in 2009 for a loss. Each of the MLS® listings indicated the home was in average condition and no changes had been made to the home. The rationale for loss in value is not known.

Property I sold in 2007 and again in 2009 for an increase of \$6,500. When the property sold in 2007 it had some updates and was in a good state of repair. When it sold in 2009, it sold in “as is” condition which suggests some type of a problem. However, it sold at an increased price in 2009.

Property J sold with a loss of \$53,000 between 2004 and 2009. There was no 2004 MLS® listing for this property, but there was an expired 2006 listing. According to the 2006 MLS® listing the home appeared to be in average condition. However, when it sold in 2009 the MLS® listing reports the house being sold “as is” condition which suggests some type of an issue. This could explain a large portion of the loss.

Property K, which was just outside of the viewshed, sold in 2005 and in 2007 for a loss of \$15,000. A review of both MLS® listings at the time of these sales, disclosed no evidence of any changes to the property. There is no rationale as to why the property sold for less in 2007.

Property L sold in 2005 and 2007 for an increase of \$177,000. The MLS® indicates that the home had been substantially updated at the time of the 2007.

Property M sold in April 2005 for \$295,000 and resold in May 2007 for \$200,000. This appears to indicate a loss of \$95,000. When this property sold in April 2005 it sold under a power of sale and in “as is” condition. When it sold in May 2007 it had a new septic system and was in average condition. The difference in the selling prices between the dates was the result that a lot had been severed off the property after the purchase in 2005. The original lot size of the property in April 2005 was larger than when it sold in May 2007. Thus the price differential was the result of the lot size difference and is not related to the wind turbines.

Property N sold in 2006 and in 2008 for a profit of \$30,000. There was no MLS® listing found when it sold in 2006 and the 2008 listing basically showed that it was in average condition. There is no rationale as to why this property sold at an increased price.

Even using “re-sales” as a point of entry in determining the impact of wind farms on property values does not show any casual relationship. With the “re-sales” that were found in the data set, there was more evidence on the outset that property values have increased despite the existence of wind farms. Yet in many instances there was no explanation of why these “re-sales” increased or decreased in value.

The problem of using “Paired Sales” or even “re-sales” as a model for determining the effect on real estate of a given property characteristic is very simple. These types of analysis cannot hold these physical differences between properties constant. In order to understand what groups of data are telling us we need to code the data. The “re-sales” “Paired Sales” methods do not allow for any coding nor do they allow for any levels of measurement.



Discussions with the realtors, buyers and sellers involve tend to be bias and skews results. A tool is required that is capable of holding constant all the variables, is capable of categorizing the variables, and finally, is capable of labeling the characteristics that impede on value.

The only real estate model that can actually hold constant all the variables that interact on price in a given real estate market place is Multiple Regression Analysis. This is the basis of this analysis and the authors have made every attempt to draw any inference, negative or positive, from the data procured from the marketplace as to the relationship of wind turbines and the sale price of nearby rural residential properties.



## **SUMMARY AND CONCLUSION**

Sales prices of property in a given area provide the best source of evidence to establish market value. In attempting to establish the extent of a specific influence on the value of real estate, the available data must be divided and analysed into two groups; those exposed to the influence and those not. In the case of wind farms, it is appropriate to group the available sales data into those within the viewshed of the wind farms and those not.

When residential properties within a viewshed (viewshed group) are compared to those not in a viewshed (control group), there will be differences in selling prices between the two groups that are not related to the wind farms. The authors adopted a basic regression modeling in attempting to rationalize these differences as it allows for the introduction of multiple variables.

An initial exploratory analysis helps to demonstrate that point. On page 41 there is a visual presentation of the average sale prices of data within the “control group” and the “viewshed” group. This graph shows a 7.5% decrease between the average sale prices of each group. On the initial examination it would appear that sales located in the “viewshed” sold “on average” 7.5% lower. It would be wrong to assume that the -7.5% is the result of the wind turbines because the average sale price from each group represents the unexplained functions of all the variables.

Through a review of the MLS® data sheets and other records, as well as ground proofing inspections, the variables were identified and placed into the spreadsheet for regression modeling. These variables include such features as lot size, location, garage, basement finish, house condition, age etc. These variables can help to explain the differences in the selling prices of the dataset to allow for a more probative focus on the influence of the wind farms on those property sales within the viewshed.

