The impact of high voltage overhead power lines on the value of residential property in the United Kingdom

Sally C. Sims (2004)

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Abstract

This thesis investigates the impact of electricity distribution equipment on the value of residential units in the UK. This is a complex task, due to the potential influence on the market from the publics' perception of a perceived link between living in close proximity to high voltage overhead power lines (HVOTLs) and a number of adverse health effects.

A review of the literature revealed that no previous studies had been undertaken within the UK to establish the impact of HVOTLs on house prices and as such, identified a gap in knowledge within the UK and provided a focus for this thesis.

Due to a lack of available transaction data in England, investigating the impact on house price relies entirely on the use of qualitative research methods. Therefore to test the accuracy of the results from the perceptual study, a benchmark was developed using transaction data obtained from a residential housing estate in Blackwood, Scotland where a HVOTL was present.

The thesis begins with an overview of the current planning and development controls relating to the siting of electricity distribution equipment and the subsequent development of land near HVOTLs. A critical review of the literature is presented which, due to the perceived relationship between living near HVOTLs and a health risk, includes literature on other related areas, for instance, property stigma, risk analysis and scientific and epidemiological studies on the possible health effects.

A multimethod approach is adopted towards data gathering, using both qualitative and quantitative research paradigms. Buyers' and valuers' perceptions of the impact of a HVOTL on value are obtained using postal surveys and interviews. Additional information is gathered from the electricity utilities, residential developers and government planning departments.

Using a case study approach and a hedonic pricing methodology (to enable the relationship between a HVOTL and house price to be explored), selling price data and asking price data from three locations were gathered and analysed. Regression analysis established that a HVOTL near a residential unit does have an impact on house price, although this impact is not always negative.

The results from three case studies, the opinion surveys and the interviews are compared, indicating that opinion surveys may result in an underestimation of the impact of a HVOTL on selling price and, by contrast, appraisers may overestimate the negative impact of HVOTLs on asking price when marketing a house. The results suggest reliance on one method may prove misleading and therefore the use of a multimethod approach towards data collection may improve the reliability of findings.

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Abbreviations

APPRAISER	A person licensed to value property (land and buildings).
EASEMENT	This gives the electricity utility a legal right to site, access and maintain electricity distribution equipment on land owned by another party.
ELF	Extremely low frequency
EMFs	Electric and magnetic fields.
HVOTL	High voltage overhead transmission line.
IEGMP	Independent Expert Group on Mobile Phones 2000 (Stewart Report).
META ANALYSIS	Meta-analysis is a statistical method used to provide a single risk estimate from a summary of the results of a similar set of studies
MICROTESLA (μT)	Unit of measurement for magnetic fields.
NGC and NGC TRANSCO	National Grid Company now known as National Grid Transo.
NRC	National Research Council.
NRPB	National Radiological Protection Board.
PYLON	Metal lattice structure, which supports the high voltage line.
ROW	Power line 'Right of Way' a corridor of land where the HVOTL is sited in which building is prohibited.
TOWER	A term often used in the USA, Canada and New Zealand to describe a pylon.
TRANSMISSION LINES	High voltage overhead transmission line.
UK	United Kingdom.
USA	United States of America.
WAYLEAVE	A right to place equipment on land and cross over land for the purpose of maintenance in return for an annual payment of rent.

Chapter One

Introduction to the Research

1.0 INTRODUCTION

The presence of high voltage overhead power lines (HVOTLs) in proximity to residential homes has been the subject of periodic media attention since the mid 1980s, following the reported link between a number of adverse health effects, most notably cancer, and exposure to the electric and magnetic fields (EMFs) which are produced by electricity lines. This association remains unsubstantiated by scientific evidence and subsequently no legislation exists within the United Kingdom (UK) to restrict the development of land where HVOTLs are sited. The only limitation on new development has been statutory safety clearances, and as a result *"a large amount of residential development has been carried out ... beneath and adjacent to overhead lines."*[i]

Previous research has suggested that, due to the demand for new residential buildings, effects on value are often not apparent until homes come up for resale, when sellers have reportedly experienced difficultly in attracting buyers and are often forced to reduce the asking price to well below the market price of comparable units (Dent and Sims, 1999[1]; Rice and Maier, 1997[2]).

Determining the impact of detrimental conditions and environmental features such as electricity distribution equipment remains one of the more intractable aspects of property valuation. Research carried out in the past by McClelland (1990[3]), Chalmers and Roehr (1993[4]), Edelstein (1988[5]), Fischhoff (1985[6]), Mundy (1992[7]), Slovic (1987[8]; 1991[9]), Syms (1996a[10]), Gallimore and Jayne (1999[11]), Jayne (2000[12]) and Bell (1999[13]), has established that public perception of non-physical contamination such as visual, noise and odour pollution can be strong enough to influence the value and marketability of residential buildings, especially when there is an association with a possible health risk.

In 1996, the Royal Institution of Chartered Surveyors (RICS) introduced Practice Statement 3.7 to its *Appraisal and Valuation Manual* (the *Red Book* [ii]), instructing valuers that, whilst there was no clear evidence of a link between living near HVOTLs and a number of adverse health effects, *"...public perception may, however, affect marketability and future value of the property"* (RICS, 1995)[14]. This Practice Statement provided professional guidance to RICS members when

[i] National Grid Transco (formally National Grid Company) document 1997,'Planning and Amenity Aspects of High Voltage Transmission Lines and Substations' Development restrictions for HVOTLs, consist of the height of buildings and trees under lines and the availability of access to maintain and renew their equipment. Although the recommended minimum clearances are set out in their document, NGC prefer to make specific recommendations for each location (paragraph: 28). NG Transco will be referred to as NGC from this point forward.

[ii] The majority of residential valuations within the UK are undertaken by Chartered Surveyors who are also members of the RICS and as such, have a mandatory requirement to follow the guidance given by the Professional Practice Statements (PS) within the Red Book. Failure to comply would constitute a breach of the RICS byelaws and regulations. Valuers are further advised to follow the Guidance Notes (GN) as a matter of good professional practice.

undertaking the valuation of property near a HVOTL, however, no additional advice was provided to aid valuers when they determine the likely impact of negative public perception on house price. This Practice Statement has been omitted from the latest edition of the Red Book (May 2003) and advise valuers on the potential impact of HVOTLs has since been included in the Guidance Note 'Contamination and Environmental Matters' (Dec 2003: 4.6). This suggests that, "If, when a valuation is carried out, there is a cause for concern over the strength of a field, an appropriate specialitst or chartered environmental surveyor should be consulted." However, unlike P.S. 3.7, this Guidance Note does not impose a duty on valuers when surveying this type of property, to instruct clients that HVOTLs may affect future value due to negative public perception.

Since the 1950s,[iii] Research aimed at establishing the impact of HVOTLs on the value of residential homes has been conducted in the USA, Canada and, to a lesser degree, New Zealand and have either investigated the impacts on value by analysing transaction data, or investigated the opinions, attitudes and perceptions of market participants (Reese, 1967[15]; Kinnard, 1967[16]; Colwell, 1990[17]; Freidrickson *et al,* 1982[18]; Boyer, 1976[19]; Callanan and Hargreaves, 1995[20]; Delaney and Timmins, 1992[21]; Hamilton and Schwann, 1995[22]). Valuation studies using transaction data and a robust methodology such as econometric modelling or regression analysis, appear to indicate a general reduction in selling price of between 2% – 10%, although a pylon could have an even greater negative impact reducing selling price by up to 27% (Bond and Hopkins, 2000[23]).

By comparison, due to the lack of available transaction data, research within the UK has focused almost exclusively on public and professional attitudes towards distribution equipment, to the exclusion of more quantitative research, and found that they were generally negative towards the presence of HVOTLs near residential buildings (Gallimore and Jayne[11]; Jayne[12]). Only one study (Dent and Sims[1]), attempted to establish whether or not negative perceptions translated into lower values or longer marketing periods, by using a hypothetical valuation[iv] to establish the likely impact on the value of residential buildings. This suggested that the presence of an overhead line could reduce value by between 5% and 11% and that a pylon had an even greater impact, reducing value by as much as 50%.

Whilst it is normal practice within the UK for valuers to keep records of property appraisals

[iii] No published research appears before this date.

[iv] To establish the potential effect on value (as there is no national or regional data base of house sales to analyse actual sales figures), 120 Estate Agents in the West Midlands area were asked to participate in a hypothetical valuation. Valuers and agents were asked to revalue a 4 bedroom house on an estate valued at £97,000 with the inclusion of a substation, an overhead power line, a pylon and an underground power line (Dent and Sims 1999[1])

undertaken by their company (RICS Appraisal and Valuation Manual 1996[14]), this information is not readily available to property researchers for analysis. As a result, professional decisions and advice rely on the existence of individual company transaction data, in addition to the valuers' personal experiences and perceptions of the market (rather than empirical evidence), and are influenced by company and institutional policy (e.g. lending institutions) and attitudes towards this issue. Transaction data in the public domain are either difficult to obtain and have, until very recently (after the data for this thesis were collected), been prohibitively expensive from the Land Registry (Daly),[24] or not property-specific, either referring to the mean value of similar property within a specific location (Halifax Regional House Price Index) or to property tax bands which are too wide to allow for variations in value as a result of negative externalities to be apparent (Syms[10]). The lack of data has left valuers without a benchmark for valuing property in close proximity to HVOTLs. In addition, planners and developers have inadequate information to help minimise any possible negative impacts on value through careful design, and buyers currently have little or no information to enable them to make an informed decision when considering the purchase of this type of property.

The primary aim of this doctoral thesis therefore, is to establish the likely impact of electricity distribution equipment on the value of proximate residential buildings within the UK using a multimethod strategy, adopting both research paradigms (qualitative and quantitative) to gather and analyse data for this research. Brewer and Hunter[25] state that by focussing in on the problem "... *from different methodological viewpoints...*" a more robust conclusion can be drawn, thus aiding the development of a benchmark to provide guidance for the valuation of HVOTL-proximate residential buildings in the future.

This chapter provides an introduction to the research area; section 1.1 describes the legislation and planning process in relation to the siting of electricity distribution equipment and the subsequent development of the land for residential use. Section 1.2 briefly explains the basis for the valuation of residential property and introduces the concept of stigma damage. Section 1.3 sets out the current legal position regarding issues of compensation for both loss of property value and ill-health allegedly caused by exposure to electric and magnetic fields from electricity distribution equipment. The implications for the UK property market are discussed in section 1.4 and finally the purpose and intended benefits of this thesis are stated in section 1.5.

1.1 PLANNING AND DEVELOPMENT CONTROLS FOR THE SITING OF ELECTRICITY DISTRIBUTION EQUIPMENT

Electricity distribution equipment is owned and operated by a number of companies collectively known as the electricity utility. Electricity is generated at power stations and distributed around the country via a network of high voltage electricity (transmission) lines owned by National Grid Transco (formally known as National Grid Company [NGC]). This transmission system operates at 400kV and 275kV and is known as the 'national grid'. Regional electricity companies (e.g. Power Gen) then distribute electricity locally, at progressively lower voltages to homes and businesses. The type of electricity distribution equipment normally found within residential areas consists of high voltage overhead electricity lines, 275kV, 132kV and occasionally 400kV lines; supporting pylons, no more than 15 metres high[v] (sometimes referred to as towers, see footnote V for a clearer explanation of the terminology used in this thesis in relation to high voltage overhead power lines and pylons); high voltage underground lines and substations (one to every 200 houses) which reduce the voltage down usually from either 275kV (275,000volts) or 132kV (132,000volts) to around 11kV for local use either in homes or businesses.

1.1.1. Planning Policy

Planning policy in relation to the siting of electricity distribution equipment within the UK and the subsequent development of this type of land are dependent upon two factors; health and safety legislation and, since HVOTLs produce EMFs, safe EMF exposure levels.[vi] The National Radiological Protection Board (NRPB) who is responsible for advising the Government and the electricity utility on safe exposure levels (see Appendix I), has stated that, the existing scientific evidence has not provided conclusive evidence of a link between living near HVOTLs and a number of adverse health effects. As a consequence, there are no statutory regulations in place to restrict public exposure to EMFs produced by HVOTLs.[vii]

1.1.2 Land Use Following the Siting of Electricity Distribution Equipment

When constructing high voltage power lines (underground or overhead), the electricity utility attempts to ensure that its equipment has a minimum impact on the surrounding environment. (Appendix II) Lines are normally sited before land is developed for residential use and whilst the NGC owns the land occupied by its substations, neither it, nor the electricity utilities, own the land

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[v] For ease of reading, the term high voltage overhead power line and the supporting pylon will be referred to collectively as HVOTL. Although this is not technically correct, it is not possible to have an overhead line without a structure to support it. Therefore one may assume that where there is an HVOTL there is also a pylon. Where relevant to the text, a distinction will be made between the two by referring specifically to either line or pylon.

[vi] The electric and magnetic fields (EMFs) have been associated, in the media, with a number of adverse health effects, including childhood leukaemia. These health risks are unsubstantiated by scientific research.

[vii] NGC is a statutory undertaker under the Town and Country Planning (General Permitted Development) Order 1995 and therefore has certain rights to carry out development without the need for planning permission from the local planning authority. However, for NGC to construct a new line, permission under section 37 of the Electricity Act 1989 is required from the Secretary of State for Trade and Industry.

crossed by its electricity lines, except in rare circumstances.
Lines will have been "*...constructed pursuant to wayleave*[viii] *agreements or permanent easements...*"[ix] and subsequently the utility will only have rights under the terms of its easement. By comparison, large industrial sites generally require their own high voltage electricity supply and often have a distribution line specifically installed to supply their individual needs.

1.1.3 Development Restrictions

Whilst it is not possible to develop land above high voltage underground cables "*...as access is required for maintenance and repair...*"(NGC, 1997),[x] the same constraints do not apply to land under HVOTLs and therefore the only restriction the electricity utility is able to place on the development of such land relate to health and safety regulations.

Other than statutory safety clearances designed to limit the height of buildings beneath HVOTLs, there is no legislation or planning guidance to restrict the development of land underneath lines. As a consequence, local planning authorities generally have little reason to refuse planning permission. Although on occasion, planning permission has been refused for a residential development "*on the grounds that the power lines above might be detrimental to the health of the residents*" (Rice and Maier, 1997[2]). For instance, in 1994, planning permission was refused, on the grounds of potential health risks, for the development of several bungalows at Mold in Wales, (see Figure 1-1). The decision was overturned on appeal and the bungalows were subsequently built. However, due to the alleged reluctance of potential buyers towards purchasing a bungalow under the HVOTL, the development remained unfinished for 12

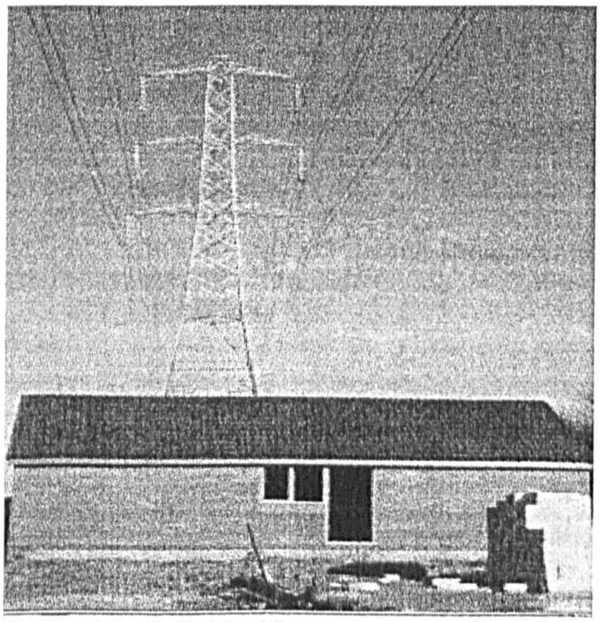


Figure 1-1: Unfinished Development in Mold, Wales

[viii] A wayleave is 'an agreement granted by the owner or occupier of land whereby transmission equipment is permitted to be installed on, over or under the land so owned or occupied in return for annual payments' NGC

[ix] A permanent easement (also known as a deed of grant) is "*a legal right in perpetuity (for ever) to NGC to install and keep installed an electric line on, under or over land and to have access to the land for inspecting, maintaining, adjusting, repairing, altering, replacing or removing the line. It may also restrict development or other works which could interfere with the right.*" National Grid Document Planning and amenity aspects of high voltage transmission lines and substations: Information for planning authorities and developers: 1997 edition, paragraph 27.

[x] NGC, *ibid.*

months despite a fairly buoyant market.

Other development companies have paid to have lines and pylons removed and replaced out of sight[x]. For example, Bellway Homes and English Partnerships arranged for 13 pylons and over 10 miles of line to be placed underground at a cost of £3million prior to a development at Barking Reach (*ibid*).

1.1.4 Planning Policy and New Residential Development

The revision of Planning Policy Guidance Note 3 (2000) has ensured that *"...planning authorities must in future give preference to recycling previously developed sites and empty properties. Brownfield first, greenfield last"* (The Deputy Prime Minister, John Prescott's statement to Parliament 1998, and July 2002[26]). Four key factors have been identified which, in addition to population growth, have contributed towards an increased amount of residential development taking place on land where HVOTLs are sited.

1. A decline in manufacturing industry over the last two decades has resulted in large, derelict and often contaminated 'brownfield' sites in and around many major city centres. Since their electricity demands were frequently high, they were often supplied with high voltage electricity (400kV), fed to them via overhead lines. The cost of removing and rerouting these lines, prior to redevelopment, is often prohibitive[xi] and undergrounding lines results in very large terminal towers (these are larger and more visually intrusive than normal pylons) where lines go underground and then resurface (NGC 2003[27]).

2. The development of green-field land has been severely discouraged by a sequential approach to halt urban sprawl (PPG3[28]). Therefore, land on the edge of existing residential developments, where power lines are often sited, is seen as an ideal location to extend existing residential estates, especially since much of the supporting infrastructure is already in place.

3. The demand for new residential property has dramatically increased over recent years; the government's target is to increase the number of households by 4.4 million by the year 2021 (71% will be one person households). The government has placed great emphasis on the re-use of inner city land for a large percentage of new development and has stated that, "*in order to achieve a 60% target for new housing on brownfield sites by 2008, the guidance requires planning authorities to*

[xi] No exact figures are available from NGC. However according to PowerGen, it costs around twice as much to underground an 11kV cable as it does to site above ground on wooden poles. To place a 132kV line underground is approximately 4 to 5 times more expensive than siting overhead on metal pylons. Based on this information it is likely that a 275kV or a 400kV cable would be considerably more expensive to site underground (see Appendix 9 Interview no. 31).

follow an urban capacity study and undertake a search sequence starting with the re-use of land in urban areas. Greenfield sites should only then be considered where they form urban extensions" (*ibid*).

4. Not only has PPG3 influenced the type of land used for residential development but it has also influenced the way in which residential schemes are designed and built. A spokesperson from NGC suggests that new planning constraints imposed by PPG3 may be responsible for the change in the way land crossed by HVOTLs is developed, as builders are now required to include a 'shopping list' of requirements such as, social housing, different housing types, specific numbers of parking spaces, green spaces and specific housing density (this is currently being overhauled to increase the number of properties built per hectare)[76].

1.2 RESIDENTIAL PROPERTY VALUATION

The Royal Institution of Chartered Surveyors states that, "*evidence of actual transactions is at the heart of the formulation of valuation figures, as it provides the Valuer with hard facts quite independent of his own opinion*"(RICS)[29].

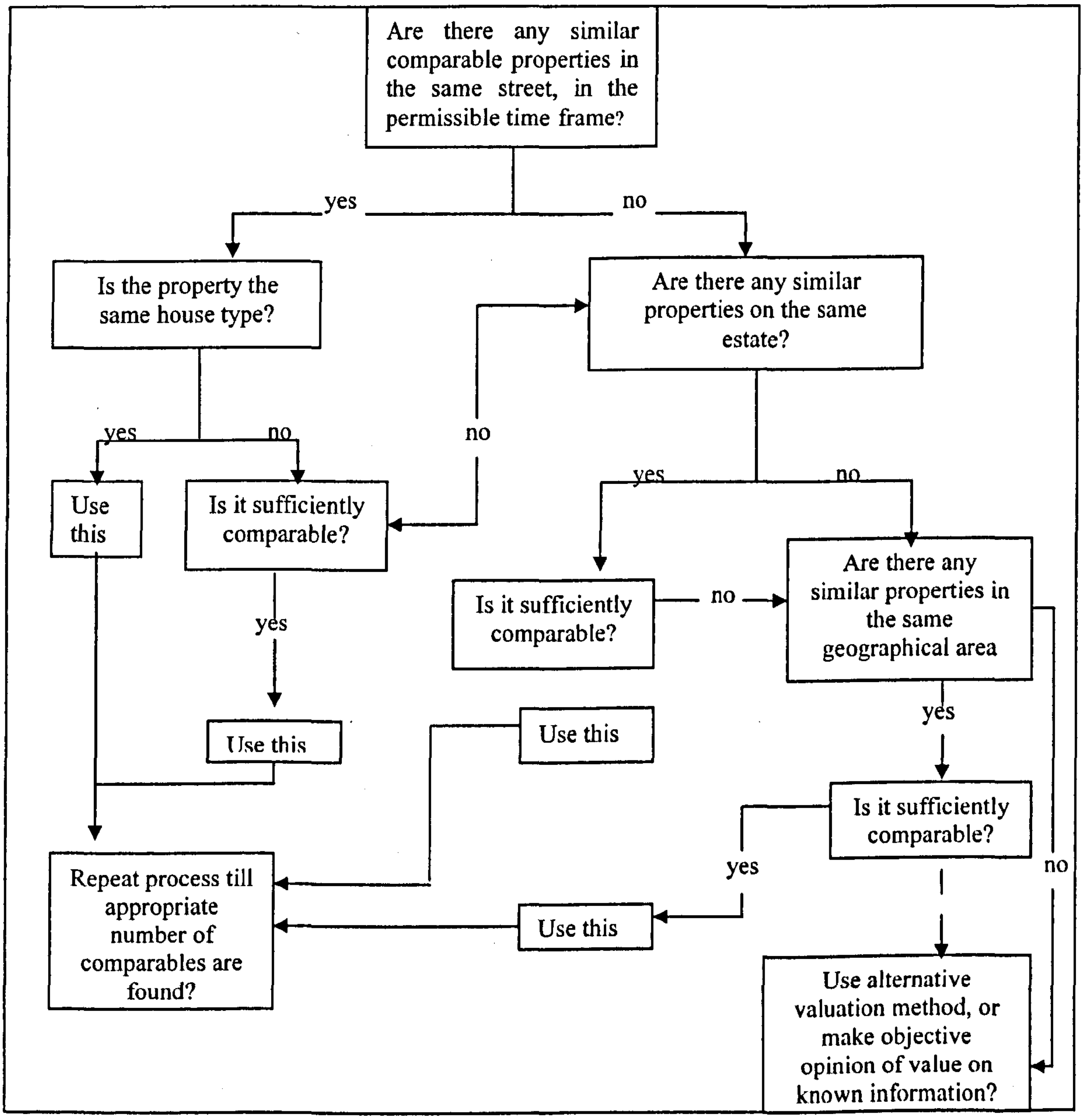
1.2.1 Common Valuation Methods

Within the UK, "*the great majority of all property transactions comprises the sale of houses and flats with vacant possession*"(Britton, Davies and Johnson, 1989)[30].

The most common method of obtaining the current value for mortgage purposes is the Direct Capital Comparison (DCC) method (Figure 1-2 below). This method relies on the availability of comparable properties, in a similar condition, sold within a similar timeframe, and within the same location. Comparable transaction data provides the valuer with a starting point or foundation (also referred to as an anchor by Diaz, 1999[31]), on which to base an initial valuation. However, consideration should also be given to the impact of "*various physical and psychological factors that may affect the perception of product attributes by the most probable buyers of a particular product*"(De Lisle, 1985[32]).

The characteristics of a particular property not only include property specific features but also the surrounding environment. Features such as good schools, public transport links or a water front view are seen as desirable and can therefore add value to a property (Chan, 2001[33]; Hometrack, 2003[34]). Whereas "*environmental features viewed as repellent, upsetting, or disruptive are stigmatised as undesirable*" (Mundy[7]). High voltage power lines are identified as one environmental feature which could stigmatise property. Slovic (1987[8]), Chalmers and Roehr[4] and Arens (1997[35]) also identified electricity distribution equipment as a cause of stigma damage which can influence the value of property negatively, in the same way as a known contaminant would. This, they suggested, was due to the perceived association between living near HVOTLs and a number of adverse health effects in particular cancer (see Chapter Three). This association has been labelled "*cancer-phobia*" by the legal profession and used as the basis for a number of "*loss of property value*" compensation claims in the USA (Bryant and Epley, 1998[36]).

Figure 1-2: Comparable Sale Selection Process



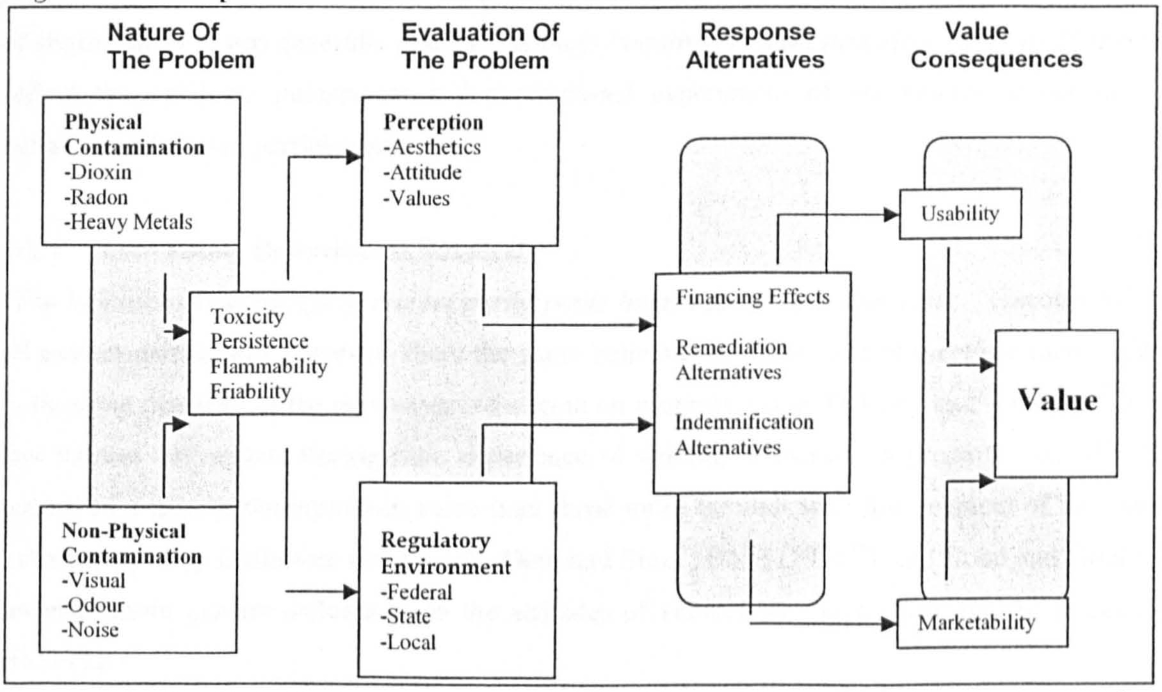
Almond N. Cited in Daly J.[24]

1.2.2 Stigma Damage

"*Stigma, as it applies to real estate affected by environmental risk is generally defined as an adverse public perception about a property that is intangible or not directly quantifiable*" (Roddewig, 1996[37]), leading to "*a loss to property value due to the presence of a risk perception-driven market resistance*"(Chan[33]) and is discussed further in Chapter Three.

The impact of stigma on value has been studied by a number of researchers (Freudenburg, 1988[38]; Mundy[7]; Patchin, 1994[39]; Wilson, 1994[40]; Arens[35]; Jaconetty, 1996[41]; Roddewig[37]; Neustein and Bell, 1998[42]; Chan[33]; Bond and Kennedy, 2000[43]) who have identified the fact that neither land nor buildings have to be directly associated with a contaminant to be affected by stigma, nor does there have to be sufficient scientific evidence to show that a perceived contaminant causes any real environmental risk (Chan[33]). Chalmers and Roehr[4] devised a conceptual framework (see Figure 1-3) to analyse the effect of contamination on value and concluded that, value ultimately depends upon a number of factors including the nature of the problem, the degree of risk associated with the problem, which can be either real or perceived risk, and the options available to remedy the situation.[xii]

Figure 1-3: Conceptual Framework: How Environmental Contamination Affects Value



Chalmers and Roehr (1993)[4]

1.2.3 Valuing Stigma

Property researchers and practitioners (Patchin[39]; Mundy[7]; Wilson[40]; Jaconetty[41]) have used a number of methods, such as the sales comparison approach (DCC), capitalisation methods, surveys, environmental value assessment, option pricing method, impaired value approach and multiple regression analysis, to evaluate the impact of contaminants on land and property values. Some of these methods (for instance; the DCC), rely entirely on the availability of transaction data. However, the availability of transaction data are likely to be limited where property is affected by some "*form of environmental impairment*" (Syms, 1996b[44]). Furthermore, none of these methods "*specifically takes all stigma criteria into account*" (Chan[33]).

[xii] Stigma damage is discussed in more detail in Chapter Three.

Indirect approaches such as contingent valuation and conjoint analysis[xiii], (Mundy[7]; Chalmers and Rhoehr[4]; McLean and Mundy, 1998[45]; Greenberg and Hughes, 1993[46]; Bond and Kennedy[43]) were introduced to address some of the problems created by a lack of market data. However, Chan[33] suggests that, due to the time constraints imposed on valuers, this type of survey-based approach is impractical 'in the real world'. Other researchers have suggested the use of a 'risk scoring' system (Mundy[7]; Roddewig[37]) or the use of a data base of perceived value impacts built up from a number of surveys carried out in order to establish professional perceptions towards the value impact from a number of different contaminants before and after remediation (Syms, 1996c[47]; Patchin[39]; Chan[33]).

Bond and Kennedy[43] questioned the validity of using a risk scoring system, as the perceived value impact for each condition is averaged out and may not produce an accurate result. Yet "*despite the presence of a variety of methods to measure stigma damage,*" Chan found that valuers' assessment of stigma damage was generally obtained through "*intuition or guesstimation,*" and would therefore reflect the opinions, perceptions and professional experiences of the valuers, rather than the behaviour of market participants.

1.2.4 Real Estate Behavioural Research

"*The behaviour and beliefs of market participants have a direct effect on value.*" (Jaconetty[41]) Not all market participants however, share the same beliefs and behaviour and therefore there is likely to be some disparity in the assessment of stigma on property value. Delaney and Timmons[21] found that valuers and agents having little experience of valuing or marketing property near HVOTLs perceived a greater diminution in value than those more familiar with this segment of the market. Later research by Gallimore and Jayne[11], Dent and Sims[1], Bond (1995[48]), and Bond and Hopkins[23], revealed more general differences in the attitudes of valuers and buyers towards the presence of HVOTLs.

The reasons for the differences between the perceptions and opinions of real estate market participants have been examined using two disciplines, behavioural research and environmental psychology. Environmental psychology is a relatively new discipline "*concerned with transactions between individuals and their physical setting*". More specifically with regard to residential property, it examines residential preferences, choice and satisfaction (Gifford, 1997[49]; Daly[24]).

By comparison, behavioural research is concerned with human problem-solving and information-processing and has gradually incorporated various aspects of psychology to improve understanding within this discipline. This type of research has been used for many years to enable public attitudes

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[xiii] Contingent valuation determines the value of non-economic goods such as a park, whereas conjoint analysis determines the relative importance of variables that contribute to a particular property's value.

towards environmental risks to be managed more effectively by identifying the factors (heuristics) used either by social groups or individuals to determine acceptable risk levels within their environment (Slovic[8, 9]; Kasperson *et al.*,1988[50]). The application of behavioural research to determine risk perception is particularly relevant to an investigation into the impact of electricity distribution equipment due to the perceived association between living near HVOTLs and a number of unproven health risks. A parallel may also be drawn between research investigating the impact on residential property values of other environmental features also known to produce EMFs such as TV/radio masts and mobile phone base stations[xiv].

Due to the perceived association between HVOTLs and a number of unproven health effects, behavioural research has, to some extent, already established the degree of risk associated with living near HVOTLs (Gallimore and Jayne[11]; Syms[10]) and as such has provided some foundation for the objectives of the research undertaken for this thesis (see section 1.5).

1.2.5 Negative Value Impacts

Property and land values reflect the "*... needs, tastes, fears, sensitivities, desires and anticipations...*" of the market participants (Bell[13]). However, attitudes, opinions and perceptions towards environmental features are not static and have been found to change in response to new information (Delaney and Timmons[21]).

Research in the USA and Canada suggests that the degree of market resistance towards HVOTL-proximate property is influenced by the amount of knowledge a person has about the related health risks. Kung and Seagle (1992[51]) stated that "*there are two ways in which power transmission lines may adversely affect property value or marketability.*" First, HVOTLs and pylons are, by their very nature, intrusive and therefore their 'mere presence' is likely to create some market resistance (Mitteness and Mooney[52]). Secondly, the perceived relationship between living near HVOTLs, cancer and a number of other adverse health effects has removed some buyers from the market (Dent and Sims[1]; Gallimore and Jayne[11]; Jayne[12]), leading to "*a decrease in demand for properties located near transmission lines and in turn lower property values in these areas*" (Kung and Seagle[51]) [xv]. Value will be reduced either as a direct result of valuer advice or due to pressure from resistant buyers forcing the price down to a more acceptable level to promote a transaction.

[xiv] The unproven health risks are discussed in Chapter Three.

[xv] Researchers have found that separating these two possible causes of value diminution is difficult, because the visible presence will alert the public to the publicised health risks (Mitteness and Mooney 1998[52]; Dent and Sims[1]).

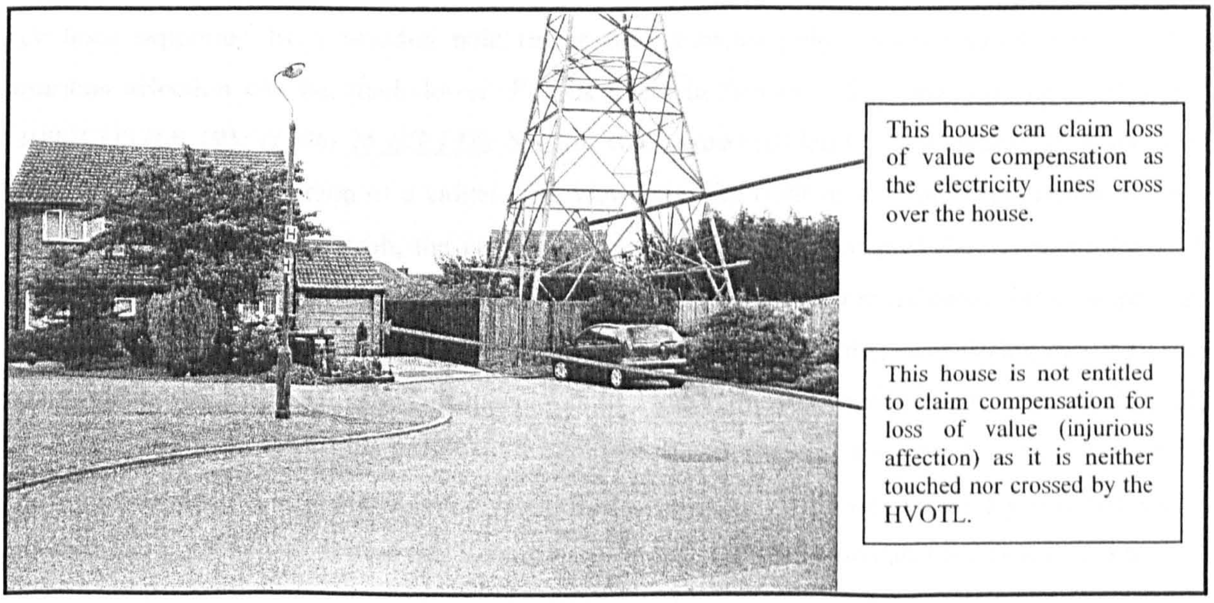
1.3 LOSS OF VALUE COMPENSATION CLAIMS AND RELATED LEGAL ISSUES

During the last decade there has been an increase in the number of loss of value compensation claims made against the electricity utility. However, '*most have no substance as they are based upon the unsubstantiated claim that there is a health risk*' (*Regina v Secretary of State for Trade and Industry, ex parte Duddridge and others [6th October 1995]* (Leigh Day and Co., 1996[53]; Scottish Power 1997[54]).

1.3.1 Compensation Claims

Courts within the UK do not consider 'public perception of potential health risks' a valid reason to accept any such claim; consequently compensation for a loss in value or amenity will only be considered if property is touched or crossed by electricity distribution equipment (see Figure 1-4). This is in the form of a wayleave payment [xvi] *(Electricity Act 1989 Schedule 4)* and makes no provision for the effect of stigma on value. The focus on adverse health effects has meant that other more tangible effects on amenity, such as visual and aural (noise) pollution, birds sitting on lines and development restrictions are often ignored (*Newhall Consortium v West Midlands Electricity [1999]*; Gell, 2001[55]).

Figure 1-4: Claiming Loss of Value Compensation



In 1998, a decision at planning appeal recognised 'public fears about health risks' most notably in *Newport Borough Council v Secretary of State for Wales and Browning and Ferris Environmental*

[xvi] *"A wayleave grants the electricity company the right the hold their apparatus on the land in return for compensation"* and rent, which is paid annually to the landowner or occupier (NFU document 12C 'Electricity' May 1996). The granting of a wayleave is, in theory, voluntary. However, if the landowner refuses access to his land, then the utility will apply to the Secretary of State for a necessary wayleave. Although compensation is the same, the rights of the landowner are usually more restricted. The rates of compensation can be obtained from the NFU document 12C 'Electricity' May 1996.

Services (1998 [56]). A 1999 planning appeal "*confirmed that the public perception of harm can be a material planning consideration*" (*ibid*). This decision was supported further in January 2001, when "*two landmark decisions by the Planning Inspectorate...endorsed decisions by planning authorities to refuse phone masts on the grounds of public fears about health hazards*" (Baker, 2001[57]). Despite the lack of any scientific justification for this fear, the recent planning authority decisions would suggest that public fears of potential health risks are a material consideration and likely to have an impact on future planning applications. There is, however, a fundamental difference between the siting of HVOTLs and mobile phone base stations. HVOTLs are sited before residential property is built, mobile phone base stations are erected afterwards.

Whilst there are relatively few legal cases associated with the impact of a HVOTL on property values in England, two Lands Tribunal cases are worthy of note. In *Turris Investments Limited v Central Electricity Generating Board* (*[1981] 1 EGLR 186 (1981) 258 EG 1303*), land crossed by a HVOTL was undergoing development for residential use to include 106 dwellings (66 houses, 20 bungalows and 20 flats situated within five blocks). Compensation was awarded for injurious affection based on an 8% reduction in value for land where development had already been completed; a 12.5% reduction for the "*land most seriously affected*" and to the remaining land 3%. In addition, compensation was awarded at the rate of 2.5% for the negative impact from the line. For lines supported by a wooden pole rather than a metal pylon, compensation awarded for injurious affection can be much lower. For instance; in *Naylor v Southern Electricity Board* (*[1996] 1EGLR 195; (1996) 26 EG 138*). Naylor, who owned the land on which the 11kV line was sited, had sought the opinion of a valuer. The view from the front of the house was dominated by the wooden pole and as a result, the valuer considered that the presence of the overhead line had devalued Naylor's property by 20%. A second valuation considered a more conservative impact at 15%. The Lands Tribunal however, considered both valuations extreme, considering that the pole was wooden and not metal. Their decision was to award compensation for injurious affection of just 2.3%. Whilst the decisions in both cases are persuasive, they do not provide a legal authority. No court case dealing with a loss in the value of residential buildings was found. By contrast, legal bodies in the USA appear to treat this issue somewhat differently. These cases are now discussed.

1.3.2 Planning Issues, Legal Constraints and Compensation in the USA.

The situation within the USA is somewhat different in that courts will compensate property owners for a diminution of value due to public fear (*Florida Power & Light Co. v Jennings. 1987*[58]; *San Diego Gas and Electric Co. v Daley.1988 (S.D.G.& E. Co., v Daley)*[59]; Goldberg D. 1994.[60]; *Potter v Firestone Tire and Rubber Company 1993*[61]; *Hicks v United States 1959*[62]). One of the leading cases to consider fear of power lines in an assessment of damages in eminent domain[xvii] is *Hicks v United States (1959)*[62]. This case was decided in 1959 before the association between living near HVOTLs and cancer became a public issue. In the determination of compensation, the land was treated as residential land, this being its highest and best use. The Court held that "*the apprehension of injuries to person or property by the presence of power lines on the property is founded on practical experience and may be taken into consideration in so far as the lines and towers affect the market value of the land.*" This decision was relied upon in *United States Ex Rel. T.V.A. v Easement and Right of Way (1959)*[63] when determining compensation for a power line right of way in eminent domain. In both cases public fear was based on the reasonable possibility of a pylon falling down or danger from electrocution (Bryant and Epley[36]).

The courts began to address the issue of compensation for the impact on market value in *Florida Power and Light Company v. Jennings (1987)*[64], rather than determining whether or not the cause of market value diminution (public fear) was reasonable. However, the decision still relied on the testimony of expert witnesses to support the *"reasonableness"* of public fear. This was later found to "*confuse the issue and focus of the trial*" and the court concluded "*any factor, including public fear, which impacts on the market value of land taken for a public purpose may be considered to explain the basis for an expert's valuation opinion*" (Bryant and Epley[36]). This decision was upheld in *S.D.G.& E. Co., v Daley*[59], when Daley was awarded compensation for the "*creation of negative perceptions*"(*ibid*), following the acquisition of a power line ROW over his land that had apparently reduced the value of the remaining property by 4% ($1.26million) (Gregory and Von Winterfeldt, 1996[65]).

The need to justify the reasonableness of 'fear' diminished in *Willsey v Kansas City Power & Light Company (1991)*[66] when the court, "*...conclude[d] that loss of market value that is proven with a reasonable degree of certainty should be compensable*" (Bryant and Epley[36]). Further clarification on this issue was given in *Ryan v. Kansas Power and Light Company (1991)*[67] when it was stated that *"in a condemnation action to acquire an easement for installation of a high voltage electrical line we find evidence of fear in the marketplace is admissible with respect to the value of property taken without proof of the reasonableness of the fear... fear of a high voltage line is reasonable"* (Bryant and Epley[36]). This ruling finished what the court had tried to do in the *Willsey* case and opened the door for stigma damage compensation.

[xvii] Eminent domain is the American term used to describe the compulsory taking of land, either by a Utility for the provision of services (e.g. gas, electricity or water) or for a new development (e.g. a factory or road) with the Government's permission, 'for the greater good of all'. This can result in a compulsory purchase order for land or property, or an easement / wayleave to have certain rights over land or property. Compensation is paid to the landowner for the value of the land taken and if the compensation is fair, this will include any reduction in value to the remainder of the land as a result of the siting of the Utilities equipment, or new development. See Appendix II for an explanation of wayleaves and easements.

Later in *Criscula v Power Authority of the State of New York.(1993)*[68], the New York State Court of Appeals confirmed that stigma was powerful enough to reduce property value and subsequently limited the responsibility of the owner, when seeking compensation, to prove that the presence of a power line posed a health risk. However, they did require that the claimant establish "*some prevalent perception*" that the power lines were the reason for the reduction in value. This ruling was explained in *Komis v City of Santa Fe, (1992)*[69], when the court ruled that "*whether danger is a scientifically genuine or verifiable fact should be irrelevant to the central issue of its market value impacts.*" Citing several prior cases, the court said that, "*there should be no requirement that the claimant... must establish the reasonableness of a fear or perception of danger.*" Gregory and Von Winterfeldt[66] suggested that it was "*this ruling which open[ed] the door to the social rather than scientific process for establishing compensation awards related to the siting and operation of transmission lines, this include[d] stigma*" and has produced an "*increase in the level of concern*" among the utilities regarding the public perception of possible EMF related health risks (Fischhoff [6]).

Other claims against the electricity utilities have involved the siting of electricity distribution equipment near schools. For instance, a civil court in Texas awarded Klein Independent School District $104 000 in actual damages and $25million in punitive damages (adjusted to $104,000 in actual damages after an appeal), following the construction of a 345kV line with a 100ft wide easement across land where 2 schools were built, with planning permission for a third school. The utility subsequently moved the line (*Houston Lighting and Power Co. v. Klein Independent School District.1987* [70]).

The desire of electricity utilities in the USA to avoid construction delays and future litigation from an EMF-concerned public, could add as much as 30% (Florig[71]) to the construction cost of a new transmission line due to either alternative site selection (the most frequent choice); under-grounding of lines; wider ROWs which has resulted in much higher land acquisition costs, or the use of higher pylons which, whilst reducing EMF exposure levels below, have increased the visual impact. Pacific Power and Light were reported to have spent an additional $2.4 million changing the configuration of their lines to halve the magnetic field at the edge of a ROW (*ibid*) and Microwave News (Gregory and Von Winterfeldt[66]) reported that one town put several blocks of line underground, at a cost of $20,000 per person.

1.3.3 Compensation and Planning Issues in Canada

In Canada, as in the UK, 'fear' is not accepted as a valid reason to award loss of value compensation (Rosiers 2003[72]). However, a different a more open approach towards providing information to the public was found to reduce opposition towards the siting of electricity distribution equipment. This became apparent in 1989, prior to the development of a new line, when British Columbia (Canada) Hydro and Power Authority[xviii] embarked upon a successful education strategy following initial strong opposition from home-owners, partly due to EMF health concerns. They made information on the health risks from EMFs available to the local community and offered to buy out anyone who was still concerned about living within 356 metres of the new power line ROW.

Out of a total of 155 eligible for the buyout, only 59 sales took place: 40 houses, 18 vacant lots, 1 former school, at a cost to British Hydro of $3.7million, who resold all the properties for $3.5 million (*ibid*). Despite the success of this approach, it was criticised for giving out the wrong message. As one of the residents said, "*If B.C. Hydro did not believe that there was a health hazard then... why did they start this buyout program?...* "(Gibney, 1991[73]), "*the public perceived the buyout option as an admission of guilt and that there is a health hazard surrounding transmission lines*"(Gregory and Von Winterfeldt [65]).

1.4 IMPLICATIONS FOR THE PROPERTY INDUSTRY IN THE UK

Results from recent studies in the USA (Colwell[17]), Canada (Rosiers[72]) and New Zealand (Bond and Hopkins[23]), suggest that the value of residential units is diminished by between 2.7% and 27% depending on the position of the building in relation to the pylon and line, the degree of screening and the surrounding topography. It is possible that the effects may be similar in the UK. However, the existence of any impact is difficult to determine due to a lack of data available for analysis.

Some developers appear to have already responded to negative public perception and have chosen to bury or remove power lines, whilst others build low cost and social housing closest to the line[xix] perhaps to avoid potential losses and future compensation claims (Dent and Sims[1]; Gell[55]; Sims, 2002[74]). In addition, National Grid Co., are seeking to encourage sympathetic development to reduce negative impacts on value and amenity (Lowe 2003[75]).

Calculating the value of this type of property can also provide a challenge to valuers in the UK, who, until recently had a mandatory duty[xx] to take into account the effect of public perception of potential health risks associated with living in proximity to HVOTLs. In addition, perceptions fluctuate and will either increase or reduce market resistance in response to information and media

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[xviii] Cited in Gregory von Winterfeldt 1996[65]

[xix] This trend provoked controversy in Bristol where a new development placed social housing nearest the lines where EMF strengths are highest. A development undertaken in Sutton Coldfield during the late 1990s also placed social housing nearest the line (Dent and Sims[1]).

[xx] See 1.0.

attention. Valuers and estate agents have found that, although property adjacent to HVOTLs sells, the presence of lines removes some buyers from the market, and reduces demand, which potentially reduces price. The sale process can also be lengthened by many months and so the true effect on value can be difficult to assess (Dent and Sims[1]).