The initial regression run showed that the variable “viewshed” returned a negative coefficient of 13%. In regression analysis, a coefficient or value will always be returned in the results. The quantum of the result indicates whether or not the coefficient is statistically significant. In this application, the “viewshed” variable returned, what is commonly referred to as a “Standard Error”, that could be inferred to be fairly wide. The word “Error” may be misleading to some, in that it is not really an error. The error in the sampling is the

difference between the data drawn and the total data population. In this case the total population of data is really hypothetical since the “Error” is the calculation of the fact that one is working with a sample not the entire population. There will always be some difference. In the case of the Standard Error in this analysis, it was .059 or 6.0%. Thus the 13% negative coefficient could have returned a value between -19% and -7% which is a very wide spread. It was also noted that the “T” value which measures statistical strength was a -2 which really signifies the weakness of the returned coefficient of -13%. In our opinion, this suggests that there was no consistency in this -13% coefficient being generated by the regression model.

Our exploratory data analysis was not limited to regression modeling on the whole data set. Since we know there are differences between the rural residential sales of each group we were able to segregate the data into closely matched datasets taken from each group. Once they were separated into like datasets, regression analysis could be re-applied to these smaller but more like sales to determine the effect of wind turbines on property values. On page 49 of the report there are four graphs. On the left side of the page are graphs (lower and upper) showing the Raw Treated and Raw Control groupings of data. By matching these sales from the data set as shown on the right side of the page (matched Treated and Control groups) we were able to create a fairly close match or analysis.

The output of the regression modeling on page 47 of the matched data sets using the “optimal” method returned a -9.0% coefficient for the variable “viewshed” with a high standard of error and a very low T value. This suggests that the coefficient returned by this regression run is not statistically significant.

We then extended the matching analysis to include the “CEM” method. The “CEM” method segregates data from two groups using a different technique than the “optimal” method. It must be remembered that both the “CEM” and the “Optimal” method does not consider sale price as a matching variable. The regression run using the “CEM” method is shown on page 52. Once again, a -7% coefficient is found for the variable “viewshed” returned by this model. The “Error” was very wide and the T value was extremely low. The conclusion is that the coefficient that “viewshed” returned is not deemed to be statistically significant.

The last considered approach was to take raw data in the form of paired sales. These paired sales were taken from the data inputs. This data set is located on page 54 of the report. Our examination of this data set was simply to determine the price differences of the same properties regardless of whether or not the residual price was negative or positive. By

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simply viewing the raw data without any formal analysis, no relationship could be determined between the presence of wind turbines and rural residential properties.

It is of paramount importance to note that any diminution in market value may be as a result of influences other than wind turbines. For example, a vendor may be motivated to accept a price lower than expected or even lower than their own earlier purchase price. Such motivations may be due to job loss, corporate transfer with employer compensation for price loss, ill health, old age or death.

The three regression models in this study returned a similar negative coefficient for the variable “viewshed” supported by a wide Standard Error and low T scores that clearly show that those coefficient results could not be relied upon as being statistically significant. It could not be said that rural residential houses located in a viewshed sold for lower prices.

## RECOMMENDATIONS FOR FUTURE STUDIES

The study of wind farms and their effect on property values is, and will likely continue to be a subject of debate for many years. Central to any future studies will be the methodology chosen for such a task. As pointed out earlier, the analytical options are limited. Furthermore, the real estate market is not perfect. It is comprised of individuals who hold differing ideals and objectives.

The motivations for buying and selling can vary significantly and can be influenced by numerous factors including, but not limited to financial capabilities, family criteria influences including physical and health limitations, employment etc. It can also be influenced by external factors such as the number of competing listings of properties available for sale, the price of gasoline vis-à-vis travelling distances, and prevailing economic conditions. As a result the data available for analysis will be imperfect, resulting in unpredictable differences and conclusions. Seeking perfection in analytical results can be an elusive and perhaps unattainable objective.

Most competent analysts will acknowledge that a large volume of well researched data, when properly analysed, is more likely to produce a more reliable result than a small selection of data. The commonly used “paired sales” analysis relies on only a few observations and frequently adopts “ad hoc” methods of rationalizing variances. This technique has been used since the 1930’s in real estate appraisal practice and can often be proven to be unreliable by rendering biased results due to flawed adjustments and insufficient support. It is for this reason that a “paired sales” analysis, using only a few

sales transactions, that are unlikely to be ideally comparable, is a statistically inferior approach.