Without a methodology or benchmark for valuing this type of property or awarding loss of value compensation, (other than wayleave compensation), all decisions seem to rely on the judgement, and therefore the perceptions and opinions, of the individual professionals involved. If there is the same negative relationship between proximity to electricity distribution equipment and residential property values in the UK as found in the USA, Canada and New Zealand, it is important that a simple, but effective methodology be found to measure this effect and enable a benchmark to be established to guide professionals in the assessment of the value of this type of property.

1.5 STRUCTURE OF THE THESIS, AIMS AND RESEARCH METHODOLOGY

The absence of data on the impact of electricity distribution equipment on the value of residential homes in the UK has provided the focus for the thesis. Therefore the overall aim of this research is to establish the likely impact of this equipment, in particular HVOTLs, on the value of proximate residential property within the UK through the use of opinion surveys, interviews and case studies which will utilise both qualitative and quantitative research paradigms. To achieve this aim, the following objectives have been established

Objective 1. To determine the key factors influencing the value and marketability of residential units in close proximity to HVOTLs, and, to examine how these factors affect the behaviour of market participants (using both research paradigms, referred to here as a multi-method approach towards data collection).

Objective 2. To establish the perceived impact of HVOTLs on the value of residential units, (using a multi-method approach towards the collection and analysis of data)

Objective 3. To determine whether there is a measurable correlation between the physical distance of HVOTLs and value, and visual encumbrance and value, (using a quantitative approach towards the analysis of transaction price and asking price data).

Objective 4. To establish the degree to which attitudes can be relied upon to provide an accurate determination of the value of residential units in close proximity to HVOTLs (This objective requires an alternative data source for a comparative analysis).[xxi]

Objective 5. To establish a set of criteria for measuring the likely impact on the value of residential units (based on the results of the investigation).

Objective 6. To establish the impact of the presence of a HVOTL on house prices in the UK (using a case study approach within a quantitative research paradigm towards the collection of transaction price data).

Research questions are designed to help achieve the aims and objectives of the research when there are no clear hypotheses to test. The following research questions have been developed to gain a clearer understanding of certain aspects of the research.

I. What are the key factors influencing the purchase decisions of buyers and potential buyers of homes near HVOTLs?

II. Do buyers and residential valuers (Chartered Surveyors and Agents) perceive that the presence of HVOTLs has a negative impact on the value of residential units? If so:
   i. which aspect(s) of the HVOTL cause(s) value diminution?
   ii. to what extent is value reduced?
   iii. do buyers, surveyors and agents share the same opinions?

III. Are there any indications of attempts by developers/builders to mitigate perceived loss of value caused by HVOTLs?

IV. How, in the absence of property specific transaction data, can perceptions of value loss be tested to establish whether they reflect actual behaviour in the property market?

Evidence from the first literature search overwhelmingly suggested that the greatest impact on the value and marketability of residential units near electrical distribution equipment was caused by the presence of HVOTLs. Initial interviews with property professionals (Gell, Barnes, Carr)[74] confirmed this, and consequently this investigation has focused almost entirely on this aspect of electricity distribution equipment. This enabled the formation of the initial hypotheses to provide a focus for further study (See Figure 1-5).

The following hypotheses are tested by this research:

[xxi] This is an important aspect of the research, as residential property transaction data are publicly unavailable in England and therefore cannot be analysed to establish the impact from environmental features such as HVOTLs.

Hypothesis 1. Chartered Surveyors perceive a greater negative impact on the value of residential units than Estate Agents (due to P.S. 3.7 which was included in the RICS '*Red Book*' from 1995 to 2003 and cautioned valuers that, negative public perceptions may affect the future value and marketability of property near HVOTLs).

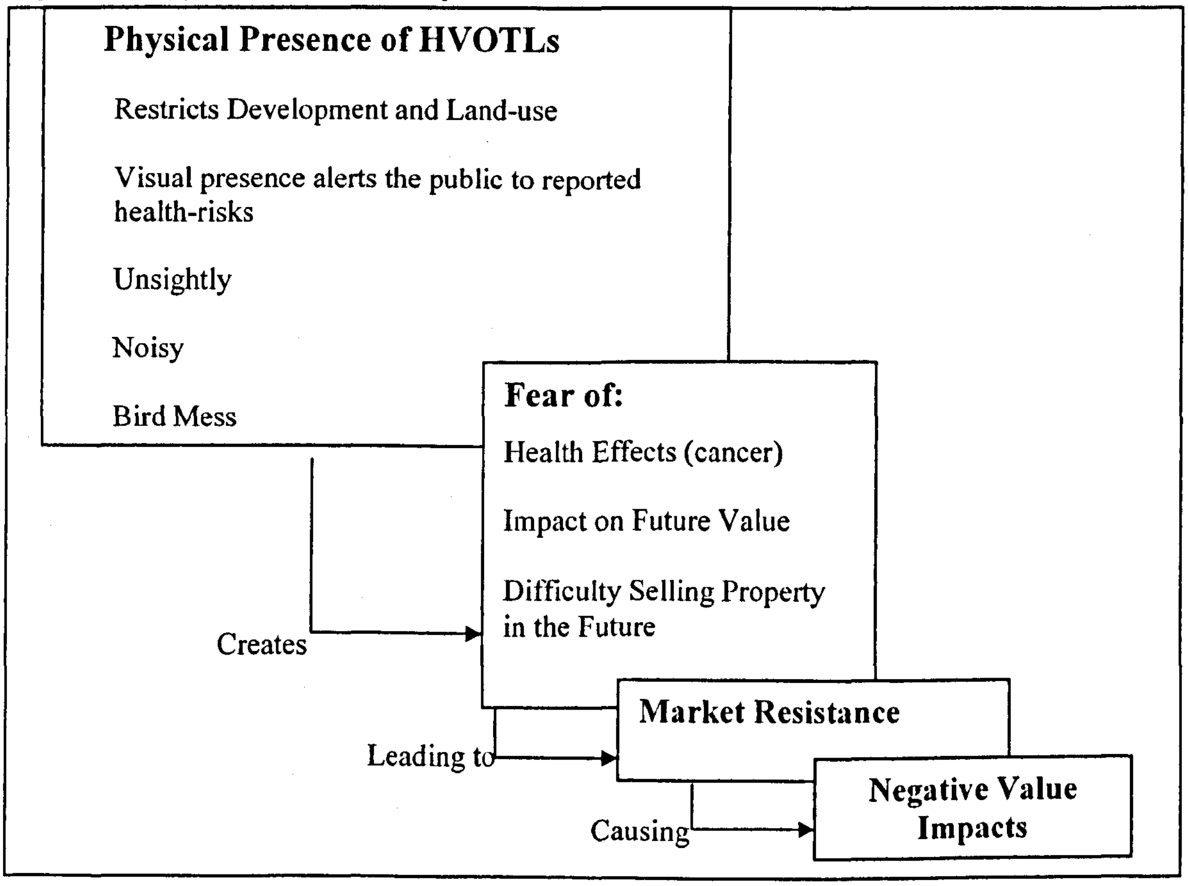
Hypothesis 2. Surveyors and agents with no experience of valuing HVOTL proximate property would perceive a greater degree of value diminution than those familiar with the valuation of this type of property.

Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential property than physical proximity.

Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line.

The hypotheses have been constructed in such a manner that does not enable testing to be undertaken using the null hypothesis format without some confusion when accepting or rejecting the null hypothesis. For instance, if the null hypothesis were accepted for Hypothesis 3, this would imply that neither the visual presence, nor the physical presence of the HVOTL had any impact on value. Since this is clearly not the case (see Chapter Five) testing in the null hypothesis format is not appropriate to use in this instance. Consequently, the real hypotheses are tested and accepted or rejected depending on the results of the analyses undertaken in Chapters Five and Six.

Figure 1-5: Hypothesised Relationship Between the Presence of HVOTLs and Value Diminution



To address the aims of this research and test the hypotheses, a qualitative approach was initially adopted to establish public and professional perceptions and determine the impact on the market value of residential property near HVOTLs. This approach is well established within real estate research and environmental risk analysis (Slovic[8, 9]; Fischoff[6]; Diaz[40]; Bond and Kennedy[43]; Syms[10]; Havard[75]; Daly[24]) and was the best means of addressing the hypotheses in the absence of available transaction data for a comparative analysis.

The perceptual study focused on three different aspects to enable the results to be triangulated and was designed using the literature review as a foundation, followed by a small number of indicator interviews to enable a postal survey to be constructed and undertaken.

Previous literature identified questionnaires as the most appropriate method of testing the perceptions of valuers and agents towards value impacts and other effects on the market. This was also considered to be the most appropriate method of testing the attitudes of buyers and their willingness to pay to have the HVOTL removed. A quantitative approach using a hedonic methodology towards gathering and analysing data was adopted to obtain house price data from two case studies and to enable professional perceptions towards the impact of HVOTLs on house prices to be explored in greater detail.
Testing the accuracy of the data generated by the study involved finding a suitable transaction data source for a comparative study. There was a possibility of using transaction data from New Zealand, although it was felt that the New Zealand market might be too removed from the UK and would therefore not provide suitable data for an accurate comparison. However, transaction data were available in Scotland and as a result a suitable site was selected for a valuation case study to enable a more accurate determination of the impact on the property market to be undertaken, using a quantitative approach, grounded in economic modelling for the collection and subsequent analysis of this data. Finally, a small number of face-to-face and telephone interviews were conducted with residents, agents, valuers, developers and representatives of the electricity industry.

1.5.1 Structure of the Thesis

Due to the nature of the research, there were several bodies of literature which were relevant to this enquiry. The literature search, therefore, was broad and included previous research investigating the impact of HVOTLs on property value, risk analysis, stigma damage and health studies. For this reason, the review of secondary data has been divided into two separate chapters.

Part One

Chapter One: Introduction to the Research. This lays the foundation for the thesis and discusses methods to address the problems raised by this investigation. It explains current UK planning policy and legislation in relation to the siting of distribution equipment, the development of land close to distribution equipment and the subsequent compensation for the creation of easements. The issue of loss of value compensation is discussed and a comparison made between the approach taken by the courts in the UK and the USA.

Chapter Two: Property and Land Value Studies. This critically examines quantitative research, more specifically, studies using transaction data to determine the impacts of HVOTLs on residential property values.

Chapter Three: Perceptual Research This chapter is essentially qualitative in nature and deals with research areas that either investigate or help explain public and professional attitudes towards the presence of HVOTLs near residential property.

Part Two: Empirical Research

Chapter Four: Research Methodology. This chapter evaluates and justifies the methodological approach used to gather and analyse data to determine the actual impact on house value, the perceived impact on house value and other effects on amenity, land use or the property market from the presence of a HVOTL.

Chapter Five: Transaction Data Analysis. This presents the analysis of selling price and asking price data from three cases studies: Walmley (see Appendix V) St Peters (see Appendix VI) and Blackwood (see Appendix VII). The methodological approach adopted for all three case studies is identical. However, data obtained from Blackwood includes the actual transaction price whereas house price data obtained from Walmley and St Peters comprises only asking price and, as such, represents the agents' perception (who is also under instruction from the vendor) of the open market value (OMV).

Chapter Six: Perceptual Research Analysis, presents the analysis of the perceptual research.

Part Three: Conclusions

Chapter Seven: A Drawing Together of the Empirical Research & Final Conclusions and Further Research. The first part triangulates the results to produce a benchmark for the future valuation of this type of residential unit and the initial research conclusions. Final Conclusions and Further Direction, concludes the thesis and suggests future direction for the research

1.6 SUMMARY AND INTENDED BENEFITS FROM AND USES FOR, THIS RESEARCH

This thesis is intended to provide a body of knowledge that is not known to exist within the UK by gathering and analysing data to determine the impact of HVOTLs on the value of residential units. Unlike previous studies carried out to determine the impact of HVOTLs on property values, the study is UK specific and as such has addressed the research barriers created by the lack of available transaction data within England.

It is hoped that this research will provide a useful source of information which can be drawn upon by participants in the residential housing market to provide a foundation, or starting point, for the assessment of the effects of a proximate HVOTL on house price. The strategy adopted for the research has been designed to generate data that shows the impact on selling and asking price as a) a function of distance from the HVOTL and b) a function of the visual impact of both the line and pylon. Thus:

a) Planning authorities may be aided in the development of appropriate policies which will promote developments that seek to minimise negative impacts through careful design of residential estates, or through the use of screening.

b) Valuers will have factual information of the impact of a HVOTL on the selling price of residential units within a case study location, which may aid them in the formulation of valuation advice to either lending institutions or buyers.

c) It will enable property owners refer to a benchmark when seeking compensation either for a loss of property value or for a loss of amenity.

d) In addition, the recent concern shown by the public towards the siting of mobile phone transmission base stations, due to the perception of a link with potential health risks from EMFs (also produced by cellular phone towers), suggests that some parallels may be drawn between the impact of a HVOTL, and the possible impact of a mobile phone base station on the value of residential units.

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Chapter Two

Property and Land Value Studies

2.0 INTRODUCTION

The body of literature dealing with the effects of electricity transmission equipment, in particular high voltage overhead power lines (HVOTLs), on the value and marketability of residential land and buildings, can be divided into two areas of research; firstly, quantitative studies that use actual transaction data to establish any market reaction to the presence of power lines and secondly, qualitative studies, that use data from opinion, attitude, or perceptual surveys, to establish the likely causes for certain behaviour in the market place or predict likely reactions to a particular environmental factor, event or situation.

Early research into the effects of electricity transmission equipment on the value of land and residential units, was generally based on valuation data alone, although opinion surveys were occasionally undertaken in tandem with valuation studies to consider possible concerns over tangible effects, such as visual and oral impacts, or the possibility of a line or pylon falling down.

The first suggestion of a link between living near HVOTLs and potential health risks, in particular, childhood cancer, was announced in 1979 (Wertheimer and Leeper, 1979[1]) and since then, media coverage (newspapers, journals and TV reports) of scientific studies suggesting a number of possible health risks, has grown (see Chapter Three). Changes in public perception were not instant, and the results from opinion surveys have suggested that, even in the early 1990's (Kung and Seagle, 1992[2]), the general public was still largely ignorant of any link between living close to power lines and possible health risks. The association with possible health risks has introduced other areas of research dealing with issues of contamination, stigma and compensation, resulting in a wealth of information and a large subject area that cannot be properly discussed in one chapter. Consequently, the relevant literature will be presented under three subject headings: Property value studies; perceptual studies, incorporating literature on contamination and stigma damage; and studies into the potential health risks from residential exposure to electricity distribution equipment.

This chapter will only evaluate property studies that have used valuation (quantitative) data, usually transaction price, to determine the effects of electricity transmission equipment on land and residential property values. The review will focus on the more frequently cited studies, carried out since the 1950s, and evaluate their worth as a reliable indication of the effect of HVOTLs on property value. This will facilitate the identification of suitable research objectives and allow a considered approach to be formulated to investigate this issue in the UK.

The published material tends to fall into one of four categories (Kroll and Priestley 1992[3]).

Literature Reviews: A review and analysis of the existing literature

Appraiser Studies: Studies carried out by surveyors (known as Appraisers in the USA and Canada) using property transaction data to analyse value effects.

Attitudinal Studies: Often undertaken in tandem with appraiser studies to determine public and professional perceptions and whether these perceptions have affected, or may affect, the future value and marketability of land or residential buildings;

Statistical Analysis: Studies that have used statistical analysis, usually a multiple regression technique[i], to analyse the data.

The majority of property value studies presented here relate to the USA and Canadian (Clarke 1972[4], Kinnard 1967[5], Kroll and Priestley[3]) practice of siting overhead transmission lines in a 'right of way' (ROW); a tract of land wide enough to ensure 'safe' exposure levels, where building is generally prohibited. The residential units built on the edge of ROWs have the use, (albeit limited) of the land under, and surrounding transmission lines, thus making comparison with the UK property market unreliable.

It should be noted that in the UK, the electricity utility normally site overhead power lines and pylons at least 50m away from residential developments. To fulfil the demand, however, for residential units, developers have expanded existing housing estates and new property has been built close to, and in many cases, directly beneath high voltage power lines (Dent and Sims, 1999[6], see also Chapter 1: 1.1). Comparisons can be made with New Zealand studies, where lines can be found crossing directly over residential homes and pylons sit on private land.

2.1 PROPERTY VALUE RESEARCH

Since the 1950s, studies have been carried out, mainly in the USA, (Reese, 1967[7]; Kinnard[5]; Colwell and Foley, 1979[8]) Canada (Freidrickson, *et al.*, 1982[9]; Boyer, *et al.*, 1976[10]) and more recently New Zealand (Callanan and Hargreaves, 1995[11]), to determine the effects on value from the siting of electricity distribution equipment on proximate land and property. Early research was often conducted to address the issue of compensation for power line right-of-way (ROW) easements and settlements in eminent domain actions[ii] in court (Carll, 1955[12]; Crawford, 1955[13]) and generally concluded that value effects were negligible. These negative results may have been

[i] Multiple regression analysis is '*the statistical technique to compute the correlation* (relationship) *between a set of scores and some criterion score*'. Kline Paul, (2000).

[ii] Eminent domain is the American term used to describe the right to acquire land by a Utility for the provision of services (e.g. gas, electricity or water) with the Government's permission, 'for the greater good of all'.

due to the fact that there was no impact on the market, or as a result of the relatively unsophisticated methodology used in assessing such impacts, possibly as a result of research based on case studies rather than " *a comprehensive testing of impacts under a range of circumstances*"(Kroll and Priestley[3]). It may also have been due to the fact that there was no association between high-voltage overhead transmission lines (HVOTLs) and potential health risks. However, since the late 1970s and the reported link between living in proximity to HVOTLs and childhood cancer (Wertheimer and Leeper[1]), more studies have suggested that HVOTLs and their supporting pylons (towers) do cause value diminution, especially with regard to residential property. Yet, despite improvements in research methodology and the use of statistical analysis, results have remained inconsistent, with some studies suggesting no real value effects and others finding significant value diminution and even blight[iii]. Several literature reviews have been undertaken in an effort to summarise the results of these studies. Some of the more comprehensive reviews have not only looked at the general findings, but also carried out an analysis of the various methodologies used and evaluated their worth. These include Kinnard[5] (1988[14]) DiMento (1982[15]), Fridriksson[9] and Kroll and Priestley[3].

2.2 EARLY STUDIES: 1950 - 1979

Early research into the impact of overhead power transmission lines and pylons on land and real estate values was generally carried out by appraisers to determine the value implications of the presence of a transmission line easement (Reese[7]; Clarke[4]). This was to provide the landowner with compensation for the land taken, the subsequent restricted use of land under a power line 'right-of-way' (ROW) and the inconvenience of the easement (Carll[12]).

Kinnard's[5] study initially concluded that the presence of lines or pylons did not have a significant impact either on the value or marketing time of proximate property[iv], reinforcing the findings of previous reports by Barton (1964[16]) Bigrass (1964[17]) and Carll[12]. However, on closer inspection, his study reveals several factors that suggest power lines do negatively impact on land values.

[iii] Blight is a term usually associated with the negative effect that a proposed development, such as a motorway, has on other proximate land and property. It is generally used by professionals in the property industry to describe a negative condition affecting property or land to such a degree that it becomes unmarketable or of little or no value under normal market conditions.

[iv] Proximate property is usually taken to mean property within 200m of the power line or pylon. In this study, proximate property is defined as:- property crossed by or abutting a power line 'Right of Way' and property within 65m (200ft) of the edge of the Right of Way. The width of the Right of Way is not specified in this study. A Right of Way (ROW) is a corridor of land directly beneath and surrounding the HVOTL, where development is prohibited from taking place.

The study focused on nine towns (17 subdivisions) in Connecticut, USA, from 1954 to 1964, which provided enough data from different localities to eliminate any market changes due to economic factors and effects that were only relevant to a particular type of locality. Each town was either intersected or abutted by a power line ROW and involved a total of 791 homes, an analysis of more than 1,200 property sales and nearly 400 interviews with property owners during that period. Despite the fact that the project was funded jointly by the Connecticut Light & Power Company and the Hartford Electric Light Company, which could arguably affect the conclusions in their favour, Kinnard maintained that 'objectivity' (presumed to mean research validity) was achieved throughout the study, because the University's research team was allowed to function independently, without any controls placed on them by the project's financiers. They were also allowed to make the decision on whether or not to publish their findings. He found that there was nothing to suggest that the typical residential property owner would suffer *"any negative financial or economic consequence"* as a result of owning a home in proximity to HVOTLs. However, unlike previous studies (Barton[16]; Bigrass[17]; Carll[12]), Kinnard sought to identify the factors that might affect the value of property. Each initial sale price was established from deed and mortgage records, then *"verified in the field"*; however, what was meant by this was not clearly explained. More importantly, plot size was established, because residential units abutting ROWs often had larger plot sizes. He also took into consideration whether or not a unit had been substantially improved since being built (size and cost of improvements were noted). Units were divided into four categories depending on proximity to the line. *"Property crossed by right of way; property abutted by right of way, property within 200ft = proximate and; property outside the 200ft mark = distant."*

In this particular study area, the electricity utility had not purchased the land and only required easements, subsequently the owners of homes abutting the ROWs tended to have substantially larger plots than those further away.[v] This, Kinnard[5] suggested, represented more of a loss to the developer than the homeowner, because *"fewer lots may be developed on acreage that is intersected by a tower line right of way. This means a reduction in the potential profit to the builder-developer..."* In addition, he also noticed on sites where there was choice of housing, a tendency for the developer to place lower cost housing next to the line, implying a belief on the part of the developer that there is a potentially negative effect on value, although no empirical research had uncovered any evidence to suggest that this reaction was founded on market behaviour. He also found that higher priced and smaller localities were slightly more affected than average localities[vi]

[v] These larger plots include a portion of the ROW.

[vi] An "average" locality is defined as a locality comprising average priced homes for the city. They are generally large subdivisions comprising mass produced standardised style homes (Bond and Hopkins, 2000: 53)[50].

and any initial value loss often dissipated with time and natural or planned screening of the lines and towers. Crawford[13] noted that rural land values were usually far more affected than urban land and that careful planning of subdivisions by developers minimised the potential for negative value effects. This concurs with Kinnard's[5] observation that any loss in value is incurred by the developer/builder and the way in which he is able to generate a profit from the development of the land.

2.2.1 Methodological Flaws

One of the problems with much of the early research (1950-1970) was the 'poor' methodology used in the case studies. Factors such as plot size, house size and property features were usually overlooked, which meant that property near transmission lines (the cases) was not being 'paired up' [vii] with similar property away from the line (in the control area). Kinnard (*ibid*), highlighted the importance of comparing 'like' with 'like' in a paired sales analysis study,

Another important factor that might indirectly impact on value is the length of time a property stays on the market when it comes up for resale. If this takes months longer than another similar property at the same market value, liquidity,[viii] which represents income, is lost, despite the fact that the same price may eventually be reached[ix]. Reese[7] noticed this problem on a housing development in the USA, (he does not specify where) with which he was involved. Residential units adjacent to the line, despite having more land and greater privacy, sold at "*a substantially slower rate*" than units across the road, which were sited about 80m (240ft) further away from the line. Between 1963 and 1964 another sector along the power line ROW was developed and although comparison was more difficult, because of the variety of lot sizes and shapes due to the mixed topography, Reese (*ibid*) found that units abutting the ROW were again selling at a substantially slower rate. He also noticed that some developers chose to pay an additional charge to erect low voltage, low silhouette service lines on the rear of the lots which reduced the potential for negative impacts.

According to Kinnard[5] the availability of finance can also affect the market value of property "*as most home buyers typically seek to obtain as much financing as possible*". His opinion survey[x]

[vii] 'Paired up' has been used here to describe the method of finding the same type of property from two or more different locations to enable a direct comparison to be made and therefore establish the effect of a particular environmental factor on value. Also known as paired or matched paired sales analysis.

[viii] Liquidity is a term used to describe the ease or speed with which a financial investment, such as stocks, shares, land or property, can be converted back into money (see Begg D., 1994: 397).