Some studies on wind farm influences to date have relied exclusively on interviews of area residents. Such interview formats as a basis by reaching a conclusion can be misleading for several reasons. Bias can be built in by the way the questions to be asked are framed. The questions asked are rarely if ever presented with the results for review. The answers given by the respondents may not be truthful for a variety of reasons. Interview format studies are not evidence, they are unsubstantiated opinions, and as such are not empirical or reliable.

The authors believe that the Multiple Regression Analysis technique is the preferred choice in the analysis of data for several reasons. It utilizes a large volume of market derived observational data, and is capable of minimizing the element of bias. MRA can extract a detailed view of the primary influencing variables on price and examined them on a micro level (assuming the data is available).

In future studies of the overall impact of wind farms on nearby property values, the many variables having independent influences must be carefully grouped for analysis. In addition to the usual adjustment for property differences, the following areas are suggested for possible groupings for analysis:

- the distance to a wind turbine;
- the number of visible turbines;
- angle/direction of visibility;
- the influence of visibility of a hilly terrain or bush cover;
- noise measurements at different times of the day;
- noise measurements under different wind conditions;
- the influence of vibrations;
- volume of competing listings of properties available for sale;
- length of exposure time prior to consummation of a sale; and
- the time of year.

Although distance is an important element that needs to be incorporated in any future design program, it must be carefully related to the other influences. If a negative effect becomes evident, then it may be necessary to study the distance at which the impact is no longer measurable. An attempt was made in this study modeling by incorporation this

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variable into the MRA equation. There was an insufficient volume of sales in order to provide any concrete evidence as to the distance of influence on property prices.

The mandatory minimum noise set back distance, based on the new Ontario guideline from wind turbines to the closest Point of Reception (neighbouring house), is 550 meters. This new set back distance may differ with set backs in other locales. The present suggested setback distance was arbitrarily determined. Absent concrete data gleaned from the market place in terms of the minimal distance of influence (if there is one) it seems unreasonable to some developers that increased boundary lines be set.

A more detailed scoring system to encompass the subtle differences may be required. The site inspection of the sale properties disclosed varying degrees of influence. For example; some had visible views of wind turbines from the driveway and others only from the rear yard. Some had views of wind turbines only when approaching or leaving a property. Some properties were proximate to wind turbines but they were not visible or audible as they were separated by trees. These subtle differences may play a role in analyzing the effect of wind farms on property values. Close proximity to a wind farm development may be a factor, but in future studies the criterion used for scoring the degree of influence requires careful consideration.

If turbine noise is deemed to be a factor to be scored, the relationship of the prevailing winds to the nearby properties may also have to be taken into account. The relationship of wind speed to turbine noise may also need study. Future studies may require mapping the sound measurement results within the viewshed of the wind farms located within the area under study. Wind turbine attributes may also need to be considered in the future.

At a public hearing attended by the authors, a neighbouring complainant suggested that vibrations from the turbines were bothersome. If vibrations are found to be a factor to be analysed, the nature of the subsoil conditions may have to be considered for their influence on the transmission of the vibrations. A clayey subsoil material may have a different influence on the transmission of vibrations than say bedrock.

The proximity of a wind farm development to a property sale may show improvement by using a more comprehensive scoring system, but its reliability is ultimately base in the volume of supporting market driven data.



When a sale property near a wind farm is consummated, an important question in future studies may be the volume of available competing listings of a similar nature, and their influence on the buyer's decision. Were there a number of listings available to the buyer at the time of the sale within the area of the viewshed, and what influence might they have had on the sale price?

In future wind farm studies specific attention to the influence on the price paid by a buyer of the length of time the property was exposed for sale on the market may be required. The exposure/listing times of the sale properties may need to be examined in the sales groupings, both in and out of the viewshed. As noted earlier in this report, there are many factors that can influence the length of marketing exposure. It may be necessary to consider these factors and determine, if possible, if a lower selling price was related to any specific factor or simply if the property became "stale" on the market. Extended listing times can lead buyers to perceptions of problems that may not exist.

The sale date of the property within the viewshed relative to the time of the year may be worthy of further study. During the summer months property owners and buyers are more mobile or spend more time out of doors. During winter months there can be less tree foliage making the turbines more visible, yet there may be less emphasis on surroundings and a greater focus on other amenities that a given property offers. An analysis to consider if buyers are more sensitive to wind farms during different periods in a given year may be worthy of consideration.

### **APPLICABILITY OF STUDY RESULTS TO OTHER REGIONS**

This study focused only on the influence of wind farm development along the north shore of Lake Erie in the Chatham-Kent area of Ontario. The study results derived from market evidence in this area may not be relevant to other regions of Ontario or Canada. Differences may arise due to variations in:

- socio-economic influences
- Wind directions
- subsoil conditions
- tower heights
- turbine models

turbine age  
volume of competing listing of properties available for sale  
jurisdictional set back requirements from property lines or neighbouring properties  
area topography  
tree lines and bush lots

As a result of differences in some of these variables there may well be dissimilar study results. Caution should be used before suggesting that similar results would be found in other areas.

## **CONTINGENT AND LIMITING CONDITIONS**

1. This consulting report is not valid unless original signatures are evident.
2. It is assumed that the market considers the sub-soil as good and acceptable. No responsibility has been assumed for the requirements of government, public or private bodies.
3. The presence of any potentially hazardous materials on the properties studied was not apparent or evident during the property inspection. Unless expressly noted, no on-site soil investigation has been undertaken on behalf of the authors, nor are they aware of any test results obtained in the past by others. Unless stated otherwise, the authors assume there are no unusual subsoil conditions or hazardous waste contaminants, which would adversely affect any future use of these sites, or adversely impact on the health of occupants, and no warranty or representation is made as to the environmental integrity of the subject parcels. We are not qualified to detect the existence of such substances.
4. All data used and described herein whether provided for this appraisal or obtained in the market place is assumed to be correct and reliable.
5. Property rights being studied are those of the “Fee Simple” interest. The authors assume no responsibility for matters, which are legal in character. The legal description is assumed to be correct.
6. The authors are not required to give testimony or attendance in court by reason of the appraisal, with reference to this study or the properties analysed therein, unless arrangements have been made previously.
7. Maps, plans, and surveys, etc. that may be in this report are included to assist the reader in visualizing the information and are not warranted as to their accuracy.
8. It is assumed that the properties comply in all material respects with all the requirements of law, including zoning, land classification, building, planning, fire and health by-laws, rules, regulations, orders, Acts and codes of all federal, provincial, regional, and municipal governmental authorities having jurisdiction with respect thereto.



9. It is assumed that, save and except for encumbrances as may be permitted, and explained in this report, there are no easements, rights-of-way, building restrictions or other restrictions so affecting the properties referenced herein as to prevent or adversely affect their operation or so as to materially and adversely affect market value.

10. This report has been prepared on behalf of the Canadian Wind Energy Association. No other third party may rely on this report unless they receive written permission by the study authors. Any liability from unauthorized use is strictly denied. The authors of this report, George Canning and Canning Consultants Inc. and L. John Simmons and John Simmons Realty Services Ltd., accept no warranties, expressed or implied, with respect to the use or interpretation of this report by any third party. Any questions related to this report should be directed to the Canadian Wind Energy Association.

## CERTIFICATION

**RE: WIND FARM STUDY – IMPACT ON REAL ESTATE VALUES**

We certify that to the best of our knowledge and belief:

- The statements of fact contained in this report are true and correct.
- The reported analyses, opinions and conclusions are limited only by the reported assumptions and limiting conditions, and are our personal, impartial, and unbiased professional analyses, opinions and conclusions.
- We have no present or prospective interest in the parcels that are the subject of this report, and have no personal interest with respect to the parties involved.
- We have no bias with respect to the properties that are the subject of this report or to the parties involved with this assignment.
- Our engagement in and compensation for this assignment were not contingent upon developing or reporting of predetermined results, the amount of the value estimates, or a conclusion favouring the client.
- Our analyses, opinions, and conclusions were developed, and this Consulting Report has been prepared, in conformity with the *Canadian Uniform Standards of Professional Appraisal Practice*. The Appraisal Institute of Canada retains the right to review this report.
- We have the knowledge and experience to complete the assignment competently.
- As of the date of this report both, L. J. (John) Simmons, AACI and George Canning, AACI, have fulfilled the requirements of The Appraisal Institute of Canada Mandatory Recertification Program for designated members.
- The undersigned inspected the properties identified herein on various dates in the months of May and June 2009.

By reason of our investigation and by virtue of our experience, we have been able to form and have formed the opinions set out in this report.