[ix] Any loss in the liquidity of an asset represents a potential loss in interest to an investor (*ibid*).
[x] Kinnard[5] used questionnaires to ascertain the attitudes of house buyers, lending institutions, builders/ developers, valuers and estate agents.

found that some (but not all) lending institutions were reluctant to lend on property in close proximity to power lines and pylons. This was a reflection of the different, and often opposing attitudes within the market towards this issue. Developers and builders were found to have greater negative attitudes towards transmission lines than the individual property owners which, "*seemed to reflect the profit-oriented, anticipatory role of builder-developers in the residential real estate market*" (*ibid*).

Overall he concluded that:

I. There were no measurable adverse effects on the value of proximate residential units or potential development land prices, provided the electricity utility had paid the market price for land purchased for the ROW.

II. Any negative impacts tend to be expressed in the form of larger plot size for residential units abutting a ROW. The width of a ROW however, does affect the number of houses which can be built on a parcel of land leading to "*...a reduction in potential profit to the builder/developer...*" (*ibid*).

III. A small portion of the house buyers' market is negative towards houses in proximity to transmission lines, citing visual unsightliness and auditory aspects as having a greater impact than actual proximity to the line or tower. This suggested that screening may be important.

IV. The anticipation of living next to a transmission line was found to be worse than the reality. Negative attitudes disappeared over time, although fears about safety aspects were still expressed. Often the provision of other amenities in the area was of far greater consideration than proximity to lines and as land becomes more scarce, larger lot sizes became more appealing.

V. Realtors and appraisers (estate agents and valuers) had more negative attitudes than the market and often influenced buyers and sellers. Therefore it was necessary to reconcile the differences between property professionals' attitudes and those found generally within the market place, as the professions have the potential to influence buyers and then financial institutions negatively creating a problem when none may otherwise exist. Dissemination of these findings should reduce the concerns of the few buyers with very negative attitudes and therefore increase the potential size of the buyers' market.

In 1968, the Valuation Department of New Zealand, published the results of its investigation into the effect that HVOTLs had on the market value of real estate in New Zealand. This study introduced other negative effects on amenity, namely, condensation, bird droppings and radio and TV interference, which have been used to account for value diminution. The results of the case study in Christchurch, New Zealand found that any negative value effects seemed to be confined to property in a superior locality; however, a similar investigation in Auckland proved inconclusive. There were certain trends which suggested that HVOTLs caused a negative market impact. For instance, the number of *"vacant sections of the site"*(Valuation Department, New Zealand 1968)[18] in close proximity to HVOTLs suggested evidence of negative market impacts, including value depreciation. An analysis of residential sales prices found that houses proximate to overhead lines and pylons, *"showed a slower rate of increase in value"* (*ibid*) than other non-affected property with which they were compared. Their overall conclusions implied that there was some resistance within the market towards buying property proximate to overhead transmission lines and pylons and that lending institutions were sometimes reluctant to finance the purchase. It was noted that any increase in the length of time a property was on the market before it sold represented a loss in value. The conclusions confirmed the findings from earlier studies (Reese[7]; Kinnard[5]).

Clarke *et al.*[4] investigated the effect of a transmission line easement on the value of residential land in Harpeth Valley Park, USA. Although the survey was too small to establish any meaningful conclusions (only 67 sales transactions were investigated), his study highlighted the importance of establishing the opinions and perceptions of all market participants and explained how inaccurate, or differing, opinions and perceptions can cause financial loss. This particular site had been subdivided into residential plots, for future development by builders. The developer's perception of the negative effect of the transmission line easement led him to reduce the value of the plots adjacent to the easement, even though plot size was on average 25% larger than plots not adjacent to the easement. The land was then sold on to various builders and once the houses were built, all sold for a similar price, despite the presence of an easement, resulting in a much higher profit for the builder than the developer who had based his decision on his own, "*...uninformed opinion...*" [xi] His survey also revealed that some buyers deliberately chose houses abutting a power line ROW because of the larger lot size. The conclusions of this study led Clarke to express the belief that carrying out a survey is the best way to avoid misreading the market and making costly mistakes and suggested some strategies for undertaking such a survey in the future (These strategies are discussed in Chapter Four: Methodology).

Colwell and Foley's[8] investigation, improved research methodology dramatically by using a multiple regression technique to analyse the data. They approached the problem by identifying property that might be adversely affected in an area consisting of two separate neighbourhoods north of Dacatur city centre, Illinois. The same transmission line ran through both neighbourhoods and both sites consisted of several subdivisions. After gathering data on these residential units, they

[xi] Clarke *et al.,*[4]

"developed a model..." (essentially the same as a hedonic price index)[xii] "... *capable of detecting the differing effects of the lines over various distances while holding a number of other factors constant"* (*ibid*), thus allowing them to test their hypothesis. After surveying 164 single-family homes in Decatur, Illinois over an 11 year period up to 1978, (representing 200 sales transaction over that time), analysis revealed that there was a substantial negative impact in the value of units located between 50 and 200 feet from an electric transmission line. The one criticism of their study was that they had not made any adjustments for the effects of inflation during the data collection period (Kroll and Priestley[3]. It could also be argued that the whole neighbourhood might suffer from a degree of stigma due to the presence of the power line. As a result, all residential units, regardless of proximity to transmission equipment, may have suffered from value diminution and subsequently, the true value effects would not have been revealed in the same way as if the study had been conducted using a 'paired sales' analysis [vii].

In a later study, Colwell (1990)[19] found that any negative impact from proximate HVOTLs diminished both with distance and time: However, negative value effects on residential units in proximity to pylons were less transient and properties not adjacent to but within sight of a power line ROW also suffered. The results, Colwell concluded, inferred that time can produce a natural screen to lines, possibly as "...*the growth of trees obscures the view...*" (*ibid*), more readily than pylons which are, by their nature, more intrusive, suggesting that the cause for value diminution was the visual impact, and perhaps to a lesser extent, aural. Other later studies have reached similar conclusions (Rosiers, 1998[20], 2002[21]; St Laurent, 1996[22]).

2.2.2 The First Reported Health Risk

1979 represented a turning point in the literature relating to the presence of HVOTLs in proximity to residential property. Following the first published association between living near HVOTLs and childhood leukaemia (Wertheimer and Leeper[1]), researchers were no longer just concerned with value effects but also potential health effects. The publicity surrounding this issue (Brodeur 1990[xiii])

[xii] A hedonic price index is a methodology used to determine how individual characteristics (variables) impact on value. In other words, sales price is a function of a number of property characteristics for instance number of bedrooms. This is similar to the methodology used by the Halifax or Nationwide Building Society, for their house price index.

[xiii] A quote from Paul Brodeur's article "Calamity on Meadow Street" The New Yorker 9[th] July 1990, states that, *"as might be expected, significant devaluation of residential property situated close to substations, high current wires, and high voltage transmission lines has already occurred in various sections of the nation where power line health hazard has become known, and wholesale devaluation appears to be in the offing as information about the problem continues to be disseminated."* His comments suggested a wide-scale problem for owners of property near HVOTLs; although it is hard to find valuation evidence to support this claim. Other similar articles include "Power Lines Raise Fears in Home Buyers" The New York Times July 11, 1993: 5; "Power Lines Short Circuit Sales, Homeowners Claim" The Wall Street Journal December 8, 1993: B1.

added another dimension for the property researcher, i.e., the effect on the market from negative opinions, perceptions and fears of adverse health risks from living in proximity to a HVOTL. However, it is important to realise that the change in perception was gradual and research carried out in the early 1990s suggested that residential purchasers were still relatively unaware of any reported health risks associated with living close to power lines

2.3 POST 1979 STUDIES

Research after this date can be categorised into-

I. Papers and articles that review and examine past literature.

II. Studies that seek to determine value effects.

III. House and land price data analysis:-quantitative studies.

- Opinion and attitude surveys:-qualitative studies, usually run in tandem with quantitative research (see Chapter Three).

IV. Studies that seek to determine the potential health effects (see Chapter Three).

2.3.1 Papers examining pre-1979 research

Throughout the 1980s, several literature reviews were carried out to determine the validity of the studies to date. Some were funded by individual electricity companies,[xiv] in North America and Canada, to assess the possible future financial impacts from compensation claims for value diminution and, as a result, have not been published. (The validity of Electricity Utility studies has often been questioned, especially when they are carried out to address compensation claims).[xv] The most notable, and more frequently cited reviews to examine the potential impacts on residential land and property are Fridricksson [9], Kinnard[5, 14] and Kroll and Priestley[3]. Some conclude that land and house prices are likely to be negatively affected by proximity to HVOTLs, (Kellough 1980[23]; DiMento[15]). Other studies conclude that results are mixed due to poor methodology and, therefore, no conclusions can be drawn (Butler 1983[24]; Kroll and Priestley[3]).

Fridricksson's review[9] for Mountain West Research was, according to Gregory and Von Winterfeldt (1996[25]) *"the most thorough examination of the pre-1979 property value effects of EMF exposure'.* A review of 27 of the more 'frequently-cited' studies which also met 'certain methodological criteria", (Furby *et al.*,1988[26]) initially produced mixed results, with 10 studies

[xiv] The Bonneville Power Administration (cited in DiMento J.1982[15]; Fridriksson G. *et al.*, 1982[9]); The Central Maine Power Company (cited in Kinnard W. 1988[14]); The Edison Electric Institute (cited in Kroll and Priestley 1992[3]).

[xv] An article in Wall Street Journal *8.12.93* reports 2 recent analyses; one by a Houston appraiser showing that 100 properties bordering a power line sold for 13-30% less than 100 comparable properties away from the line. The Kansas City Power and Light Co. study concluded that there were no impacts on property values. Both parties apparently were involved in litigation proceedings and neither study has been verified.

concluding that HVOTLs did not adversely affect value, 7 finding that overall HVOTLs reduced value, and the remaining 10 failing to reach any definite conclusions either way. A closer investigation of these studies, however, *"revealed widespread methodological weaknesses"* (Gregory and Von Winterfeldt[25]). Furby[26] suggested that this was because either sample sizes were too small to produce a meaningful result; the difference between asking price and the actual transaction price was often ignored; or important variables, such as lot size, property improvements or locational factors, were omitted. Fridricksson[9], only considered two studies to be *"methodologically sound"* (Colwell and Foley[8] and Boyer *et al.*,[11]). Colwell and Foley[8] used a regression analysis based on 10 residential housing characteristics and this included the proximity of each residential unit to the line. The results are discussed above.

Boyer's case control study used a statistical analysis package (SPSS) to analyse a total of 1007 property transactions over a ten-year period along two stretches of line in Eastern Canada (this area was predominantly farmland). Questionnaires were used to determine attitudes, opinions and perceptions regarding transmission corridors and their impacts. The responses were coded and analysed. They found that the average price per acre for land along the line was between 16% and 29% lower than land sited away from the line and that the largest effect was found on smaller property, with value diminution decreasing as property size increased. Their analysis of previous studies also highlighted some of the methodological flaws, (small sample size, important variables omitted etc.) previously mentioned above, which has revealed the unreliability of much of the data.

Kinnard[xvi] examined more than 75 studies and articles (published and not published) dating from the 1950s to 1988. He stated that most concluded that, transmission lines had little or no effect on the value of residential units. He classified the literature reviewed by 'date' *(pre 1970 or post 1970)*, by 'topic' *(studies that focus on the health issue verses the economical issues)* and by the 'methodology' used, particularly in the latter studies which rely primarily on statistical models *(for instance, direct comparisons of group sales, case studies, mini appraisals, judgmental and non empirical studies, including those that rely on questionnaires)*. Out of the four that used statistical models to determine any effects from proximity, three studies, Blinder (1981)[27]; Brown (1976)[28] and Kinnard (1984)[29] found no effect but one study by Colwell and Foley[8] found a significant negative impact.

[xvi] The Real Estate Counseling Group of Connecticut, Inc. The Effect Of High-Voltage Overhead Transmission Lines on Sale Prices and Market Values: An Annotated Bibliography and Evaluation Analysis. Prepared by W. Kinnard for the Central Maine Power Company, September 1988[14]. Cited in Delaney and Timmins, (1992)[36]

Two studies using paired sales analysis[xvii] and six case studies were analysed with no measurable differences noted[xviii]. Of the ten studies classified as non-empirical or judgmental, only two appear to have dealt solely with the potential economic (value) effects and both found no adverse impact.[xix]

Kroll and Priestley's[3] review, published in 1992, was probably the most *'extensive'* examination of the literature to that date. Their review was funded by the Edison Electric Institute, and benefited from the support of many individuals and organisations and perhaps more importantly, they were given access to data, and therefore able to review many unpublished studies carried out by, or on behalf of, the electricity utility. They identified four main approaches used in the literature; the case study - an approach used predominantly by appraisers; literature reviews and general articles; attitude or opinion surveys; and statistical analysis - usually a multiple regression analysis of the data used in appraisal case studies. After reviewing 45 studies consisting of eight literature reviews, 14 appraiser studies, eight attitudinal studies and 15 statistical analyses,[xx] they concluded that, despite some improvements in methodology, there were still some serious methodological weaknesses and as research methods varied widely, *"there is little opportunity to confirm the findings from one study with the results of another"* (*ibid*). Although results were inconclusive, they did suggest a number of findings:

I. *"There is evidence to suggest that overhead transmission lines have the potential to reduce the value of nearby property."*

II. *"Where impacts occur they are often not large...generally in the range of 2-10%."*

III. *"Overhead transmission lines are generally not the major determining factor of property values. Other factors, such as neighbourhood characteristics and characteristics of the land and improvements tend to explain much more of the variation in home prices"* (*ibid*).

Perhaps the most frequent weakness in early methodology was 'plot size', which was not held constant in many studies (Kinnard[5]). The practice of giving larger plots to property adjacent to a power line easement indicates that developers were already compensating for the presence of the power line. In addition, these properties have, as the true boundary is unmarked, a much larger area of land which can be enjoyed, albeit with limited use.

[xvii] Canada Real Estate Research Co-operation ltd, (1973); Realty Research Group Ltd, (1974).

[xviii] Lamprey. S., (1985); Realty Research Group Ltd, (1974); Commonwealth Edison, (1978); Minnesota Power, (1983); Sherman. R., (1974); Vredenburgh M., (1974).

[xix] Ball T., (1970); Layton. C., (1962)

[xx] 12 of the 14 appraiser studies and 10 of the 15 statistical studies were carried out on behalf of, and presumably funded by, the electricity utilities, arguably leading to the possibility of biased conclusions.

Colwell's earlier study with Foley[8], was one of the few to take into consideration the effect of plot size and one of the few to conclude negative value impacts. In his later investigation he stated that, "*what is needed for just compensation is knowledge of the impact on selling price while holding constant such things as lot area, real or perceived*" (Colwell[19]) and as consequence he set out to answer several questions: first; whether the lines, pylons or both had an impact on the selling price of proximate residential land and buildings and to measure the magnitude of these impacts, if they existed. Second; to determine whether any impact diminishes through time as suggested by earlier research from Kinnard[5] and Reese[7], possibly as a result of screening from the growth of trees, or for a number of other reasons. Finally; the extent to which any impact extends beyond plots with an easement.

Using the same data from his earlier research with Foley[8], Colwell added more variables to the analysis, the most important being distance to a pylon and the presence of an easement, in addition to, six describing the characteristics of the building (plots size, building size, number of bathrooms, basement, garage size, the presence of a deck) and four separate variables to represent improvements. Selling price then became a function of property characteristics and proximity to the line or pylon.

He hypothesised that residential units in close proximity to lines and pylons would suffer from a large negative impact but that any impact would decline at a decreasing rate as distance increased. He only included units adjacent to transmission lines with an easement, rather than a 'right of way', unlike Derbes (1968)[30] and Bigras[17], who included both and as a result did not isolate the benefits of a larger plot size or a 'green' corridor[xxi], thereby reducing the overall validity of the results.

Using multiple regression analysis, Colwell[19] concluded that proximity to a transmission line was associated with reduced selling price; however, this impact diminished over time, possibly due to natural screening from the growth of trees or for other reasons. Regarding towers, the results suggested that the effects did not diminish over time. He also found that value diminution was not just related to the presence of an easement, there was a *"proximity effect even for those properties that do not have the easement"* (*ibid*).

2.4 COMPENSATION AND OTHER ISSUES

The legal and compensation issues surrounding the siting of HVOTLs and other electrical distribution equipment in the UK and the USA, are dealt with in Chapter One. However, several studies dealing with these issues have also highlighted other important factors relating to the valuation of land and residential buildings and are therefore worthy of a mention here.

[xxi] Land that cannot be developed, affording a degree of privacy to proximate property.

Furby *et al.*,[26] considered the legal issues and in particular, the basis for determining compensation for a diminution in property value due to the siting of a new HVOTL[xxii]. He concluded that there were several issues which future research should address; first, finding a solution to the lack of good empirical valuation data and second, the development of a generally accepted procedure for determining compensation on the basis of fair market value. Sage and Johns (1991)[31], Green (1992)[32] and Rikon (1996)[33] also acknowledged that comparable valuation data was hard to find. Bryant and Epley (1998)[34] suggested that, since the use of comparable sales was the preferred approach to determine the level of damages, valuation data needed better management, including the building and maintaining of a database for all to share.
Furby *et al.*,[26] suggested that this would solve only part of the problem and future research was also needed to determine the attitudes and reactions of the market participants. However, Bryant and Epley[34] questioned the validity and reliability of opinion surveys as *"an individual cannot accurately estimate his/her reaction without the pressure of the transaction, negotiation and financial commitment."*

Sage and Johns'[31] legal article highlighted another important issue regarding compensation claims. This was the fact that prospective homebuyers had begun to pay more attention to the proximity of electrical transmission equipment and the association between EMFs (produced by lines) and cancer, adding that, the courts' decision, in *San Diego Gas & Elec. Co v Daley*[xxiii], to validate compensation for 'fear of EMFs' from power lines, would be reflected in buyer behaviour and result in 'slower sales and lower prices' (see Chapter One: 1.3).

Bryant and Epley[34] suggested that potential compensation for future litigation would be reduced if wider easements were adopted. This would show a degree of prudent avoidance should any link between cancer/ill health and EMFs be found at a later stage and, therefore, lessen the electricity utility's and property professionals' liability.

2.5 HEALTH RISK CONCERNS

Despite the publication of several articles (scientific and medical journals; newspaper articles; see Chapter Three: 3.3) on the possible, although unproven, association between living in proximity to power lines and childhood cancer in 1979, some researchers [xxiv] believe that health concerns really

[xxii] In the UK, transmission lines are not usually sited over existing residential buildings, however, agricultural land is frequently crossed by HVOTLs.

[xxiii] *San Diego Gas and Electric Company (SDG&E) v Daley (205 Cal. App. 3d 1334, 253 Cal. Rptr. 144, Dec 22nd 1988)* Cited in Sage C. and Johns J. G.[31]

[xxiv] Gregory R. and Winterfeldt D.[25]. Research partially funded by The Electric Power Research Institute under contract No. RO-2301-3.

rose to the public's attention following the publication of a book and several widely circulated articles by the science writer Paul Brodeur in 1989. Research carried out in the early 1990s[xxv] suggested that the public were still largely unaware of any potential link between living in proximity to power lines and adverse health effects. Arguably, the lack of public knowledge of this association may have accounted for the conclusions of some research that there was little or no effect on the value of property in close proximity to power lines. Florig (1992)[35] believed that concern was growing, driven by the epidemiological[xxvi] studies that continued to show an increased risk of cancer.

2.5.1 Combined (Opinion and Valuation) Studies

Delaney and Timmons (1992)[36] found that there had been a 'dramatic shift in perception' regarding the value of residential units in close proximity to power lines and addressed the issue of perceived value effects on proximate units versus actual market effects. They suggested that the most commonly cited reason for this shift was "*the potential health hazards detailed in epidemiological studies claiming a positive correlation between long term exposure to the electromagnetic fields produced by power lines and certain types of cancers in humans.*" [xxvii]. They questioned whether any value reduction was based on fact or "*simply a belief unsubstantiated by market evidence.*"

To determine this they used a combination of 'matched paired sales analysis'(see footnote vii for an explanation), and public and professional opinion surveys to assess the effect on value for residential units. If, as suggested by their study residential building values are adversely affected, then arguably this may also apply to the value of residential land. Residential appraisers were split into two groups; those who had previously dealt with property proximate to HVOTLs and those who had not. Opinions from both cohorts were sought on the value effects from proximate HVOTLs.[xxviii] Comparing the responses the researchers were able to determine whether a) house value was lower near HVOTLs and b) whether both groups perceived that value would be affected to the same degree. The results suggested that the value of residential units can be negatively affected by proximity to HVOTLs and that both groups cited the 'visual unattractiveness of the power lines' (93.9%) as the main reason for value diminution, followed by; 'potential health

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[xxv] Kung and Seagle.[2]

[xxvi] Epidemiology is the study of the incidence and distribution of diseases in the population, rather than a scientific study carried out under laboratory conditions. Epidemiological studies found a relationship between smoking and cancer and asbestos and lung disease, long before a scientific causal link was discovered.

[xxvii]New York Times E.P.A. (Environmental Protection Agency) Draft report cites studies linking cancer to electricity May 22 1990. – Wall Street Journal. February 16th 1990 'How electric fields may damage human cells'

[xxviii] 500 Appraisal Institute members holding the RM designation were sent questionnaires.

hazards' (58.9%); 'disturbing sounds' (43.1%) and the perception that they were 'unsafe' (28.6%). They also indicated that HVOTLs may affect some residential units and not others; the effect being a function of the relative price of the unit being appraised. These findings are supported by other studies (Hamilton and Schwann, 1995[37], Gregory and Von Winterfeldt[25]), differing only in the level of diminution of value or distance from the lines.

Appraisers who had no experience in valuing this type of property perceived a greater negative value effect (11.94% compared to 10.01%), suggesting that perception has a more negative effect on value than actual market evidence. They noted that the results of their study contradicted much of the research carried out since the 1950s, which had, in general, found no correlation between proximity and negative value effects, and concluded that, *"one logically would have to credit the increased public awareness..."*[xxix] of potential health risks for the change in attitude, which they added, '*...is being incorporated into the pricing calculus of residential home purchasers and capitalised into lower property values.*' Builders' reactions were also noted, with 68.5% reducing prices; 58% offering larger lot sizes; 48.7% providing visual buffers and landscaping and 8% of the respondents included choosing other sites.

The perception of a potential health risk was an important consideration in Kung and Seagle's[2] investigation in Memphis and Shelby County, Tennessee. They suggested that not only was the value and marketability of such property affected by the *"mere presence of the transmission towers,"* but also that the *"presence of these possible health hazards, if known to the general public, could certainly lead to a decrease in demand for properties located near transmission lines and in turn lower property values in these areas."*[xxx] Their study analysed the spatial relationships between power lines and property values using power line maps available from 'Memphis Light, Gas, and Water (MLGW)'. Homes directly beneath or adjacent to lines were surveyed to collect information on 'real or perceived influences', including the potential health risks, on house price and marketability. Valuation data were collected from reliable sources (local estate agents) on houses near and not near HVOTLs. This was used to formulate computerised spatial maps of the areas (distance to power lines, square footage, type of housing, and information listed on the Geographic Information System - Multiple Listing System (MLS).

The results revealed that house values were generally unaffected by the presence of HVOTLs which, the authors suggested, was due to the fact that the homeowners surveyed were largely

[xxix] Delaney and Timmons[36]

[xxx] Kung and Seagle[2]

unaware of the reported health risks and were more concerned about visual unsightliness. However, following a degree of 'enlightenment' as a result of being asked to participate in the survey, the majority (87%) stated that, had they been aware of the potential health risks at the time of their purchase, it would have negatively affected their decision to buy and the price they were willing to pay. Kung and Seagle[2] suggested, on the basis of this evidence, that the public should be made more aware of the potential health risks and that development should be restricted in the vicinity of power lines and towers.