Using the time period June 2009, the estimated impact on the property values, as analysed herein simply states that: No empirical evidence can be drawn from the Chatham-Kent market place to suggest that wind turbines have a negative effect on the sale prices of rural residential properties

By reason of our investigation and by virtue of our experience, we have been able to complete a Consulting Report setting out opinions and property sales evidence to assist the addressee herein in considering the impacts on certain property values. This report should **not** be construed as an appraisal report setting out an opinion of Market Value, and should **not** be relied upon by others for any reason except as provided for herein.

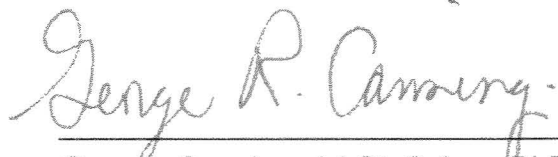
The findings set out in this report are subject to the Critical and Extraordinary Assumptions, as well as the usual limiting conditions and underlying assumptions as outlined herein. The authors reserve the right to revise the opinions in light of any facts and conditions that become known subsequent to the date of this report, which have an impact on the conclusions reached.

**John Simmons Realty Services Ltd.**



L. J. (John) Simmons, AACI, FRI, CMR, PLE  
Dated: February 4, 2010

**Canning Consultants Inc.**



George Canning, AACI, P.App, PLE  
Dated: February 4, 2010

**ADDENDUM “A” – PRIVACY STATEMENT**

## PRIVACY STATEMENT

**John Simmons Realty Services Ltd.** and **Canning Consultants Inc** have privacy policies in accord with legislation as it affects the **Personal Information Protection and Electronic Documents Act (PIPEDA)**. In general, the firms deal with the collection, use, and distribution of commercial rather than personal information. In the event that personal or sensitive data may be required to properly complete an assignment, the policies recognizes that consent is required for information that:

1. permits someone to learn sensitive, private information;
2. relates to a natural person; and
3. permits the identification of that person.

In accord with corporate policy, therefore, information provided by our clients will be used, secured and maintained based on criteria which include:

limited use, only the data needed to complete the assignment is required.

obtaining consent with respect to use of sensitive personal information about an identifiable individual (does not include the name, title, business address, or telephone number of an employee of an organization).

non-disclosure of files, (subject to Law, or review by authorized representative of **Appraisal Institute of Canada**, the Courts, Provincial or Federal agencies that have appropriate jurisdiction).

the use of facts in the public domain as part of the appraisal process.

information retained in our database that is relevant only to the subject property.

tight control in the production of reports, and distribution only as authorized by the Client.

**ADDENDUM “B” – AUTHORS QUALIFICATIONS**

### **CANNING CONSULTANTS, INC**

The firm has been in existence for seven years. Its principal, George Canning has been in the appraisal/real estate consulting business for 25 years and was a partner in one of the largest real estate firms in Southwestern Ontario. Recognizing that the needs of the clients were not being met by traditional valuation methodologies, this firm was organized to provide specialty consulting services. Solutions to complex real estate problems using modern techniques are now required to address those real estate issues that in the past could not be reliably solved.

Canning Consultants, Inc. is one of a very few fee based real estate consulting Companies that employs modern statistical methods and modeling tools with a common sense approach based upon many years of analyzing real estate.

### **George Canning, AACI, PAPP, PLE**

- 2006          Designated Ontario Land Economist.
  
- 2006          Received designation of DAC.
  
- 2005          Elected as Regional Director to the Association of the Appraisal Institute of Canada-Ontario.
  
- 2004          Wrote a long distance learning course for the American Institute of Appraisers on Quality Point-a Direct Comparison Approach to Value.
  
- 2004          Appointed to the Professional Development Committee for the Ontario Association of the Appraisal Institute of Canada-Ontario for a one year term.
  
- 2004          Appointed to the Professional Steering Committee for the Appraisal Institute of Canada to chart the future course of the industry.
  
- 2004          Guest speaker at the 2004 world joint AIC/USA Appraisal Conference to be held in Toronto, Ontario June 24-27, 2004.