2.6 MID 1990s RESEARCH

As the literature reviewed shows, different studies have used different methodology for assessing value effects and few have agreed on the impact. Gregory and Winterfeldt[25] suggested that recent studies were even less conclusive than those prior to 1979. The possible reason for this dichotomy is the emergence of the idea that *"property values are a mental concept, relating to people's attitudes and perceptions, as well as a social construct, relating to the existence of a market within which experience is gained over time in the buying and selling of properties."*[xxxi] Therefore the results of market-based studies conducted by appraisers will differ from the results of an attitudinal one which attempts to discover the public's true feelings and therefore predict their willingness to purchase a particular property. They found that attitude studies were likely to show larger declines in value than studies of actual market sales. This supported Kroll and Priestley's[3] findings from a review of six attitudinal studies, which suggested a much larger negative effect on the value and desirability of proximate residential units than actual sales figures indicated from their review of appraisal (house price) studies. An interesting finding to emerge from this was that the number of respondents who had experienced 'actual' value effects from proximity to lines was far smaller than the percentage of respondents who perceived that there would be a negative effect. As Kinnard[5] observed, *"it really does not matter that they may be uninformed or inaccurate judgements, at variance with the 'facts' of the market. Buyers and sellers base their actions on their expectations and anticipations. If fear is a widespread influence, whether justified or not, it will affect value adversely."*

Gregory and von Winterfeldt[25] questioned whether or not any negative value effects were the result of perceived health fears. Their study noted that the focus of public opinion had recently shifted from a specific fear of the possible link between EMFs from power lines and cancer, to a more general fear of living in proximity to power lines, perhaps as a result of perceived health risks or

[xxxi] Gregory and Von Winterfeldt[25]

perceived threats to equity[xxxii]. They suggested that the "*effects of this shift, from linking property-value effects with cancers to linking property-value effects with fears, could prove to be far more significant*". Risk perception will affect potential buyers differently and research in this area has suggested that people tend to fear hazards that are unfamiliar, unseen, difficult for an individual to control, or those with delayed effects (like, for example, the health effects from exposure to radiation). Slovic (1987)[38] provides a good basis for the understanding of the possible sources of many fears that may affect property desirability (and as a result its value) and suggests that the way in which nuclear power has been stigmatised may hold a clue to how the most appropriate way of dealing with power line stigma (see Chapter Three: 3.1.2).

Reviews of past research have suggested that there may be several reasons why a power line and pylon could devalue property (Priestley and Evans, 1996[39]). These include the visual aspect; land use restriction; an increase in personal fears about health leading to a possible reduction in the number of potential buyers; an increase in the cost to the seller as he/she has to obtain a report of the EMF emission levels, and longer marketing periods. Furby (*et al.,)*[26] found "*a clear discrepancy between what laypeople and experts think about the effects of transmission lines on property value.*" This perhaps explains, to some degree, why most studies have concluded that it was not the health and safety issues that influenced the negative market effect. Other factors such as unsightliness, visual and aural pollution were more often identified above any risks to health. It is these elements which have proved to be more useful to claimants or significant in court action.

Hamilton and Schwann (1995)[37] found the visual aspect to be an important consideration in their study of 12,907 single detached dwellings in four Vancouver Canada neighbourhoods over the period 1985-91. Using a similar method to Colwell[8] (a hedonic approach), the estimated regression results showed that proximity to pylons was statistically significant, although the overall value effect was small. Their results suggested that moving from a house adjacent to a tower to one 100m away increased the value by 5.8% and removing the visual unsightliness created by the tower increased value by 5.7%. Removing transmission equipment completely from view, i.e., burying lines, increased value by 6.3%

In New Zealand, two studies arose from a consultation in November 1993 between Transpower New Zealand and the Massey University Real Estate Analysis Unit (MUREAU). Transpower were interested in the effect of high voltage power lines on property values because of the possible compensation that may have to be paid to property owners. The only previously published study

[xxxii] Perceived threats to equity may come from the belief that the perceptions of prospective house-buyers may also be negative towards living in proximity to HVOTLs, thereby reducing the number of potential buyers and perhaps increasing the length of time a property is on the market before a buyer is found (*ibid*).

had been carried out in Christchurch and Auckland, in 1968, by Valuation New Zealand (VNZ)[18]. It concluded that overhead power lines did not appear to have any effect on the value of residential units in the 'average locality' [xxxiii] but did have a negative effect in the 'superior locality'[xxxiv].

Callanan and Hargreaves (1995)[40] used regression analysis to determine the effect on the value of residential units in the suburb of Newlands, New Zealand. Sales data from a five-year time frame were extracted from the New Zealand Institute of Valuers' database (Valpak II) and produced a total of 330 sales transactions, within 300m of the line for analysis. 4.5% of these were directly under HVOTLs and 10% were within 50m of the line.

Their model used three different types of variable:

I. Property specific variables – e.g. plot size.

II. Real estate market variables – e.g. month of sale and location within the suburb.

III. Transmission line and tower distance variable: They noted that this variable produced largely inconclusive results, due to the fact that the Newlands area is very hilly and it is possible for a property to be within 50m of the HVOTL and yet suffer no visual impact and therefore, a line of sight variable would have been of more use to this study.

The results indicated a negative effect on the value of some, but not all property, which diminished to almost nothing at around 100m from both the line and the pylons. This had the effect of reducing value by around 27% at a distance of 10m from the pylon, 13.6% at 20m, 5.4% at 50m diminishing to 2.7% at 100m (see Table 2-1). For properties directly under the line, the effect on value was less than 1%, leading to the conclusion that the presence of a pylon had a greater impact on the value of property than the power line itself.

However, an earlier study by Millar and Hargreaves (1994)[41] reported that the transaction price for residential property appeared to depend more on the location within the Newlands area, than on proximity to either power lines or pylons [xxxv] (possibly due to factors such as the 'hilly terrain' and the view of the harbour).

[xxxiii] See footnote 'vi' for a definition of 'average locality.'

[xxxiv] A "superior" locality is defined as a locality comprising homes at the high end of the price range for homes in the city. These homes are generally purpose built to meet client requirements, have a more expansive layout, better quality fixtures and fittings, and are more aesthetically appealing than "average" homes " (Bond and Hopkins 2000: 53).[50]

[xxxv] Newlands is of a hilly terrain and has panoramic views of the Hutt valley, downtown Wellington and the harbour. (Callanan and Hargreaves, 1995)[40]

One factor which may have affected the results of the survey came to light after the study was completed. This related to the 'strong rumour' that either one or both of the transmission lines was shortly to be removed. (Shortly after the completion of this study, the section of line that runs through the largest area of the Newlands suburb was, in fact, removed).

Table 2-1: Percentage Reduction in Average House Price in Relation to Distance from a Pylon

Distance	Dollar Amount	Percentage
At 100 metres	-$3551	-2.7%
50 metres	-$7102	-5.4%
30 metres	-$11,836	-9.1%
20 metres	-$17,755	-13.6%
15 metres	-$23,673	-18.2%
10 metres	-$35,510	-27.3%

Source: Callanan and Hargreaves (1995)

The second study by Bond (1995)[42] was a parallel study of the attitudes and reactions of property owners and professionals. This was conducted in the same residential location and ran concurrently with the Callanan and Hargreaves study[xxxvi]. The conclusions were that "*both valuers and real estate agent groups are particularly negative in their reactions towards the saleability of properties situated close to the tower and/or HVOTLs.*" This would influence their advice to potential customers and the value they placed on such properties in the market place. Gallimore and Jayne (1999)[43], Kinnard and Worzala (1996)[44], Slovic[38] and Syms (1996)[45] dealt with this issue in their attitude studies which have been reviewed later, in Chapter Three: 3.4.

A Canadian study (Rosiers[20]), supported Callanan and Hargreaves'[40], Colwell's[19] and Hamilton and Schwann's[37] earlier findings, following a survey of 507 single family house sales. Part of the transmission line corridor passed through a wood and was screened from the property adjacent to it. This property, although physically more proximate to the line and towers, did not suffer from value diminution in the same way as property further away that had a direct view of the towers. Overall, Rosiers found that the value of property having a view of the HVOTL was reduced by between 3% and 23%. A later study, based on the same sample (Rosiers[21]), was analysed using a micro-spatial approach to valuing HVOTL proximate property. Rosiers stated that several factors must be considered when assessing the impact of HVOTL structures on residential areas. For instance; the extent of visual encumbrance affecting home owners"; the 'distance' from the line or pylon; the pylon height and 'design'; *"the quality of easement landscaping and, finally the surrounding*

[xxxvi] The results of both studies were summarised in a later article by Bond and Hopkins (2000).

topography, which may enhance or reduce negative externalities." His conclusions reaffirmed the earlier findings, adding that a reduction in property value averaged at 14% at the narrowest part of the easement and 10% for the whole sample area.

2.6.1 Studies in the UK

Due to the lack of available transaction data in the UK, most studies have concentrated on the attitudes and opinions of valuers and buyers to determine any value effects and are dealt with fully in Chapter Three. Surveyors and agents have found that although property adjacent to HVOTLs sells (Dent and Sims[6]), the presence of lines removes some buyers from the market, and reduces demand, which consequently reduces price. The sale process can also be lengthened by many months and so the true effect on value can be difficult to assess [xxxvii]. Calculating the value for this type of residential unit can also provide a challenge to surveyors who were, until recently[xxxviii] expected to take into consideration the effects of public perception of health risks on the future value and marketability of such property.

Several recent studies have looked at the effect of perception in respect of this issue (Bond[42]; Dent and Sims[6]; Gallimore and Jayne[43]; Mitteness and Mooney, 1998[46]), and have generally concluded that the 'perception' of negative value effects on homes in close proximity to HVOTLs is much more negative than activity in the market, in other words, actual property transactions, would suggest.

2.7 SUMMARY

On balance, most research carried out before the mid 1990s concluded that there are no real effects on the value of residential land or buildings. However, closer inspection reveals that either research designs have not been standardised, making comparisons between studies difficult, or that there are weaknesses in the methodology, and either important variables were omitted or factors such as a larger plot size, or longer marketing periods, as indicative of a loss in value, were not acknowledged.

More recent studies have generally used statistical analysis, usually a regression technique, to analyse the data and determine accurate effects and most have concluded that the presence of HVOTLs and, more importantly, their supporting towers, does negatively affect the value and marketability of residential units.

[xxxvii] For instance, the financial cost of an illiquid asset.

[xxxviii] This Practice Statement (P.S. 3.7) was removed from the latest edition of the RICS '*Red Book*' as it related to valuation methodology (Simon Coates, RICS. London. August 2004).

2.7.1 The Most Frequently Cited Effects Were:

I. Diminished price;

II. Increased marketing time - this represents a real loss to the seller by deferring receipt, availability and use of sale proceeds.

III. Decreased sales volume - a more subtle indicator of a negative impact[xxxix] (Kinnard and Dickey, 1995[47]).

Other studies added that, there may be a reduction in the number of buyers due to:

IV. Health fears - most resistance is found amongst parents with children still at home.

V. Equity fears - concerns that future marketability and value may be negatively affected.

2.7.2 Residential Developments: Changes in Attitude

Over the last decade, there has been a noticeable change in the way residential land, crossed by power lines is developed in the UK, suggesting a perception within the property industry (developers, builders, investors) that HVOTLs and pylons de-value residential units (Dent and Sims[6]). However, it is not known whether this perception is based on fact supported by market evidence, since no data are freely available for analysis in England, or simply the opinions, attitudes and perceptions of property professionals. These changes have included:

I. the removal of lines and pylons (some developers will pay to have lines either re-routed or laid under-ground, others will not consider this type of land for a residential scheme) or;

II. the introduction of 'power line corridors' with developers building residential schemes around HVOTLs and pylons, producing a 'power line corridor' effect similar to a power line 'right of way' (ROW) found in Canada and the USA.

III. Developers and builders placing low cost and social housing closest to the line, "*indicating an effort to avoid the full impact of what they conceive to be a detrimental influence*"(Reese[7]).

2.7.3 Main Causes of Value Diminution

Overall, the factors most frequently cited as contributing to a diminution in value are; visual unsightliness; health concerns; noise; safety concerns (electrocution, falling down) and; restricted land use (Bryant and Epley[34]). Some attitude and opinion based surveys have suggested that the visual impact has the greatest effect on value, followed by health concerns (Delaney and Timmons[36]; Kung and Seagle[2]). Other reports (Priestley and Evans, 1996[48]; see also 2.7.1 above), identified health and safety concerns (lines and pylons falling down and electrocution), above

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xxxix "*A measurable decrease in sales in the impact area compared with sales in the target area could represent evidence of a decreased market value from proximity to the HVOTL*" (Kinnard and Dickey[47]).

property value impacts.[xl] It could be argued, therefore, that, if screening diminishes the negative impact on value (Colwell[19]; Rosiers[20]), the fact that HVOTLs are less visible may also reduce public concern about the possible adverse health effects which have been associated with living near HVOTLs.

2.7.4 How Much Impact Do These Factors Have?

Overall, the literature reviewed would suggest that:

I. Not all property is affected - only mid-priced to high-priced localities seem to suffer (Callanan and Hargreaves[11]), and other factors such as a water-front view can mitigate negative value impacts (Chan, 2001[49]).

II. Negative value effects appear to range on average between 2-10%, although, diminutions as large as 29% have been found (Gregory and Winterfeldt[25]; Bond and Hopkins[50]).

III. Pylons have a much greater impact on value than a line - suggesting that it is the visual impact rather than health concerns that reduce value, as the electromagnetic fields thought to cause adverse health effects are greatest under the centre of the line (Colwell[19]).

IV. Several studies have found that negative effects are transitory, especially those associated with the line rather than the pylon, and diminish with time, due, most probably, to natural screening (Kinnard[5]; Colwell[19]).

V. Results from most studies suggest that negative effects are usually only found on property within 200 metres of transmission equipment. Outside 200m, any negative effect is minimal (Callanan and Hargreaves[11]; Hamilton and Schwann[37]; Bond and Hopkins[50]).

2.7.5 Methods Most Frequently Used to Determine Value Effects

Analysis of the literature would suggest that there are three generally accepted methods of measuring proximity impacts; 'paired sales analysis'; 'survey research/opinion polling' and; 'market impact studies' using a multiple regression technique. (Kinnard and Dickey[47]).

A 'paired sales analysis' is usually undertaken to establish any effects on the market value of property/land. This compares property in the impact area, with similar property in an unaffected area; however, there are several problems with this method. First; it has been found that surveyors studying the same locality will often produce different pairings. Second; insufficient numbers of similar comparable properties can render the entire procedure questionable in terms of representing the market.

Survey research or opinion polling is the method used to produce a contingent value model (CV

[xl] The data for this study were collected in 1987 before the perceived link between living near HVOTLs and adverse health effects, such as cancer, were widely publicised.

model) that attempts to quantify likely/probable market behaviour by potential buyers. However, there are also problems with this type of investigation. Kinnard and Dickey cited the Report of the National Oceanic and Atmospheric Administration Panel on Contingent Valuation published in January 1993, which highlighted several problems with this approach. They suggested that there was a need to ensure that the budget and information was adequate, also to ensure that the section of the market surveyed was representative and relevant to the study. They also noted that there was often a difference in the public's 'willingness to pay' in order to avoid a particular hazard as opposed to being compensated for living next to it, such as the siting of a new HVOTL. Research suggests that buyers may be quite willing to purchase a house next to a power line if the price is 'right'; however, those same buyers may expect far more compensation if they have a new power line imposed on them subsequent to their purchase. More importantly, studies have also shown that respondents do not always react in the manner indicated by their response to questionnaires.

Finally, the third method generally accepted by researchers in the determination of market effects is multiple regression analysis (MRA) in the hedonistic pricing model format. This method gathers data on house prices over the impact area and other surrounding areas over a period of time and then analyses them. Often, measurements are included to show distance from the hazard. This is an excellent method if the researcher has access to the relevant data and there is evidence of homogeneity; in other words, results can be transferred from one area to another.

2.8 CONCLUSIONS OF THE CHAPTER

Implications for the United Kingdom: As the literature review reveals, most research has been conducted in the USA, Canada and New Zealand where property transaction data are 'open and more readily available' for analysis. Transactions in the UK are, by comparison, *"usually private between vendor and purchaser and as such tend to be shrouded in secrecy,"* (Jayne 2000[51]) and, as a result there is a lack of available data for a similar study to determine actual value impacts in the UK. Several perceptual / attitude studies had been conducted to assess the 'likely' reactions of the market. However, due to the dichotomy between hypothetical behaviour and actual behaviour when faced with the financial pressures of a 'real life' situation, conclusions from this type of study are not robust enough to support an accurate assessment of the value effects from the siting of distribution equipment.

It is clear that developers are already assuming some value impacts prior to developing residential land; however, it is not clear on what evidence this assumption is made. Estate agents have found that, although residential units near HVOTLs and pylons sell, their presence removes some potential buyers from the market. This, in turn, increases marketing time and can often lead to a price reduction to secure a sale.

Some opinion surveys suggest that property professionals are more negative towards the presence of HVOTLs than the general public. This may be creating a problem within the market where none previously existed. Any reaction, within the property industry, to a particular environmental factor, should be based on sound market evidence and not on the opinions and perceptions of individual professionals. However, the lack of available valuation data within the UK makes this very difficult.

Therefore the key issue for the UK market is to overcome the data 'void' with an alternative methodology which can be shown to produce accurate results. That is one aim of this study.

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Chapter Three

Risk Perception, Attitude Studies and Stigma

3.0 INTRODUCTION

Property values and marketability are driven by many diverse factors, including Government policy, the economy, supply and demand, current social trends and location. Bell (1999)[1] states that, "*...all the factors that have an influence on a property's desirability, and therefore its value, are traced back to the market's perceptions,*" and therefore property desirability and worth will reflect both buyers' and sellers' "*... needs, tastes, fears, sensitivities, desires and anticipations...*". The effect of market perception is particularly apparent when dealing with the valuation and remediation (cleaning up) of contaminated land and there is a growing body of literature devoted to this issue, in particular, the difficult task of placing a value on the effect of perception.

When carrying out an assessment of value, the actual price paid, (the transaction price) whether for land, property or consumables, is no doubt the most accurate determinant of its value.[i] Any changes, or anomalies in the way the market behaves can be identified by analysing transaction data (quantitative data) over a period of time. However, there are two fundamental problems with relying solely on quantitative data for a true analysis of the property market. First, the quality and strength of the result will reflect the quality of the data used for an analysis. Clearly, for instance, old data are unlikely to produce a reliable indication of current market or likely future trends, and it can often be a problem finding sufficient properties (cases) to be representative of the type of market being studied (Mundy 1992[2]; Syms,1996[3]), especially when the case study involves a detrimental condition.[ii] Second, transaction data can only reveal the value differences between individual goods; it cannot explain, for instance, why a buyer will choose one property over another despite little or no apparent difference in style, function or quality. Qualitative analysis is the analytical tool used to determine these differences and explain buyer preference thus enabling professionals to predict (to some degree) the probable reaction within the market towards new products or environmental features (see Chapter Four: 4.2 and 4.4).

The use of qualitative analysis as an alternative method of establishing value impacts is not widely accepted within the UK, although in the absence of transaction data it is the only method available. For qualitative analysis to be predictive, it must establish the key factors that influence market participant behaviour, for instance; socio-economic status, age, and number of children. However, establishing the impact of HVOTLs is somewhat more complex due to the publicised yet unproven link between living close to HVOTLs and a number of adverse health effects, in particular, childhood leukaemia. The publicity generated by the more widely publicised health studies has

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[i] Market value can only be a reliable indication of worth if this price is obtained in a market free from constraints. In other words that there is a willing buyer and a willing seller.

[ii] A detrimental condition is anything that influences the market negatively, for instance, a leaking underground storage tank or a murder committed in the subject property (Bell[1]).

already influenced the property market to some extent (RICS, 1997[4]; Gallimore and Jayne, 1999[5]; Jayne 2000[6]), leading to the introduction of a new RICS Practice Statement in 1996 (see 1.0).

Since public and professional perceptions have been found to influence the residential property market, they are therefore an important consideration when determining value (Bell[1]). This chapter explores the use of qualitative analysis to determine attitudes and perceptions towards HVOTLs. Due to the complex relationship between different factors influencing attitudes opinions and perception, this chapter is separated into three interrelated sections.

Section 3.1 presents a general overview of the development of qualitative research and explains the way in which improvements in methodology have enabled researchers to establish a number of key factors (heuristics) that have been found to influence a persons' attitude towards environmental risk and therefore produce a greater degree of reliability when attempting to predict likely market response towards environmental features, particularly where there is an element of risk attached.

Section 3.2 establishes the basis for the public's perception of a relationship between living in close proximity to sources of EMF[iii] and a number of adverse health effects and attempts to place this risk into context by carrying out a review of the more publicised health research investigating this relationship. It was postulated that this knowledge would enable a more informed residential survey to be undertaken and therefore identify how public concerns might impact upon buyer behaviour.

Section 3.3 examines the existing body of research undertaken using a qualitative approach to determine public, professional and institutional attitudes towards the presence of HVOTLs in close proximity to residential property.

Finally, the ability of qualitative analysis to predict likely market participant behaviour towards the presence of HVOTLs near residential homes and the subsequent impact on value effects is discussed.

3.1 QUALITATIVE ANALYSIS

Qualitative approaches to research originate from within the field of sociology and have been used to explain the behaviour of people and the society in which they live (Walliman, 2001[7]). Results drawn from early studies using this type of approach were regarded as "*limited, unreliable and lacking in solidarity*" largely because, unlike quantitative data, opinions, attitudes and perceptions

[iii] This included electrical distribution equipment, mobile phone base stations and TV/ Radio masts.

did not produce what was perceived as 'hard' reliable data. However, improvements in methodology have resulted in a general acceptance of the use of this approach and in the ability of the results to enable more robust conclusions to be drawn (Dey, 1993[8]).

Bryman (1988[9]) compared the contrasting features of quantitative and qualitative research and explained that qualitative research "*is used to construe the attitudes and motivations within a subject*...[with] *the researcher... getting as close as possible to the subject of the research in order to collect resonant, fertile data to enable the development of a social construct.*" This approach "*tends to be unstructured, allowing concepts and theories to emerge.*" By comparison a quantitative approach "*begins with concepts and theories and tests them in a rigorous, structured fashion with the result that they are either supported, amended or rejected.*"

Property professionals have used basic qualitative analysis techniques (opinion surveys) since the 1950's to determine the impact of HVOTLs on property values, particularly when assessing compensation in eminent domain cases. Early studies were principally concerned with the effects on future land use (Carll, 1956[10]) as there had, at that time, been no association between HVOTLs and health risks. The usefulness of the results obtained from the type of methodology used in early qualitative analysis began to be questioned by social scientists who had been given the task of assessing public opinion towards natural and manmade environmental risks (Krimsky and Golding, 1992[11]; Slovic 1987[12]) and, more importantly, to find some explanation for "*what they viewed as paradoxical behaviour.*" Why, for instance did people continue to live in flood plains, often without insurance, where there was a high probability of flood damage to their land and homes; or in high-risk and high-probability earthquake or avalanche areas? Even more perplexing was the fact that people would accept risks such as smoking and yet be more hostile towards technological risk, however minor (*ibid*).

With the growth of technology, risk analysts found that existing research methodologies were not adequate to understand, explain or predict public behaviour towards technological risk. In addition, man-made incidents or disasters such as the underground chemical storage leak at Love Canal in New York and the accident at 'Three Mile Island' nuclear power plant,[iv] appeared to produce an effect on the value and marketability of affected land and property that went beyond the cost of remediation. Simply removing the detrimental condition, cleaning up any damage and guaranteeing no further risk was not enough to ensure an immediate return to normal market behaviour. This

[iv] Media attention towards disasters such as the nuclear accident at Three Mile Island in 1979 has helped to create a negative impression of the nuclear industry which proved very costly for the utility which owned this power station and "*imposed enormous costs on the nuclear industry and on society*" (Slovic 1987[12]). In fact, in this case the incident proved that the safety features in place to prevent a major disaster (radiation leak) worked. No one died and it is thought that there will be few, if any, latent cancer fatalities.

effect became known as 'Stigma' and was directly related to the public's perception of the 'risks' association with that particular hazard (Krimsky and Golding[11]).