- 2004 Guest Lecturer in Kingston on March 5, 2004. Quality Point Analysis, on behalf of the Appraisal Institute of Canada.
- 2003 Guest Lecturer in Hamilton November 7, 2003. Quality Point, Exploratory Data Analysis, and AMV, on behalf of the Appraisal Institute of Canada.
- 2003 Guest Lecturer in Ottawa November 21, 2003. Regression Analysis on behalf of the Appraisal Institute of Canada.
- 2002 to 2004 Elected to the Board of Directors-National Governing Council.
- 2002 Guest Lecturer in Ottawa, Ontario on the behalf of the Appraisal Institute of Canada. The topic is an Introduction to Regression Analysis and Qualitative and Quantitative Comparative Analysis.
- 2002 Guest Lecturer in Halifax, Ontario on the behalf of the Appraisal Institute of Canada. The topic is an Introduction to Regression Analysis and Qualitative and Quantitative Comparative Analysis.
- 2001 Contributed to a new text book on Real Estate Appraising through the University of British Columbia. The material is on Automatic Valuation Models.
- 2001 Guest Lecturer at Trent University on the behalf of the Appraisal Institute of Canada. The topic is about Qualitative and Quantitative Comparative Analysis.
- 2000 Teaching 'Introduction to Linear Regression' through Fanshawe College's London and Middlesex Continuing Education Course Program.
- 1999 Teaching 'Introduction to Linear Regression' through Fanshawe College's London and Middlesex Continuing Education Course Program.
- 1998-Pres Teaching 'Investing In Real Estate' through Fanshawe College's London and Middlesex Continuing Education Course Program.
- 1998 - Pres Associated Member of the London St. Thomas Real Estate Board



- 1997            Granted Professional Appraiser by the Appraisal Institute of Canada (P.App)
- 1997            National Investigations Committee for the Appraisal Institute of Canada (One  
Year Term)
- 1996 to 1998 Appointed Executive Director of the London Chapter of the Appraisal Institute  
of Canada
- 1994 to Present    Provincial Admissions Committee for CRA and AACI candidates  
(Appraisal Institute of Canada)
- 1988 to 1998 Certified Instructor for the Ontario Real Estate Association (Real Estate  
Appraisal Course)
- 1987            Granted AACI Designation (Accredited Appraiser Canadian Institute)
- 1983            Granted CRA Designation (Canadian Residential Appraiser)

#### **STUDIES & PUBLISHED ARTICLES**

The following list involved studies in which Regression analysis was used:

Studied the Effects of Potential Real Estate Loss on Housing in Cambridge, Ontario as a  
result of a Gas Spill.

Studied the Impact of Urea Formaldehyde on Residential Housing in London, Ontario.

Determine the Effect on Value over the Loss of On Site Parking of a Dental Building in  
London, Ontario.

Determined the Impact of the Loss of Front Yard Depth on Residential Housing for  
Expropriation in London, Ontario.

Determined the Impact of the Loss of Trees on Residential Housing for Expropriation in London, Ontario.

Determined the Impact of the Increase in Traffic Flow as a Result of the Taking of Land for Road Widening in London, Ontario.

Determined the Impact on Value of Subdivision Lots that Back onto Green Space in London, Ontario.

Determined the Impact of Underground Easements on Residential Property Values in London, Ontario.

Determined the Impact of Mutual Driveways on Residential Property Values in London, Ontario.

Determined the Contribution to Old Farm Buildings on Rural Property Values in South Western Ontario.

Contributed to summary results of the impact of tainted water on Walkerton, Ontario.

Determined the Impact of Property Values in Proximity to Garbage Dumps.

Determined the Loss in Value as a result of a new home being hit by an unattended semi trailer truck.

Determined the Impact on Value of Hydro Easements on Farm Properties in the Lambton County.

Determined the Change in Price Levels of Housings with Selling Prices between \$400,000 to \$600,000 in the City of London between 2001 and 2005.

Completed a province wide study in conjunction with the University of Waterloo on the impact of heritage designations of real property.

In addition,

Co-wrote courses on Data Analysis and Investigation presented through the AIC.

Co-wrote courses on Regression Analysis presented through the AIC.

Published articles include the “Impact on Hydro Lines” and a “20 Year Study of the Apartment Market in the City of London”. Other articles have been written for private organizations such as the Canadian Car Wash Association of Ontario and the Ontario Private Campground Association. The topics were valuing car washes, and valuing public recreational campgrounds.

An article was written for the Appraisal Institute of Canada on the “Contemporary Direct Comparison Approach to Value”. It was published in the Canadian Appraiser Fall 2000. It was recently published in “Readings in Real Estate”, Fourth Edition.

Based upon the application of the multiple regression technique, a major assessment appeal case was won regarding the valuation of many office buildings in London, Ontario. The result was a saving of \$1,000,000 in tax for the clients.