3.1.2 A Brief Introduction to Risk Analysis

The study of 'Risk' involves a combination of 'technical' analysis; focusing on the probability of an event happening and the consequences (number of deaths, environmental damage, property damage, financial costs etc) and 'social or perceptual' analysis of the hazard or risk[v]; focusing on the complex interplay between a set of stimuli involving psychological, sociological and cultural perspectives (Freudenburg, 1988[13]). Kasperson *et al.,* (1988[14]) explains that an "*investigation of risks is at once a scientific activity and an expression of culture,*" The term 'risk' therefore represents a multiplication of the probability of an event occurring and the consequences and is based on "*the assumption that society is indifferent to low-consequence/high probability hazards and high-consequence/low-probability hazards*" (Krimsky and Golding[11]). However, the accuracy of this early assumption was disputed by a number of social scientists (Kasperson, 1992[15]) because, despite steady improvements in the health and safety of the general public due to technological advances, "*people* [now] *view themselves as more rather than less vulnerable to the dangers posed by technology.*"

Kasperson suggested that, despite the public's general familiarity with taking risks, some environmental hazards considered to be 'low risk' or to have a 'low probability' of occurring (e.g., the risk of developing cancer from living in proximity to HVOTLs), provoked the most illogical and negative reactions from the public when compared to high risk activities such as smoking. This behaviour led social scientists to "*challeng*[e] *the theory of rational behaviour*"(*ibid*), which had been postulated by the technical analysts for many years and to develop new approaches towards risk perception analysis. He found that one of the main barriers towards the creation of a coherent 'risk analysis' methodology had been the separation of what various social scientists viewed as different aspects of environmental risk analysis and suggested that social scientists, in particular, had "*failed to incorporate the important insights generated by alternative approaches to harness the full power of the social sciences in enriching the analysis of risk*"(*ibid*).

During the late 1980s, a new all-embracing approach to risk analysis was advocated, partly in an effort to explain why the public reacted so negatively towards some "*relatively minor risks or risk events, as assessed by technical experts*" (*ibid*). By developing the use of psychometric testing[vi] and

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[v] Hazard has been defined as "*threats to people and the things they value*" Risk has been defined as "*the probability of experiencing harm*" (Kasperson *et al.*, 1988).[14]

combining this with risk perception and behavioural decision theory, they were able to lay "*bare the heuristics* (Krimsky and Golding[11]) *that ordinary people utilise to cope with the complex array of risk information...*" (*ibid*). As a result, risk perception analysis evolved and no longer just focused on risk management and communication but provided important information to facilitate a more accurate calculation "*of risk consequences and probabilities...as well as analysing and explaining public responses to risk.*" (Freudenburg[13]).

To develop further this new approach towards risk analysis, a conceptual framework was introduced under the heading of the 'social amplification of risk', which was designed to 'link' up, "*the technical assessment of risk with psychological, sociological and cultural perspectives of risk perception and risk related behaviour*" (Kasperson[14]). It was based on the theory that risk 'amplification' could occur at two stages; first, in the transfer of information about the risk and second, in the way that society responded to that information. The transfer of risk essentially represented the manner in which the risk is communicated to others, such as information from technical experts or the media. This information is then interpreted by ndividuals, groups and institutions and the response which follows will reflect the psychological, social, institutional and cultural influences that shape individual, group or institutional risk behaviour. This can result in behaviour that reflects an increased concern towards low risk, low probability hazards or a reduction in concern over a high level risk that has a high probability of occurring.

One study to demonstrate this effect was conducted by Morgan, *et al.*,(1985)[16]. He found that "*the perceived risks associated with electric and magnetic fields from power lines and electric blankets were relatively low. However, when the respondents were given a supposedly non-alarming briefing about research on health effects of EMF fields (which stated that many studies had been done and that no adverse human health effects had been reliably demonstrated), their perceptions on subsequent retest shifted toward greater perceived risk.*" In some cases, the change in public perception can generate secondary social or economic consequences (e.g., Three Mile Island), which can result in "*significant indirect impacts such as liability, insurance costs, loss of confidence in institutions, stigmatisation or alienation from community affairs*" (Kasperson[14]).

Slovic's development of the use of psychometrics to identify the determinants of behaviour has established some basic premises to explain and predict likely behaviour, even when it fails to follow a 'logical' pattern. In particular, he was able to identify a number of factors or 'heuristics', which could account for some seemingly illogical public behaviour in response to certain risks. One

[vi] Paul Slovic was largely responsible for the use of psychometric testing to determine public perceptions of risk. Interestingly, this has evolved into two distinct paradigms; one based on the behaviour of individuals

such factor to influence the public's acceptance of risk was found to be "*voluntariness of exposure...*" (Krimsky and Golding[11]). Other studies (Starr, 1969[17]; Slovic[12]; Mundy[2]) have found that "*... familiarity, control, catastrophic potential, equity and level of knowledge, also seem to influence the relationship between perceived risk, perceived benefit, and risk acceptance*" (Slovic[12]). For instance; radiation from medical sources such as x-rays is seen as high benefit/low risk, whereas radiation from industrial technologies such as nuclear power is seen as low benefit/high risk. Slovic found that not only could 'a lack of knowledge' increase public fear towards exposure to EMFs from electricity power lines, but, in a quotation from Coy (1989)[18] reveals that "*...as research studying health effects of exposure to electric fields remains inconclusive but is discussed frequently in the news, perception of risk from these fields is rapidly increasing.*" Negative perceptions, fear, lack of knowledge and uncertainty are all causes of property-related stigma.

3.1.3 Real Estate Behavioural Research

Behavioural research has more recently been used to analyse the decision-making behaviour of real estate market participants, in particular the way in which value is determined. Transaction data is said to be the result of human behaviour and real estate behavioural research has focused on nature of problem solving and information processing (Diaz, 1990a[19]). Information processing occurs in response to a task. Humans use information processing when a decision has to be made. According to Daly (2001[20]) "*heuristics is fundamentally a rational response to expanding levels of information*" and are used to 'short cut' the decision making process by "*reducing the number of alternatives available for a resolution*" (*ibid*). Previous research (Diaz[19]; 1990b[21]) indicated that valuers used heuristics to reduce the valuation process into a more cognitively efficient form by, "*...reduce*[ing] *complex tasks of assessing probabilities and predicting values to simpler judgement operations*"(*ibid*), or rules of thumb. However, as Daly argues, the use of different heuristics to simplify the valuation process may lead to a number of errors due to potential bias (see Table 3-1).

Bias as a result of anchoring behaviour was first hypothesised by Slovic and Lichtenstein (1971)[22] and can occur within the property industry when used by valuers as a starting point for an appraisal. Several studies have found that valuers have a tendency to anchor to list price and can be inappropriately influenced by it (Gallimore, 1996[23]; Diaz[19, 21]; Daly 2001[20]). Residential valuers for instance, will use a price anchor that reflects their knowledge of a particular segment of the market and the quality of available comparable evidence. Price adjustments will then be made to yield the final result but will still be based on the initial anchoring value and therefore may not always produce the most accurate results. Syms[3] found that "*the availability of an adequate volume of*

(psychometric theory) and the other on the behaviour of groups (cultural theory). See Krimsky and Golding, (1992)[11].

good quality transaction and appraisal data....is likely to be limited, particularly when a property is affected by a detrimental condition." Arguably then, the use of anchoring is likely to produce a greater degree of error as the number of available comparables is reduced.

Table 3-1: Potential Bias Arising from the Use of "Rule of Thumb"

Heuristic	Definition	Reason for Bias
Representativeness	Evaluation of an uncertain probability by the degree to which sample characteristics are similar to key features of the population	Similarity or representativeness fails to account for characteristics that should affect judgements concerning probability
Availability	Using ease of recall (of available information) of past occurrences or correlation to assess event probabilities	Availability is affected by factors other than frequency and probability.
Anchoring and Adjustment	Estimates, which originate from an initial starting point (value), that is adjusted to yield the final answer.	Different starting points yield different estimates, which are biased toward the initial value.
Positivity and Conformation-bias	Humans seek data that are fundamentally consistent with existing beliefs, theories and cognition.	Bias occurs when data that should be deemed relevant are not because of a preconscious search for positive feedback.
Recency	Proposes that conclusions may be distorted by the order in which information is received.	Tendency for valuation figures to be moderated towards recent valuation conclusions.
Dilution	Refers to the way in which information is presented and the receiver's attitude towards the information.	Impact of evidence is reduced because of the way in which it was presented.

Source: Daly (2000)[20]

Although in theory the appraisal process should start with general locational features and gradually narrow down to property specific information, Diaz found that almost the opposite was true, with valuers quickly focusing on property specifics and only broadening their information search in response to some ambiguity (Daly[20]). There was also evidence that valuers may have a tendency to seek information that conformed to their beliefs, theories and cognition and would adjust less to negative evidence than to information that supported their views (Gallimore[23]). Conformation bias has also been documented in studies of public response to environmental risk, particularly when there is a publicised association with a health risk (Slovic[12], Fischhoff, 1985[24]) such as the perceived risk from living near HVOTLs (Jayne[6]).

For instance, Fischhoff[24] found that '*...people tend to ignore evidence that contradicts their current beliefs, and base their perceptions of relative risk on what they see in the news media.*' For this reason, the study of risk analysis is particularly relevant to an investigation into the value impacts and potential stigma damage from the presence of electricity distribution equipment, TV/Radio masts and mobile phone base stations due to the perceived link between exposure to EMFs produced by this equipment and a number of adverse health effects including cancer.

In addition, the use of behavioural research to determine the heuristics used by residential property buyers might therefore enable real estate professionals to understand this dichotomy and improve the valuation process where comparable transaction data are limited.[vii]

3.2 PROPERTY RELATED STIGMA

Investigating the impact of stigma on property value is undertaken using a qualitative approach, as stigma is not a physical entity. There are several definitions of 'property-related stigma', for instance, Chalmers and Roehr (1993)[25] define it as "*the reduction in value caused by contamination resulting from the increased risk associated with the contaminated property*". According to Chan (2001)[26], "*stigma is a loss to property value due to the presence of a risk perception-driven market resistance,*'" which not only affects contaminated property, but can also affect the value of land and buildings in close proximity to sources of contamination. Mundy[2] says that, "*environmental features viewed as repellent, upsetting, or disruptive are stigmatised as undesirable. One such source is technologies such as petroleum processing, nuclear power plants and high voltage power lines.*" Chalmers and Roehr[25] also identified EMFs from power lines as one type of stigma capable of influencing the value of residential units negatively.

Bell[1] explains the function of stigma in relation to a number of detrimental conditions (see Table 3-2 below) classified according to the severity of the condition. By means of a case study approach he demonstrates the effects of stigma associated with each of the ten classes of detrimental condition. This includes stigma not related to, or caused by, any form of environmental contamination. In fact, as Bell[1] points out, buildings can be structurally sound, in a well-placed locality and yet be totally unmarketable. Factors such as cultural beliefs, horrific events and disasters can all have an impact, to varying degrees, on the value and desirability of property which may be associated or perceived to be associated with a detrimental condition. An early example of property stigma based only on the perceptions of the market participants, rather than associated with either a natural or manmade hazard is *Feng Shui* (*ibid*[1]).

Feng Shui: In Asian countries and cultures, property values and desirability rely more on the perception of good *Feng Shui* (an ancient system of beliefs governing the arrangement of physical living and working environments using the concept of harmony) than on any other single factor. A survey undertaken in Southern California during the late 1990s revealed that 70% of Asian

[vii] For a more in-depth account of behavioural research see amongst others, Daly J.[20]; Diaz III. J.[19, 21]; Diaz III. J., (1996); Gallimore P. (1994); Havard T. (1998).

purchasers considered *feng shui* and 25-30% consulted a *feng shui* master before buying property. Premiums are often paid for property considered to have a 'good' *feng shui,* whereas a property with bad *feng shui* can suffer from longer marketing periods, lower prices and may not even be considered as a purchase option (*ibid*[1]).

Table 3-2: Detrimental Conditions

Detrimental conditions are categorised. **Class I** 'no detrimental condition' - **Class X** 'severe/incurable detrimental condition'		
	CLASS	**EXAMPLE**
I	No Detrimental Condition or Benign condition	Could include any Detrimental Condition where there is 'No Impact'
II	Non-market Premium	Special Buyer Motivation, Feng Shui
III	Market Condition	Economy, Supply & Demand, Recession
IV	Temporary Condition	High vacancy, Tragedy (crime scene), Distress (bankruptcy)
V	Imposed condition	Eminent Domain (HVOTLs, water), Historical Listing
VI	Building Construction Condition	Construction Defect, Functional Depreciation
VII	Soil or Geotechnical Construction Condition	Soil Construction, Drainage, Retaining Wall
VIII	Environmental Condition	Soil/Building Contamination
VIIII	Natural Condition	Flood, Earthquake
X	Incurable Condition	Complete loss due to severity

Source: Bell, 1999[1]

Other non-physical contaminants which have been found to have a negative impact on the property market include, the occurrence of a tragic or horrific event and conditions imposed by government, for example, planning constraints.

Tragic or Horrific Events usually cause a temporary negative condition. However, this type of event can occasionally be so severe that it will create what Bell classifies as an 'incurable' condition. For instance; loss of life through violence or suicide can stigmatise a building to such a degree that it becomes unmarketable. Bell found that the effect of crime on marketability and value related to the severity of the crime, how recently it was committed[viii] and the amount of media coverage relating to the event. In most cases, however, any negative effects on value or marketability usually lessen and finally disappeared over time.

[viii] The more recent the event the more negative the impact on the value and marketability of affected property, for instance; stately homes and castles often publicise their violent history and the claimed presence of the ghosts of murder victims to entice the public to visit.

Imposed conditions: The provision of services such as water, gas, electricity, roads and sewage can negatively affect property value in two ways, first; by the taking or using of private land to enable utilities to site and maintain equipment necessary for the provision of these services.[ix]. Second; by the public's perception of that utility which will reflect their opinions towards any unpleasant conditions; for instance; odour from a sewage works; the visual impact of a landfill or the association with a health risk such as the perceived link between mobile phone base stations and childhood cancer (Kinnard 1967; Slovic[12]; Syms,[3]; Gallimore and Jayne[5]; Bond 2003[27], 2004[28]).

The property stigma can be caused by real or perceived risks. Real risk effects can be quantified fairly accurately unlike perceived risk, which is based on factors such as; choice, knowledge, the degree of risk involved, in other words; how catastrophic it is[x] (Krimsky and Golding[11]; Mundy 1992[2]; Bell[1]). The level of risk placed on an environmental hazard or contaminant is said to be largely a function of uncertainty by Mundy, who found that the more information people had about the risks to health, property and their immediate environment, the less of a risk an environment hazard or contaminant is perceived to be. Control over a hazard or contaminant was found by Slovic[12] to be one of the more important factors influencing a person's acceptable risk level. Some risks were found to be more acceptable than others because of the potential benefits (e.g. x-rays).

Stigma often reflects negative news and images and, according to Fischhoff[24] 'people tend to ignore evidence that contradicts their current beliefs, and to base their perceptions of relative risk on what they see in the news media'. Levels of risk also vary according to the different people in the prospective markets, for instance, the business sector might not be as concerned about some contaminants as home buyers and for some individuals a price reduction may be all that is needed to secure a sale, although this may not persuade a lending institution to finance the purchase (Mundy[2]). In the UK recently, some lending institutions have shown reluctance towards lending on residential units which are either under, or in close proximity to HVOTLs (Dent and Sims 1999[29]). Earlier research undertaken by Kinnard and Worzala (1996[30]) also indicated a reluctance on the part of some lending institutions which they concluded was due to the fact that, unlike most other contaminants where health risks can be quantified and safe public exposure levels set, the potential health risks from exposure to residential EMFs are still unknown.

The degree of stigma associated with contaminated property is 'dynamic' and will fluctuate in response to a number of factors. Neustein and Bell (1998)[31] investigated the effect of 'diminishing

[ix] In this case, compensation paid to the landowner is calculated to include any loss of value to the remaining parcel of land. However, regarding the sighting of electricity distribution equipment in the UK, compensation is only paid to owners of property touched or crossed by distribution equipment.

[x] For instance, whether it is a personal risk or one which could affect many people.

diminution,' with respect to environmental stigma and explained that the degree of loss due to a contaminant or detrimental condition is lessened by a number of factors which include "...*attitude shifts within the market, advanced valuation methodologies, and emerging risk-management techniques...*" (*ibid*). Time and media attention (Bell[1]; Fischhoff[24]; Jaconetty, 1996[32]) have also been found to have an impact on the degree of negativity expressed towards affected property. Concerns or negative perceptions can either increase due to a growth in media attention or lessen as time passes.

Although 'stigma' is normally associated with contaminated land, Arens (1997)[33] found that proximity to electricity equipment could stigmatise residential buildings in the same way as a known contaminant would. Bryant and Epley (1999)[34] found that, although valuers had been used to addressing the impact of HVOTLs on property values, this was usually related to calculating compensation in easement and eminent domain cases and not due to fear or the expectation of future health problems; "*this issue is new to the literature.*" They suggest that because of this change a "*correct definition and measurement of this new concept is critical as it can be a part of the future evidence in any stigmatised property*"(*ibid*).

The uncertainty surrounding the possible health risks from exposure to EMFs from HVOTLs stems from the conflicting and often controversial reports surrounding the results from health studies carried out since the 1940s. To give weight to the public's perception of 'risk' from living near HVOTLs and other sources of EMF, an overview of the findings from the more publicised health research will now follow.

3.3 RESEARCH INVESTIGATING THE IMPACT OF EMFs ON HEALTH

Until 1979, professionals involved in the valuation of property in proximity to HVOTLs were generally concerned only with overt effects such as visual unsightliness, noise and the loss of amenity due to land use restriction. There were some financial and health or safety concerns (Bigras, 1964)[35], such as "*difficulty in obtaining mortgage financing*" or physical danger from "*falling wires*", but these were rarely cited as factors contributing to value loss or reduced demand for residential property sited close to lines.

Serious concerns about the possible adverse health effects from living in proximity to HVOTLs began in 1979, following the Wertheimer and Leeper (1979)[36] epidemiological study[xi], which

[xi] There are two types of studies used by scientists and researchers to determine the health effects from exposure to EMFs. Scientific studies (sometimes referred to here as biological studies) are carried out under laboratory conditions. Experiments are conducted using animals and cell cultures to measure changes in biological function. Epidemiology is the study of the incidence and distribution of diseases in the population. It was this type of study that showed a relationship between smoking, lung cancer and heart disease.

reported a two-to-threefold increase in cancer death amongst children living near high voltage power lines. This report sparked off thousands of scientific and epidemiological studies (all using a quantitative approach), to determine the biological effects from exposure to electric and magnetic fields (EMFs)[xii]. The results, so far, have been controversial and have failed to resolve this issue either way. For instance; some quantitative research suggests there is no relationship between exposure to EMFs and adverse health effects (Gurney *et al.*,1996[37]; Preston *et al.*, 1996[38]), whilst other studies have reported a number of adverse health effects, including; headaches, epilepsy, severe depression, suicide (Baris *et al.*,1996[39]), Alzheimer's Disease (Sobel, 1995[40]) and childhood leukaemia (Savitz *et al.*, 1988[41]; Feytching and Ahlbom, 1993[42]; Linet, 1997[43]).

The subsequent media coverage of the reported health effects, in addition to valuation and attitude studies conducted by researchers to establish any impact, particularly on the property market, has helped to raise public awareness and create an association between electricity distribution equipment (in particular HVOTLs), and ill health.

3.3.1 Health Research

After the discovery of electromagnetic energy, scientists initially believed that low frequency radiation, also known as 'non-ionising radiation', was biologically non-active and therefore not harmful because it did not produce any 'thermal effects', i.e., it did not heat body tissue. When maximum exposure levels were set in the 1950s, they were based on levels the human body could withstand without causing a significant rise in body temperature; the possibility of non-thermal effects was discounted.

3.3.2 Reported EMF Health Effects

Early health effects were discovered in the 1940s when an increase in the incidence of leukaemia, brain tumours, heart conditions and cataracts was noticed in military personnel exposed to electromagnetic fields of relatively high strength from high frequency radar systems and video screens during World War II.[xiii] Concerns about the potential health effects from other sources of

('Questions and Answers EMF in the Workplace' National Institute for Occupational Safety and Health and National Institute of Environmental Health Sciences. U.S. Department of Energy. September 1996).

[xii] Electromagnetic fields vary in strength and intensity depending on how fast they vibrate. For instance; UK mains electricity is A.C. (alternating current) and reverses its direction 50 times per second. (50Hz) Very high frequencies are known as 'ionising' radiation (ultra violet, medical x-rays, gamma rays) and can break molecular bonds and cause DNA damage. By comparison 'non-ionising' radiation (infrared, microwave ovens, cell phones and radio waves) produces optical and thermal effects at high frequencies. High voltage electricity lines and substations emit electromagnetic fields, which are at the lower end of this frequency scale and therefore do not produce thermal effects in humans. However, it is the unknown potential health effects from living and working in proximity to electricity distribution equipment that has been the focus of health research and the cause of much debate (an explanation of EMFs is provided in Appendix I).

[xiii] Electricity Power lines and Health Conference notes for Powerwatch and Scientists for Global Research. Presentation given by Alasdair Phillips (1994).

EMF grew and soon included police radar, antenna systems used by the military, cell phones, microwave ovens, HVOTLs and other electrical appliances used at home and at work.

High field-strengths produce noticeable affects, such as the heating of body tissue and are known to cause adverse health effects most notably, cancer. Standards for occupational and public exposure levels have been set below the level at which tissue heating takes place (NRPB [xiv]). However, scientists so far have been unable to establish whether, or not, low EMF levels might also be responsible for adverse health effects. Over the last decade, scientific investigation has focused on three kinds of adverse heath effects reported in epidemiological studies.

1. Cancer- particularly childhood leukaemia.

2. Reproductive and development effects; primarily abnormalities and premature pregnancy termination.

3. Neurobiological effects, including learning disabilities and behavioural modification (National Research Council 1997).[xv]

3.3.3 Epidemiology: The link between property, power lines and cancer.

The first study to suggest a link between living in proximity to HVOTLs and cancer was carried out by Wertheimer and Leeper[36] in Denver, Colorado. They had noticed '*an excess of wiring configuration*' (HVOTLs) suggesting high EMF fields near the homes of children diagnosed with cancer. There also seemed to be an '*over-represented*' number of cancer cases found around substations. The results of their investigation suggested that living near HVOTLs increased the risk of developing childhood cancer by a factor of "*two or three*," particularly for children "*who had spent their entire lives at the same address, and it appeared to be dose-related.*[xvi]"

The cause of these adverse health effects was thought to be linked to the magnetic fields, produced by power lines because unlike electric fields which are easily screened, magnetic fields, are not and can penetrate buildings and '*the human body readily*' (*ibid).* To determine if a correlation existed between exposure levels and an increased risk of cancer, researchers developed a system of coding

[xiv] A full report can be found on the NRPB's website at http://www.nrpb.org/publications.

[xv] Possible health effects of exposure to residential electric and magnetic fields National Research Council, National Academic Press (1997). See Appendix I.

[xvi] Wertheimer and Leeper (1979)[36] "*Dose-related or a dose-response-relationship*" are terms used by the authors of this study to describe the relationship, or correlation, between two variables, in this case, exposure to EMFs and childhood cancer.

the wiring configurations of electric power lines which allowed them to estimate the exposure levels over a period of time. The system was known as 'wire coding'.

3.3.4 Wire Codes: A method used to estimate residential EMF exposure levels

Initially, homes used in the study (both case and control locations), were classified as either high current or low current depending on proximity and the type of electricity line. In a subsequent paper by Wertheimer and Leeper[36], four categories were used; very high, ordinary high, ordinary low and very low current configuration.

However, there were many criticisms of their system of estimating exposure levels because the relationship "... *between wiring and fields is quite complicated, and there are many other factors (e.g., home wiring, appliances and grounding) which affect magnetic field exposure*" (Savitz[41]). However, in subsequent studies, their coding of distribution wires was found to *"predict measured magnetic fields and was argued to be a useful predictor of long term average fields if not moment-to moment levels"* (*ibid*). Perhaps another more serious criticism of the Wertheimer and Leeper[36] study, was that the results could have been biased, due to the fact that the researchers given the task of determining the wire code for each house knew whether the house belonged to a 'case' or a 'control' subject in the study area (Savitz[41]).

Fulton *et al.*, (1980)[44] attempted to replicate these results by comparing 119 cases of leukaemia in children, up to the age 20 years, with 240 controls in Rhode Island. No evidence was found to suggest any relationship between EMF exposure and leukaemia. However, the results of this study were even more questionable than the Wertheimer and Leeper[36] study in the light of methodological inadequacies. Fulton had used the same 'wire code' measurements designed for the Denver study, even though Electric Utility Systems, and therefore wiring configurations, differ from region to region, which according to Savitz[41], could have accounted for the "*spurious null results*".

A UK childhood cancer study by Myers *et al.*, (1985)[45] in Yorkshire, estimated exposure levels by measuring the distance "*...of case and control birth homes...*" from power lines and "*...calculating exposure estimates for homes within 100m*" (*ibid*). More children with cancer were found within 100m of power lines, although cases and controls seemed to be exposed to the same field levels. These levels were not thought to be significantly high compared to other countries because most power lines in UK residential areas are underground.

Tomenius (1986)[46] carried out actual measurements in his childhood cancer study in Stockholm and found that cases were more likely to live within 150m of power lines or substations (odds ratio 1.3); however, exposure levels for both case and control were found to be virtually the same (0.069μT and 0.068μT[xvii]). Once again, though, study methods came under criticism. This time it was because they were 'one-off' measurements and not taken over a period of time to take into account seasonal and diurnal variations.

Savitz[41]

improved the method of estimating field measurements in a case control study for the New York State Lines Project. This had been set up, following substantial concern about the proposed construction of two 765kV lines by two different power companies.[xviii] Permission for their construction was granted on two conditions; first, that there was a 350 ft right of way (ROW) corridor surrounding each 765kV power line within which residences are not allowed to be built;[xix] and second that a research programme was set up to determine possible human health risks arising from the HVOTLs.[xx] At this time, information on the possible health effects from residential EMFs, was only available from 7 previous epidemiological studies. 5 had been published in scientific journals and 2 were extended abstracts from a scientific meeting.[41] The approaches used to assess exposure levels were: wire codes, spot measurements and the identification of the field levels of nearby transmission facilities. All had been criticised for various reasons.

Savitz[41] looked at all the cases of childhood (aged 3-14) cancer in Denver between 1978 and 1983. Exposure levels were estimated by the determination of both 'wire code' and direct measurement of the field[xxi]. *"An important finding was a correlation between magnetic field measurements and wire codes"* (New York State Lines Project, 1987[47]), and the major factor contributing to the magnetic fields was the distribution lines. He concluded that there was a positive association between wiring configuration and increased cancer, especially leukaemia and, to a lesser degree,

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[xvii] See Appendix I for an explanation of measurements.

[xviii] In 1973, two applications were received for the construction of two 765kV power lines. One was submitted by the NY Power Authority for a line from the Canadian border near Massena NY to Utica NY (case 26529) and the other application (case 26559) was submitted by two private corporations, the Rochester Gas and Electric Corporation and the Niagara Mohawk Power Corporation for the construction of a line from Rochester NY to Oswego NY. (Cited in New York State Power Lines Project (1987) Biological Effects of Power Line Fields Scientific Advisory Panel Final Report: p.11).[45]

[xix] This was based on the same 1.6kV/m levels found at the edges or 345kV power lines but no magnetic field measurements levels were made.

[xx] These provisos were made following a joint hearing on the issues of common interest. The findings of this hearing were embodied in an Opinion (No 78-13) issued by the New York Public Service Commission on 19th June 1978. The health research was funded by a $5million research budget from the power authority and the New York State investor-owned utilities and administered by the New York State Department of Health under the guidance of an impartial scientific panel, and was to be conducted by contract, with independent investigators.

[xxi] This was carried out by taking measurements throughout the home, at different times and dates, with all appliances on and then off to assess the background field levels.

brain tumours. There also appeared to be a positive correlation (although no causation) with exposure levels and adverse health effects, despite the inexact measures of exposure (NRC, 1997[48]).

In all, the New York Power Line State Project[45] funded a total of 16 research studies to investigate the biological and epidemiological evidence. They concluded that magnetic fields possibly stimulated the growth of cancer cells but of "*more serious concern* [was] *that studies suggest that children with brain cancer and leukaemia are more likely to live in homes with elevated 60Hz magnetic fields*"(*ibid*).

Until Savitz'[41] childhood cancer study, epidemiological findings were not taken seriously, due to the methodological flaws highlighted above. Subsequent studies used either wire coding, calculated fields, spot measurements, personal exposure[xxii]or a combination of measurements to assess magnetic field exposure levels (London *et al.,* 1991[49]; Olsen *et al.,* 1993[50]; Feytching and Ahlbom, 1993[42]; Verkasalo, *et al.,* 1993[51]; Preston –Martin, *et al.,* 1996[52]; Gurney, *et al.,* 1996[53]; Linet, *et al.,* 1997[43]; Tynes and Huldersen, 1997[54]; Michaelis, *et al.,* 1997[55]). Although many results support the findings of earlier studies, the causal relationship was still no more than a hypothesis.

3.3.5 Meta Analysis

With so many studies, all drawing different conclusions on the potential health risk to humans, the US Government felt it was time for a new empirical research approach and so in 1991 a committee was set up from members of the National Academy of Science (NAS), the Dept of Energy and the National Council of Research.

They were asked "*to review and evaluate the existing scientific research...*(NRC[48]), which included a meta-analysis[xxiii] of 12 epidemiological studies of childhood leukaemia and 5 on adult cancer carried out between 1986 and 1993.

3.3.5.1 Risk Assessment Using Meta Analysis

Previous meta-analysis of childhood cancer and residential exposure (Washburn et al., 1994[56]; National Radiological Protection Board (NRPB) 1992 and 2001[57]; Ahlbom, *et al.,*1993[58]), had found mixed results. For instance, the NRPB[55] concluded that, although a statistically increased odds ratio was found for wire codes, the small sample size and methodological problems in each of the studies precluded drawing definite conclusions. Ahlbom, *et al.,*[56] found a statistically significant

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[xxii] Found by Kaune, *et al.,* (1994) to show consistently higher levels of residential exposure, than spot measurements, with the exception of exposure levels in the bedroom.

increased risk ratio for childhood leukaemia when the results from three similar studies were combined.[xxiv] Similar conclusions were found by Washburn *et al.*,[54], who carried out a meta-analysis for leukaemia, lymphoma and nervous system cancers. This involved 13 studies and the combined results showed an increased risk for all three cancers, although other studies by ORAU (1992)[59], and Peach, *et al.*, (1992)[60] did not show a consistent pattern of association.

Due to inconsistencies in the results of much of this work and "*faced with growing concern on the part of the public about whether EMFs might be adverse to human health, Congress mandated the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Program, in the 1992 Energy Policy Act, Public Law 102-104*"(NIEHS[61]). The Department of Energy and the National Institute of Environmental Health Sciences were given responsibility for directing and managing the project which involved a large number of scientists from a variety of disciplines. This five-year study focused on the replication of experiments considered important to understanding the mechanisms by which such fields might interact with the living system; and since electric fields were observed to be screened easily, research concentrated on the effects of magnetic fields.

3.3.5.2 The Findings of the 'EMF RAPID' Study

The use of hairdryers (Savitz, *et al.*, 1990[62]) and electric blankets (Preston-Martin, *et al.*, 1988)[52] was associated with a slightly elevated risk of developing childhood leukaemia. A 'possible association' (a weak relationship) was found with depression and suicide, (Savitz, *et al.*, 1994a[63]; Baris, *et al.*, 1996[64]) neurodegenerative diseases (Sobel, *et al.*, 1996a[65]; Feychting, *et al.*, 1998[66]; Johansen and Olsen, 1998[67]) and cardiovascular disease (Cook, *et al.*, 1992[68]; Savitz, *et al.*,1994b[69]). One of the most interesting results was an association with occupational exposure to extremely low frequency (ELF) EMFs, like those produced by HVOTLs and domestic appliances. Often, occupational exposure provides the first indication that a particular substance or environmental factor, for instance asbestos, causes adverse health effects.

3.3.6 Occupational Link With EMFs and Alzheimer Disease.

The first study to show an occupational link between EMF exposure and adverse health effects was conducted by Sobel[40]. A correlation was established between users of both residential and industrial

[xxiii] Meta-analysis is a statistical method used to provide a single risk estimate from a summary of the results of a similar set of studies (Dickersin and Berlin, 1992). It can also be used to evaluate the strength and consistency of an exposure - disease relationship (Blair *et al.*, 1995).

[xxiv] The three studies (Olsen, *et al.*, 1993[50]; Feychting and Ahlbom, 1993[42]; Verkasalo, *et al.*, 1996[51]) were carried out in Nordic countries and each used a population registry and estimated historical exposure, which, the authors argued, meant that they were appropriate for use in a meta-analysis.

sewing machines and the development of Alzheimer's.[xxv] In a follow-up study, Sobel, *et al.*, (1996b[70]), again found a relationship between occupational exposure and the development of Alzheimer's Disease, although at a slightly different odds ratio (4.9 for men and 3.4 for women). Savitz (1998a[71]) also investigated this association and initially found no relationship, although the results from a later study (Savitz *et al.*, 1998b[72]) showed a slight increase in risk. Motor neurone disease was investigated (Deapen and Henderson, 1986[73]; Davanipour *et al.*, 1997[74]) and some of the findings appeared significant; however, their validity was questioned, since exposure levels were estimated from job titles and subjects for the case study were few (NIEHS[59]).

On balance, based on a comprehensive evaluation of the published studies up to 1998 relating to the effects of power frequency electric and magnetic fields on cell, tissue and organisms including human, the committee concluded that, ELF EMF are "*possibly carcinogenic to humans...*" although, no conclusive and consistent evidence shows that exposures to residential EMFs produce cancer or other adverse health effects. However, they did note that epidemiological studies appeared to show a persistent correlation between living in homes estimated as having a high wire code[xxvi]and a small increase in the incidence of childhood leukaemia, although there was no obvious causal link to account for this.

The NIEHS made a number of future research recommendations to ensure that areas found to be either inconclusive or showing a weak association with health effects continued to be investigated (*ibid*). EMF research has since grown to include mobile phone technology (IEGMP, 2000[xxvii]).

3.3.7 The Missing Causal Link: between exposure to EMFs and adverse health effects

Perhaps the greatest problem faced by scientists studying the biological effects from exposure to EMFs has been establishing a 'causal link' between exposure and ill health. EMFs are not like other contaminants (for instance, tobacco, asbestos, radon and chemicals) where the health effects following exposure are usually consistent, "*can be defined by the amount of contaminant (dose) that enters the body*" (Anna, 1989)[75], and have an identifiable causal link. Existing studies suggest that EMFs may have an impact on a variety of human biological systems in many different ways, but, unlike most environmental carcinogens where 'safe' exposure levels have been established, the

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[xxv] The odds ration of developing Alzheimer disease was 3.9 for seamstresses and 2.9 for tailors.

[xxvi] In other words, an estimated high EMF exposure level associated with homes close to HVOTLs and substations.

[xxvii] The Independent Expert Group on Mobile Phones (IEGMP, 2000) Chaired by Sir William Stewart and referred to as the Stewart Report. A copy of this report can be found on the internet at http://www.iegmp.org.uk/

levels at which EMFs cause harmful health effects do not seem to correlate with specific exposure levels at which adverse health effects will either definitely happen or not happen.

There are several possible reasons for this; for instance, it is possible that EMFs react with human biological systems at a particular resonance, rather like exposure windows (Morgan, *et al.*, 1987)[76] and this could explain why more is not necessarily worse. Another possible explanation lies in an emerging scientific theory, which suggests that the development of cancer is a multi-step disease process. In this process, a single cell can develop into a malignancy that can eventually destroy the organism. Adey (1998)[xxviii] states that many papers give evidence of EMF as a cancer promoter in this process. Cherry (1997)[77] adds that scientific evidence would also suggest that "*EMF is both a cancer initiator and a promoter, which also enhances progression of the disease.*" Sobel's[68] research suggested one possible causal link between exposure to EMFs and adverse health effects could be the relationship between exposure to EMFs and a reduction in melatonin production.[xxix] Reiter (1997)[78] states that the "*reduction of melatonin at night, by any means, increases a cell's vulnerability to alteration by carcinogenic agents.*" In addition, the production of calcium, which plays a central role in the development of the immune system, is reduced by exposure to EMFs.

A study by Luben (1994)[79] suggests that EMFs do not need to cause genetic damage to promote cancer or cause development abnormalities. "*By influencing signal transduction pathways, which in turn can generate cell proliferation, cell differentiation, and even transformation to a cancer phenotype, EMF can potentially be involved in a host of disease processes without ever penetrating the cell membrane in any significant manner*"(*ibid*). Other research has found that exposure to EMFs limits the effectiveness of Tamoxifen, which is the drug used to inhibit the growth of cancerous cells. (Liburdy and Levine, 1998[80]; Afzal and Liburdy, 1998[81])

Henshaw (2002)[82] suggests that the key to finding a plausible biological casual link may lie in the use of physics rather than other scientific disciplines. The results from his UK study suggests that EMFs from power lines attract particles in the air, (known as aerosols) which could include pesticides and radon (present wherever there is granite), both known carcinogens. These would then be inhaled by anyone living in close proximity to lines and potentially, in his opinion, lead to cancer production or other adverse health effects.

[xxviii] A speech given by Dr Ross Adey at the 1998 EMF Meeting, Department of Physics, Bristol University. Chaired by Professor Dennis Henshaw.

[xxix] Melatonin is produced by the pineal gland which functions best in the dark. Melatonin is normally produced while the body sleeps during the night and is thought to act as a detoxifier.

3.3.8 Epidemiology -v- Scientific Research

Whilst epidemiological studies have serious limitations in their ability to demonstrate a cause/effect relationship as the results are based on frequency analysis, laboratory (biological) studies by design, can clearly establish a causal link[xxx]. Biological research has suggested many possible health effects from exposure to EMFs (NIEHS 1992).[83] But, in the same way that epidemiological research has been criticised for poor methodology, the results of many scientific studies have not stood up to replication. The NIEHS stated that, "*in the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the epidemiological evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children. Unless, however, further research indicates that the finding is due to chance or some currently unrecognised artefact, the possibility remains that intense and prolonged exposures to magnetic fields can increase the risk of leukaemia in children*" (*ibid*).

3.3.9 Health Research Conclusions

"*If EMFs are a risk, how large a potential risk are they? Residential studies show a possible risk equivalent to the risk from in-utero x-rays*" (Travis *et al.*, 1987[84]). With regard to childhood leukaemia, that equates to around 1 extra case each year.

"*Occupational epidemiological studies*[xxxi] *report excess risks of EMF-related cancer deaths for electrical occupation workers average a few chances per 100,000 per year (small fraction of overall occupational risk of death in this industry) but well above the threshold at which the US regulatory agencies have acted to reduce occupational risk on occasions*" (*ibid*).

3.3.9.1 Residential Exposure To EMFs

On balance, the evidence to date suggests that it is unlikely that EMFs cause cancer. However, the NIEHS, IARC, NRPB and the California Health Department, who conducted the most recent large-scale study (June 2002), have all found an increased incidence of childhood leukaemia. The California study also found an increase in adult brain cancer, ALS and miscarriage. All groups classify magnetic fields as a 'possible carcinogen' (Henshaw, 2002[xxxii]).

[xxx] NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. Prepared in Response to the 1992 Energy Policy Act (PL 102-486, Section 2118). Cited in the NIEHS Working Group Report.[81]

[xxxi] Research focussing exclusively on occupational exposure.

[xxxii] Conference notes from the NRPB Power Lines and Health Debate. 5-12-02 National Exhibition Centre, Birmingham, UK.

3.3.9.2 Implications For The Housing Market

Due to the problems of finding conclusive proof, either way, public concern of the possible health effects is "*fuelling a costly controversy over how safe power lines distribution equipment, property wiring, and domestic equipment is*" and has "*prompted a host of political, legal and market reactions*" (Florig, 1992[85]). Other markets have also suffered from the public's negative attitude towards EMFs and have resulted in the introduction of new 'low level' products such as VDU screens (*ibid*). There has also been an increase in the number of compensation claims for EMF-induced health effects and diminution in the value of homes along power line corridors, in addition to, delays in siting new lines and pylons due to increased consultation periods (Scottish Power Wayleave Department, 1999[xxxiii]; Gell, 2001[xxxiv]).

Alden says that "*public perception is quoted by many as the main reason why EMF is still an issue*"[86] and until the health issue is resolved, this is unlikely to change. However, Jayne[6] "*suggested that disproving a fear increases belief that there is a problem*". Paradoxically, this would imply that, as more research concludes EMFs are not a health risk, the public are likely to be less confident about these results and subsequently more concerned about the potential risks (Morgan[16]). Jayne explains that, "*due to the nature of scientific enquiry, conclusions are that, ' no such link has been found'. This is not the same as a statement that, 'no link exists'. Consequently, it could be alleged that, even in the face of overwhelming evidence to the contrary, it is possible for some people to justify a statement that there may still be a link, but that it hasn't yet been found.*" In conclusion, Jayne suggests that, if EMFs are found to have a proven link with childhood cancer, there would be a "*consequent detrimental effect on the value of certain properties*" (*ibid*).

The inability of scientists to establish conclusively that EMFs are not harmful has left a degree of uncertainty surrounding the issue and it is this uncertainty, according to Mundy[2], which causes a greater negative impact on value than when a risk is known, understood and therefore quantifiable. Kinnard observed that public fears do not have to be rational to have a negative effect on the desirability or price of residential units. He stated that, *"it really does not matter that they may be uninformed or inaccurate judgements, at variance with the "facts" of the market. Buyers and sellers base their actions on their expectations and anticipations. If fear is a widespread influence, whether justified of not, it will affect value adversely" (Kinnard, 1967[87])*. This effect is known as property 'stigma' (previously defined in section 3.1).

[xxxiii] Information received from a telephone conversation with an employee from the Wayleave Department at Scottish Power Ltd. 1999. No formal record of the conversation was made.

[xxxiv] Information received from telephone conversations and meetings with Colin Gell. No formal record of the conversations were made.

3.4 PERCEPTUAL RESEARCH

3.4.1 Introduction to Perceptual Research

Stigma as in relation to contaminated land or buildings, is gaining acceptance as a cause of value diminution (Arens[31]; Edelstein. 1988[88]; Kinnard and Worzala[30]; McClelland. *et al.*, 1990[89]; Roddewig, 1996[90]). Chalmers and Roehr[25] identified EMF as "*one type of stigma that can influence the value of property negatively*" as early as 1993 and the majority of attitude studies conducted since then, conclude that there is some degree of negativity towards HVOTLs (attributed to either the visual impact or a fear of EMF-related health risks) which could translate into a value reduction for proximate residential buildings.

Whilst, transaction data enables the impact of an environmental feature on the value of land or buildings to be determined, Furby (*et al.*, 1988[91]) states that valuation data may "*only touch on part of the problem. Research must also address the attitudes and reactions of participants in the residential real estate market.*" This suggests that perceptual research is as important as valuation data when seeking to determine the impact of a HVOTL on proximate house prices.

This section examines previously conducted research undertaken to establish opinions, attitudes and perceptions towards the impact of HVOTLs on the value and desirability of residential units. The research presented in this section has been conducted using both qualitative and quantitative research paradigms.

3.4.2 Attitudes, Opinions and Perceptions Towards HVOTLs

There are two important features of the existing research into this area that should be highlighted at this stage:

1. "*Nearly all of it [was] unpublished, (until the mid 1990's) available only in technical reports...*", carried out by, or on behalf of a number of Electricity Utilities, predominantly in Canada and the U.S.A. (Bonneville Power Administration; Hydro-Québec, Montreal; Electric Power Research Institute; New York Power Authority; Southern California Edison; Ontario Hydro; and others) Subsequently, other than a few independent studies, what is available tends to be material already reviewed and included in a 'published' report, by an author who may be using material previously generated for an Electricity Utility study (Priestley and Evans, 1996[92]). Therefore, the results of this early material should be treated with caution.

2. Studies conducted before 1979 need to be distinguished from those carried out after that date, due to the introduction of another factor which could impact on the perceptions of property professional, lenders and buyers. Until this date, there had been no publicised association with a possible health risk, other than the physical harm caused by a power line, or pylon falling down and possible electrocution. In 1979, the first association between childhood cancer and living close to HVOTLs was asserted by Wertheimer and Leeper[36], in the USA. The results were published and subsequently reported by the media, creating an association between living close to HVOTLs and possible adverse health effects, in particular cancer. Although opinion studies do not suggest that the public became 'instantly' concerned about the association with possible adverse health effects after 1979, researchers found that, as public awareness increased, it became more difficult to disentangle public concern of health effects from other impacts on value, such as visual unsightliness.

3.4.3 Early studies: Pre 1979

Attitude, opinion or perceptual studies are generally regarded as a fairly new addition to the body of literature on the effects of electricity distribution equipment on property values. However, many studies conducted over the last 40 years in this research area, have often included a survey to test the opinions of either residents or professionals involved in the development, financing or valuation of such property.

Carll[10] used personal interviews to help him assess the impact on land values in eminent domain compensation cases. He stated that the purpose of these interviews was not to analyse statistically the responses, but to identify and give consideration to the factors, which may affect the future use of the remaining land, after the power line right-of-way easement had been granted (in the same way as focus groups use a grounded theory approach to current research). Initial interviews found that the landowners, (who were developers in this particular study) had no experience of planning a residential development on land crossed by power lines and they were 'fearful' that the new power line would, "*...seriously and adversely affect the market value of new homes that they would build*" (*ibid*). Although Carll found no valuation evidence to support this fear, he stated that homes adjacent to power line ROWs had larger lots and a greater degree of privacy as a result of either owning, or having the use of the land on which the utility's equipment was sited (for example; adjacent homeowners were gaining extra land at no extra cost, as compensation for living next to distribution equipment). Interviews with a number of property professionals (including mortgage lenders, bankers and other business men), resulted in "*all kinds of opinions,*" which were often based on personal perceptions rather than fact, as many had, "*...no experience in the subject...*[and] *were merely guessing*" (*ibid*). The results of such interviews were therefore of little or no help to the appraiser. The main concern of residents living close to the line was that the electricity line would interfere with TV and radio reception.

Bigras reached a similar conclusion to Carll[xxxv], noting that, *"there seems to exist in the minds of the general public, a belief that power lines tend to decrease the bordering property values due to the general appearance of the line, danger of falling wires, interference to radio and TV reception, difficulty in obtaining mortgage financing, and severance of the properties. This belief is erroneous in itself and is not supported by the facts... "* (Bigras, R., 1964[93]).

A more in-depth study was carried out by Kinnard[85], who surveyed homeowners and property professionals in Connecticut, USA. Questionnaires were sent to assessors, appraisers, builders, lenders and homeowners (who were either classified as 'proximate' or 'distant'). Proximate homeowners lived within 200ft of the ROW; [xxxvi] homes further away were deemed to be 'distant'. A total of 1,487 questionnaires were returned for analysis and although there were a 'large number of individual variations' in the responses *"a clear enough pattern developed"* to allow some 'meaningful' conclusions to be drawn. For instance, Kinnard stated that the value of residential units was *"neither appreciably nor measurably affected by adjacency* [to], *or intersection by, overhead electric transmission lines."* Yet he contradicted this statement by noting that units abutting the ROW had considerably larger plots, due to the utilities negotiating an easement rather than purchasing the land for the siting of its equipment. The effects on value of a larger plot size were, apparently, not taken into consideration. Another suggestion of negative effects on value was the tendency for lower-priced homes to be built nearest the line. This, he said, reflected, *"...a belief on the part of developers for which no empirical evidence is known to exist... "* Any negative reactions from residents were found to be reduced if the ROW was screened and any negative market impact tended to disappear with time.[xxxvii]

Reese (1967[94]) was generally critical of the methodology used by Kinnard and the conclusion that no measurable value effects were found and questioned the reliability of responses from homeowners by posing the question, *"should we expect an unbiased answer from an owner who is asked, in effect, if he thinks he showed wisdom and good business acumen in making one of the largest and most important financial transactions of his life?"* He suggests that there may be a number of reasons why negative effects on value might not be very obvious. For instance, it may be that *"studies, rather than showing no difference in value, merely show no easily measurable difference,"* possibly due to difficulties in analysing house prices in a rising market. He also explained that personal experience of building and selling homes had led him to believe that the

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[xxxv] Although it was not possible to appraise his study as the article was out of print.