**L. JOHN SIMMONS, AACI, FRI, CMR, PLE**

**Memberships and Affiliations**

Accredited Member of the Appraisal Institute of Canada #723. (February 1969)

Fellow of the Real Estate Institute of Canada – Marketing. (January 1971)

Charter Member of the Association of Ontario Land Economists. (April 1970)

Active Member of the London & St. Thomas Real Estate Board. (April 1971)

Licensed Real Estate Broker. (April 1971)

Associate Member of the Canadian Association of Real Estate Boards.

Director of the St. Clair Region Conservation Foundation.

Past Regional Vice President of the Ontario Expropriation Association.

**Background**

Real Estate Appraisal Courses of the Appraisal Institute of Canada at Toronto 1963 to 1965.

Courses in Business Law, Sociology, Industrial Real Estate, at York University, 1967 to 1970.

Obtained Real Estate Sales Licence 1967. Broker since 1971.

Arbitration Courses I & II (AMIO) at University of Western Ontario 1996/97. Has acted as a sole arbitrator.

Past lecturer for Real Estate Appraisal courses at the University of Western Ontario on behalf of the Appraisal Institute of Canada.

Past Chairman and Director of the London & District Chapter of the Real Estate Institute of Canada.

Past member of AIC Professional Standards Investigating Committee.

Past Chairman of the London Chapter of the Appraisal Institute of Canada, 1986.

**L. John Simmons – Overview of Professional Experience**

Founder of the L. J. Simmons Group and its predecessor companies. President of John Simmons Realty Services Ltd. Has provided Real Estate Consulting and Fee Appraisal services continuously since 1962 for clients, including:

- Federal Government Departments and Corporations;
- Provincial Government Ministries, Departments, and Agencies;
- Various First Nation Councils;
- Power and Utility Corporations;
- Various Conservation Authorities;
- Counties, Cities, Towns, and other Municipal Corporations;
- Various Universities, and Boards of Education;
- Various National and International Corporations, Developers, Lawyers, Industries, Accountants; and
- Banks and financial and lending institutions.

Appraisal and Consulting services provided to the Corporation's clients have included the following:

- expert witness testimony before various courts, boards, and other tribunals;
- case analysis for damage, loss of use and injurious affection claims;
- valuation estimates for property purchase and sale;
- multi property land assembly projects;
- municipal redevelopment and rehabilitation projects;
- natural resource and recreational land valuations;
- utility corridors, right of way and flood easement acquisition and expropriation appraisals;
- subdivision of land;
- public and private institutional property valuations;
- senior citizens housing projects;
- feasibility studies and market analyses;
- investment analyses, benefit and cost studies;
- leasehold valuations and rental property analyses;
- assessment review;
- valuation estimates for relocation and mortgage financing;
- industrial and commercial property valuations;
- valuations of equipment, machinery and industrial assets;
- divorce and estate settlements; and
- property and fire insurance claim appraisals;
- forensic reviews of appraisal reports and purchase agreements; and
- structuring agreements of purchase and sale.

## **IBI GROUP**

### **ELECTRICAL ENERGY RELATED EXPERIENCE**

#### **Enbridge Wind Power Project**

In 2006, IBI Group was retained by Enbridge Ontario Wind Power L.P. to undertake land use planning approvals for the Kincardine Wind Farm that involved 120 wind turbines and the production of 181.5 Megawatts of power on 4,100 hectares of farm land located east of the Lake Huron shoreline. This undertaking involved preparing zoning by-law regulations, preparing background reports, and presenting at public meetings. As large scale wind farms are a relatively new land use throughout Ontario, community acceptance of the wind farms has been mixed. As a result, the Kincardine project was appealed to the Ontario Municipal Board for adjudication. For the Hearing, IBI Group undertook and was responsible for OMB Witness Statement, evidence preparation, individual turbine setback analysis, shadow flicker impact analysis, ice throw impact analysis, noise impact analysis, zoning by-law amendment revisions, emergency procedures, and dispute resolution protocol.

#### **Township of Malahide and Municipality of Bayham: Wind Energy Official Plan Policies**

The development of electrical wind energy systems is growing in southern Ontario. The prevailing winds along the Great Lakes shoreline are a natural resource with investment opportunity for commercial wind farm development. Wind farm development provides economic and tax benefits to the local municipality. IBI Group has researched wind generation systems for Council, municipal staff and community members of both the Township of Malahide and Municipality of Bayham, and developed Official Plan policies, Zoning regulations and Site Plan Agreements that meet community needs. These planning tools balance the environmental and economic benefits with potential site specific impacts of the turbine.

#### **Ontario Power Authority – Planning for Electrical Infrastructure: A Review of Selected Municipalities in Southern Ontario**

IBI Group was retained by the Ontario Power Authority (OPA) in November, 2008 to provide “The Services of An Urban Planner” within the following three streams of work:

Municipal Specific Infrastructure Siting Research;

Advice and Counsel in respect to urban planning issues; and

- Advice and Counsel in the development of a workshop aimed at improving the knowledge of municipal planners in respect to generic electricity infrastructure project siting.

Through a comprehensive evaluation of current Provincial, Regional and local policies and Zoning By-Laws, and planning approval processes, this report is intended to assist the OPA in identifying opportunities and constraints within the overall planning framework for developing a new cogeneration natural gas-fired electrical generation facility and possible transmission upgrades within Study Area 1 (Southwest Toronto, Southern Mississauga, Southeast Oakville) and Study Area 2 (Waterloo, Kitchener, Cambridge, Township of North Dumfries, Township of Woolwich, Guelph).

#### **North Dumfries Energy Centre: Peaking Power Generation Facility**

The North Dumfries Energy Centre site is located on Dundas Street South in the Township of North Dumfries. This project is being proposed by CPV Canada Development in attempt to address the increased load growth in the Region of Waterloo. IBI Group's responsibilities include the overall project management of the planning process and planning approvals including Amendment to the Township Official Plan, Amendment to the Township Zoning By-Law, and final Site Plan Approval. IBI Group's responsibilities also included planning and public consultation, on-site analysis with respect to site specific land use compatibility and good planning practices.

#### **Nanticoke Energy Centre: Combined Cycle Facility**

The Nanticoke Energy Centre site is located on Haldimand Road 55, north of the Nanticoke settlement area. This project is being proposed by CPV Canada Development in attempt to address the need for an additional supply of electricity, and a renewal of significant components of the province's electricity generation infrastructure. For this project, IBI Group's responsibilities include the overall project management of the planning process and planning approvals including Amendment to the County Official Plan, Amendment to the local Zoning By-Law, and final Site Plan Approval. IBI Group's responsibilities also included planning and public consultation as well as on-site analysis with respect to site specific land use compatibility and good planning practices.

**ADDENDUM “C” – REFERENCED STUDIES**



### Reports Reviewed

1. Noise Radiation from Wind Turbines Installed Near Homes: Effect on Health; Barbara J Frey, BA, MA, and Peter J Hadden, BSc, FRICS, Feb 2007
2. Poletti and Associates, Inc. January 2007 - A Real Estate Study of the Proposed White Oak Wind Energy Center, McLean and Woodford Counties, Illinois.
3. Bard College Study April 2006 Madison New York.
4. Land Value Impact of Wind Farm Development – Crookwell New South Wales (Australia); Henderson & Horning Pty Ltd. February 2006.
5. Impact of wind farms on the value of residential property and agricultural land; RICS survey.
6. Wind Turbines and Infrasound; Howe Castmeier Chapnik Limited, November 29, 2006.
7. Property Value Study: The Relationship of Windmill Development and Market Prices; Peter Bobechko, AACI, P. App, of Blake, Matlock and Marshall Ltd. September 2006.
8. Living with the Impact of Windmills. (Slide presentation) Chris Luxemburger, real estate agent with Sutton Group.
9. Impact of Wind Turbines on Market value of Texas Rural Land. (Slide presentation) Derry T. Gardner of Gardner Appraisal Group Inc. Feb 15, 2009.
10. Property Stigma – Just the latest Fashion : Wind Farms & House Prices in the UK; Sally Sims and Peter Dent (Oxford University) September 2007.
11. Modelling the impact of wind farms on house prices in the UK. Sally Sims & Peter Dent, December 2008.
12. The effect of Wind Development on Local Property Values. Renewable Energy Policy Project study; George Sterzinger, Frederic Beck and Damian Kostiuik. May 2003.

## **ADDENDUM “D” – ONTARIO GOVERNMENT DOCUMENTS**

**Documents Reviewed**

1. The Green Energy Act, 2009.
2. Noise Guidelines for Wind Farms: Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities. Ministry of the Environment, October 2008.
3. Noise Modelling Approach for On-Shore Wind Farms; June 2009.
4. Proposed content for Renewable Energy Approval Regulation under the Environmental Protection Act. June 9, 2009.