[xxxvi] See Chapter Two: 2.0 for an explanation of a power line 'Right of Way'.

[xxxvii] This is a key issue raised in the current research due to the fact that no evidence exists to explain or justify the changes in the way land crossed by HVOTLs has been developed during the last ten years.

reason why people may have bought *"these homes of less charm,"* may have more of a relationship with favourable mortgage terms than a lower price (*ibid*).

Clarke (1972)[95] began to develop the use of surveys and market research techniques and suggested some criteria to improve methodological rigour for transmission line impact studies. He found that studies were most often *"instigated by utility companies and handled either by staff personnel or on contract with independent firms and associations."* Whilst an *"excellent source of information* [despite being rarely published] *on the methods and techniques of easement valuation"*, the validity of their findings could only be given credence after careful consideration of the methodology used to assemble and analyse the data.[xxxviii] With this in mind, Clarke conducted a study to examine the effects of a power transmission line easement on commercial, retail and residential house values and marketability and land zoned for residential or rural use. Regarding residential units, he found that values were slightly lower next to the easement; $235 compared to $241 for the same house type further away. Yet marketing time was the same and there was little difference in the plot size of homes next to the easement and homes further away. Questionnaires revealed that potential buyers were 'affected' by a number of factors, including the strength of the market and the availability of different house types at any particular time. Property professionals had commented that, when occupation was high in a particular area, house buyers had, *"of necessity accepted proximity to a power line"* which they would not have done in a 'softer market' without some concession to, *"price or rental"* (*ibid*).

Boyer, Mitchell and Fenton, (1978[96]) prepared a comprehensive report for the Royal Commission on Electric Power Planning Province of Ontario on the Socio-Economic Impacts of Electric Transmission Corridors. This was a follow-up study to an earlier investigation by Mitchell (1976[97]) in which he had concluded that, *"there appears to be an inverse relationship between the degree of perceived effect that a hydro corridor would have on the public and the current proximity of such a responding public to the facility in question. Control respondents seem to respond more strongly and more negatively towards the idea of a hydro corridor than those respondents who are already (supposedly) affected by an existing corridor"* (*ibid*).

The findings did not support Mitchell's statement as a generalisation of the market around the Ontario area and there were some criticisms of the study, in particular the questionnaire design

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[xxxviii] *"While most of these studies seek to objectively reflect market reactions, some seek support for a predetermined conclusion."* (Clarke, 1972). [95]

[xxxviii] A thorough review of previous studies by Fredriksson *et al.*,(1982) found this to be one of only two methodologically sound studies out of 27 key studies reviewed. Cited in Furby (*et al.*,).[91]

(which was different for both groups making direct comparison difficult) and the sample size, which although an improvement on Mitchell's earlier study, was still smaller than desired. However, improvements on the method of analysis[xxxix] meant that the findings could be considered relevant to the property market. Differences in the perceptions of 'on-line' residents (generally farmers whose land the transmission line crossed) and control groups away from the line were "*not as marked as the previous study would indicate*" (*ibid*) and comparing the perceptions of the 'on-line' group to the control group 1 mile away did reveal some differences in their opinions towards high voltage electricity lines and pylons. The results also indicated that the strongest opposition towards HVOTLs was found to be at the planning stage but once the line was in place, any opposition seemed to lessen, then disappear over time, supporting Kinnard's[85] earlier findings.

The 'online' group (defined in Kinnard's study as 'proximate') had fairly negative attitudes towards HVOTLs and surprisingly already had some concerns about possible adverse health effects, despite the fact that there had been no publicised association at that time. The majority of the control group seemed unwilling or unable to 'express' an opinion either way and those who did gave contradictory responses, suggesting that "*direct personal experience rather than proximity is a more important factor in the formation of perceptions and attitudes*" (Boyer, Mitchell and Fenton[96]). Line size and type, (500kV or 230kV; new or old equipment) appeared to make little difference to attitudes. Interestingly, although perhaps not unexpectedly considering the visual impact of the pylons, "*the most significant continuing impact perceived, (to the same degree by both groups in this study)*[xl] *was the effect of the presence of the* [power line] *corridor on the market value of property*"(*ibid*), with almost double the number in the control group (78.4% compared to 44.4% 'online' group) stating that it would be a 'consideration', in their purchase decision. The presence of the line itself was not found to be a strong enough reason not to purchase a particular house; however, being able to see the pylons would deter some potential buyers.

The public's reaction to noise from electricity distribution equipment in Southern California was explored by the Electric Power Research Institute (EPRI 1979)[98]. The study involved face to face interviews with 400 people in 17 different locations living next to power-line corridors or in neighbourhoods adjacent to transformers (taken to be large sub-stations). They concluded that "*relatively low level noises such as barking dogs, garden equipment, and other people's voices annoy far more people than electrical noise sources, by virtue of their greater prevalence*" (*ibid*).

[xl] Mitchell's[97] earlier study found that 33% of people living on a transmission line corridor perceived negative value impacts compared to 94% of people living 'not near'. In this study a much larger sample was used which indicated that in response to the same question the difference between the two groups was negligible at 74% compared to 79%

3.4.4 Summary of Early (pre 1979) Studies

Since no relationship between adverse health effects and living near HVOTLs had been reported before 1979, studies conducted before this date did not have the association with a possible health risk to contend with and therefore, in some respects, should have resulted in a clearer indication of the particular features or aspects of HVOTLs that might cause a negative impact on the value or marketing of nearby residential units. Despite some general criticism of the methodology used in these early studies and the problems of potential bias which had been associated with Electricity Utility funded research, the general conclusions did indicate some negative attitudes (professional and public) towards the presence of HVOTLs. Whilst the results suggested that negative opinions were generally the result of visual unsightliness and loss of land use, attitudes towards the effect on value and marketability seem generally confused and often appeared to be based on personal feelings rather than substantiated by fact (Bigras[93]; Boyer *et al.*,[96]; Carll[10]). The reliability of the public's responses to attitude surveys was also questionable, due to the behaviour of the market participants, which appeared to reflect the availability of substitute residential units rather than the 'stated' depth of feeling towards this particular environmental feature. In addition, the responses indicated that the public were already beginning to be concerned about a relationship between living close to power lines and possible health risks.[xli]

Research undertaken after 1979 also had to consider the possible impact from the publicised association between living in proximity to HVOTLs and adverse health risks, although studies suggest that the general public had little knowledge of such effects until the early 1990s.

3.4.5 Post 1979 Studies

One of the problems previously mentioned with conducting a review of the literature was the unavailability of the research carried out by the Electricity Utilities, who have generally not made their research public. Although a few independent studies have been published (for instance; Kinnard *et al.*, 1984[99]; Boyer *et al.*,[97]; Mitchell *et al.*,[98]), a comprehensive review of the research undertaken before 1990, for the Edison Electricity Company, gave Kroll and Priestley (1992[100]) access to many previously unpublished papers and technical reports. Although their assessment of the literature typically remains unpublished.

3.4.6 Kroll and Priestley's Review of the Literature up to 1990

This review identified nine attitude studies they considered to be methodologically sound. The nine studies either focused specifically on the perceptions of property value effects (Thompson (1982)[xlii]; Kinnard *et al* (1984)[xliii]; Ball (1989)[xliv], or looked at a wider range of effects on amenity

[xli] Boyer, Mitchell and Fenton, (1978).[96]

including property values, health, safety, and aesthetics. (Mitchell *et al.*,1976[xlv]; Boyer *et al.*, 1978[xlii]; Market Trends, Inc., 1988[xlvi]; Rhodeside and Harwell Ltd., 1988[xlvii]; Economics Consultants Northwest, 1990[xlviii] and Beauregard Consiel, Enr., 1990[xlix]). Attitude studies at this time were usually undertaken in tandem with a valuation study and generally found that the population had either little or no knowledge of any possible health risks associated with living in proximity to HVOTLs.

In the majority of surveys participants were asked whether they thought that the nearby power-line affected the value of their own home or the value of other homes in their neighbourhood. Most researchers assumed that "*the effect would be negative,*" although in a few studies[l] there was a follow up questionnaire which asked whether the presence of the HVOTL would reduce or increase value (arguably, the presence of a HVOTL in a ROW may have some benefits, e.g., increased privacy, use of extra land, to adjacent home owners), and if so, by how much. Kinnard's[99] survey also asked about the availability of mortgage finance and the length of time a house was on the market before selling. He found that other surveys tended to focus on personal choice, for instance:

-Whether the presence of the line had affected the respondents' decision to buy a particular house?

-Whether they had considered moving away from that location?

-Would they buy another home in the same location?

-What characteristics of the line or right of way (e.g. voltage, tower height, right of way width, landscaping, distances from nearby residences) had the greatest impact on value or desirability?

-Which house types are most vulnerable to impact?

Kroll and Priestley found that all nine studies had "*presented the data in terms of simple descriptive statistics*". Some used cross-tabulation and significance tests to "*identify significant*

[xlii] Prepared for his Masters Thesis, University of Alberta, cited in Kroll and Priestley, (1992).[100]

[xliii] Independent study.

[xliv] Prepared for the Salt River Project.

[xlv] Independent study.

[xlvi] Prepared for the Arizona Utility.

[xlvii] Prepared for Virginia Power.

[xlviii] Prepared for the Bonneville Power Authority and others.

[xlix] Prepared for Hydo-Québec.

variations associated with differences in context or respondent variables"[li]. Priestley and Evans (1990)[lii] published the results of their study which had explored the relationship between the respondents' personal characteristics and their perceptions towards HVOTLs (and their impact on value and amenity) using scale building, correlation analysis, regression analysis and discriminant analysis[liii].

Kroll and Priestley's review suggested that, despite variations in the type of property studied, the location for the study and the questionnaire design, it was possible to draw some conclusions about general attitudes towards HVOTLs. For instance, Thompson[xxxvii] and Kinnard[99] both found that, although there appeared to be a general perception of negative value effects, actual market behaviour did not support this. In Thompson's study, 67% of the respondents felt that the presence of HVOTLs had an adverse effect on the value of their home. However, both Kinnard and Thompson asked individuals who had recently bought or sold houses close to power lines whether or not the presence of the lines had affected the transaction or the selling price. 7% of residents who responded in Kinnard's study reported paying lower prices, compared to 23% of the respondents in Thompson study, who said it had affected the transaction (although only 15% reported any effect on the price).

Comparison between individual studies also suggested that the degree of negativity expressed by proximate residents towards HVOTLs appeared to be closely related to whether they bought the house before or after the HVOTL was sited (Kinnard[99]; Priestley and Evans[92]). Kinnard found that residents who had purchased their house after the line was built (56%) were less negative towards HVOTLs and less adverse towards buying another house in the same area, compared to homeowners who had bought their house before the line was built. Rhodeside and Harwell (1988[liv]) did not differentiate between people who had lived in their home before the line was built or after, but found that the majority of residents (74%) who responded would have bought another home in the same area. Their study also revealed that screening could actually increase the value of

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[l] Kroll and Priestley (1992)[100] are not specific about which studies they are referring to in this context.

[li] (Mitchell *et al.,*[97]; Boyer *et al.,*[96]; Rhodeside and Harwell.,(1998) and Economics Consultants Northwest., (1990), cited in Kroll and Priestley.[100]

[lii] A report prepared for the Southern California Edison Electric Company.

[liii] Recent attitude studies usually include questions to enable a profile to be constructed of the socio-demographic characteristics of the respondent, thus enabling predictors to be identified that may be associated with a particular response. An early study by Zube, *et al.*, 1976 (Cited in Kroll and Priestley[100]) identified factors such as age, occupational status and number of children as possible predictors.

[liv] Rhodeside and Harwell Incorporated, (1988). Cited in Kroll and Priestley.[100]

residential units when the ROW was screened from proximate houses by trees, which provided a "*permanent wooded green belt behind the house.*"

One study conducted by Priestley and Evans in 1990[92] (published in 1996) and included in Kroll and Priestley's review[100], addressed, for the first time, the issue of adverse health effects "*from the lines electric field*" (an early reference to EMFs) as one of a number of questions on general health and safety issues. A psychometric questionnaire[lv] was designed to probe the attitudes of residents towards HVOTLs. Respondents were asked to rank their concerns in order of importance. Health and safety concerns were listed most often, followed by the impact on house price then aesthetics.[lvi]

Not surprisingly, Priestley and Evans noted that the respondents who showed the most concern towards the presence of HVOTLs were often those who had lived in their homes before the line was built. This group also tended to have higher-status occupations and generally perceived the visual impact to be much greater, with 57% of the respondents overestimating how much of the line they could see.

The overestimation of the lines' proximity, was not found to be a problem by Bishop *et al.*,(1985[101]). This unusual study explored the use of visual simulation techniques to assess the degree of negativity towards HVOTLs in Melbourne, Australia. The study used photographic techniques, computer generated images and graphic enhancements to establish whether or not there was any correlation between a variety of landscapes, pylon designs, public opinion and the socio-economic status of the participants. Analysis revealed that changes in the landscape had little effect on public opinion. However the "*presence/absence of transmission line structures (pylons) accounted for approximately 90% of the variation...*" in the participants' assessment of HVOTLs (*ibid*).

3.4.7 Expert v Lay Opinions

Differences between expert (property professionals) and lay opinions (the general public – buyers, sellers) have occasionally been blamed for an exaggerated diminution in the value of proximate house prices (Gallimore and Jayne[5]). Kinnard's[99] study found that agents (90% of the respondents in his study) perceived a much greater negative effect than the owners of proximate homes; however, in a later literature review Furby (Furby *et al.*,[91]) found the complete opposite. His study

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[lv] See 3.1 above.

[lvi] It is important to note that the data for this study was collected in 1987 before adverse health effects were widely publicised.

suggested that lay people generally believed there was a "*significant negative effect*," whereas experts "*often maintain that there is no effect at all.*" He suggested that this discrepancy might be due to greater knowledge on the part of the experts who would have access to the results of property value studies, which generally found little or no value effects. Furby stated that, "*the discrepancy between what the studies claim to show and what people (representing potential clients) claim to think is so large that it is hard to believe that professional appraisers would uncritically accept the studies.*"

A later study by Delaney and Timmons (1992[102]) supported Kinnard's earlier view, to some degree, when two groups of residential valuers[lvii] were asked their opinions on the effect of HVOTLs regarding proximate house prices. Both groups, regardless of experience, said that value was negatively affected, although the cohort who had not valued homes near HVOTLs before "*believe a greater negative value adjustment is warranted.*" House price, in this study were reduced by an average of 10%, with 93% of the respondents citing visual impact as the cause of value diminution, compared to 58% citing health concerns. Other effects on amenity contributing to value loss included disturbing sound (43.1% of respondents); health and safety concerns (28.6% of respondents) and 14% listed several other factors, such as; interference with "*television or radio reception*"; a reduction in utility (this point was not expanded on) due to proximity of the power line right of way; the fact that "*the rights-of-way (if abutting the property) allowed unauthorised entry to the property,*" and that "*rights-of-way were often not well maintained by the Utility*"(*ibid*). The inclusion of potential health risks as a reason for value diminution suggested a "*dramatic shift in perception regarding the value of residential property located in close proximity to high voltage electric power lines...The most commonly cited reason for this shift is the potential health hazard detailed in epidemiological studies claiming a positive correlation between long term exposure to the electromagnetic fields produced by power lines and certain types of cancers in humans*" (*ibid*).

3.4.8 The Impact of Media Attention

By 1992, a number of peer-reviewed and published epidemiological studies[lviii] had suggested that a variety of adverse health effects, including cancer, appeared to be associated with exposure to EMFs from living close to electricity power lines. Media attention to these studies, most notably, articles by campaigning journalist Paul Brodeur[lix] in the USA, led to many more similar articles

[lvii] Those who had valued residential units in proximity to HVOTLS, and those who had not.

[lviii] For instance: Perry S. (1979); Wertheimer N. and Leeper E. (1979, 1982); Savitz D. (1986, 1988); Feychting and Ahlbom (1992).

[lix] Information gained from John Moulders EMF Medical website which includes a transcript which appeared in Network News, Special Spring 1995 issue and reprinted with permission from the IEEE Engineering in

featured in both local and national newspapers,[lx] and several journals.[lxi] Brodeur reported these epidemiological findings and suggested that the Electricity Industry was involved in a major cover-up of the health risks to the public. He published 3 major articles in the New Yorker[lxii] which later went on to form the basis of his second book in this area[lxiii] His arguments were very influential, leading other tabloids to focus on this issue and to the screening of several television documentaries.[lxiv]

3.4.9 Research in the 1990's and the Impact of Legal Issues

Another possible cause for the "*dramatic shift*" in public perception highlighted by Delaney and Timmons[102] may have been the success of several 'loss of property value' claims against the Electricity Utilities in the U.S.A. This followed a decision by the Florida Supreme Court in 1987 to allow fear of electromagnetic fields to be admitted "*without independent proof of reasonableness*" [*Florida Power and Light Co v Jennings* 518 So.2d 895 (Florida Supreme Court, 1987)]. This decision allowed compensation for loss of value to be based on a "*calculated diminution of the present market value of the property as a result of the public fear of electromagnetic radiation.*"[103] The combination of media attention and legal redress for loss of value compensation would have almost certainly have increased the public's perception of risk (physical and financial) towards living near HVOTLs. It could also be anticipated that, as adverse publicity increased, so too would public feelings of 'mistrust' towards the electricity industry.

The Kung and Seagle survey in 1992[104] found that the public was still generally unaware of any potential health risks and viewed HVOTLs as an eyesore only. Their questionnaire produced some predictable responses, with 87% of homeowners who responded stating that if they had known about a link with health effects, the price they were "*willing to pay for their home would have been adversely affected or they would have looked in other areas for comparable housing*"(*ibid*). Despite earlier studies suggesting that what the public say they will do in a hypothetical situation and what they actually do are not necessarily the same, Kung and Seagle concluded that once the general

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Medicine and Biology Magazine 15(1): 116-120, 1996 and 15(2): 106-110, 1996. The HTML version by: John Moulder, Medical College of Wisconsin, USA. jmoulder@its.mcw.edu

[lx] For instance:- The Times; The Sunday Times; The Financial Times; The Guardian; The Observer; The Independent; The Independent on Sunday; The Daily Telegraph.

[lxi] For Instance:- New Scientist; British Medical Journal; Time Magazine; Environmental Health; Solicitors Journal; Estates Gazette; Property Week; New Zealand Valuers Journal.

[lxii] "The Calamity on Meadow Street", July 9, 1990; "Department of Amplification," November 19, 1990; and "The Cancer at Slater School," December 7, 1992. The New Yorker.

[lxiii] Brodeur P. (1993) The Great Power-line Cover-up. Published by Little Brown.

[lxiv] For Instance; BBC Panorama 31-1-1994.

public were aware of this association, concern over potential health risks "*would probably have a profound effect on the real estate market for homes located in close proximity to power transmission lines*"(*ibid*).

Whilst several more recent surveys have suggested that proximity to HVOTLs will remove certain buyers from the market, there is only limited evidence to suggest that this type of housing will not eventually sell (Rikon, 1996[105]). The conclusions drawn by Kung and Seagle's attitude study were based on a small sample size; 80 participants, from 2 neighbourhoods, with a 57% (47 respondents) response rate, and their valuation study used transaction data from the sales of 2 case properties and 3 controls in one location and 2 cases and 4 controls in a second location. As such, the results might not be very representative of the market in general.

Studies throughout the 1990s concluded a growing awareness of health risks, probably as a result of an increase in the number of reports of cancer clusters near schools, homes and amongst workers with a high exposure to EMFs. According to a public poll taken in 1993 by Cambridge Reports Research[lxv], 63% of all adult Americans were aware of the EMF issue, compared to only 31% in 1989 and nearly 50% responded that they were "*extremely worried*" about it. Some owners of property adjoining HVOTLs had even found their homes to be un-saleable at any price (Dent and Sims, 1998[106; 29]). Rikon[105] suggested that "*this ELF could be the next giant in environmental hazards*," and stated that it was "*entirely possible to conclude after an EMF market study that most parcels of EMF affected property will have a restricted resale value*"(*ibid*).

Kinnard and Dickey (1995[107]) found that using results from a residential survey as a measure of likely market behaviour was often questionable because of the "*sharp dichotomy between fear of health hazards by current and potential residents of an area and the market behaviour of buyers and sellers in that area*," and add that "*it is both improper and misleading to confuse the two.*" Analysis of transaction data over a period of time identifies "*actual past and likely future behaviour of buyers in market areas identified as proximate to HVOTLs*". Opinion surveys only reflect the responses of interviewees to a hypothetical situation, not necessarily the opinions of prospective purchasers in that location.

It was the inability of attitude studies accurately to predict market behaviour in terms of economic (valuation) effects that had been one of the major criticisms of the reliability of this type of research. The unreliability of such data was highlighted by the results of many attitudinal studies

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[lxv] Marx R. D, (1993) "This ELF Could Be The Next Giant In Environmental Hazards" Econ The Environmental Magazine For Real Property Hazards (November 1993): 22. Cited in Rikon (1996).[106]

that had found respondents' 'perceived value impacts' did not reflect actual behaviour in the market place, *"although the degree to which this occurred had not been tested"* (Kroll and Priestley[100]).

Another important consideration in the assessment of likely market behaviour was discussed by Jaconetty,[35] in his investigation of the impact of stigma, phobias and fear on property values. He stated that, to have a complete understanding of the *"dynamics of the marketplace we must consider not only what the sales data and social science research might show, but also what subjectively and personally motivates market participants"*(*ibid*). In the case of EMFs associated with HVOTLs, he found that the concern their presence induced in the public, *"appear[ed] to be a good example of a subjective fear that will continue to play a significant role in the marketplace"*. His research into this area led him to the conclusion that no amount of scientific studies refuting any claims of adverse health effects would *"overcome what people actually believe and fear"* (*ibid*).

From the mid 1990s, attitude studies generally compared property professionals' attitudes and opinions (in particular appraisers and valuers) to those of homeowners, (either living in proximity to HVOTLs or further away) in an attempt to assess the likely market resistance from buyers and the degree to which the valuer perceived such market resistance would impact on value.

A New Zealand study (Bond 1995)[108] found that valuers, estate agents and residents living near the line, *"all think of the HVOTLs in negative terms"*. Residents' attitudes in particular, were influenced by the degree of proximity to the line and tower, with residents close to HVOTLs having *"more negative attitudes than those further away."* The study was conducted in a low to middle income single-family suburb of Wellington known as Newlands; a hilly location overlooking the harbour. This afforded some homes a harbour view or screening from the HVOTLs. Other residential units had a view of several pylons and no harbour. Bond zoned residential units, for the purpose of this study, according to the proximity to HVOTLs and pylons (units within 50m of the line was classified as 'close' and units 50-300m away from the line, distant). The value of units classified as 'close' was perceived to be negatively affected by a *"high percentage of real estate professionals and valuers"* which, Bond suggested, could translate into lower valuations and negative advice either to potential buyers or sellers of proximate homes. She found that real estate sales persons (Estate Agents) appeared to have *"perceived the HVOTLs more negatively than the valuers."* [lxvi] Both groups suggested that the presence of HVOTLs could negatively affect the value of a house by as much as 10%. This figure was less than expected, considering the negativity expressed by the residents and alluded to the possibility that the degree of negativity expressed by residents does not give an accurate assessment of their actual behaviour in the market, in other

[lxvi] Valuers are referred to as Chartered Surveyors in the UK

words; negative opinion is not always reflected in lower house prices. This was confirmed by a parallel study of transaction data undertaken by Callanan and Hargreaves (1995)[109] using the same case study location. An analysis of transaction prices over a ten-year period suggested that the decline in value was, on average, 10%, (similar to earlier assessments of value diminution found in other studies)[lxvii] and that the greatest impact on value was caused by the pylon. HVOTLs in this study, were not sited in a ROW but crossed over residential units in the same way as transmission equipment is sited in the UK.

A study by Saint Laurent (1996)[110] suggested that the benefits of a ROW to an individual homeowner could 'cancel out' any inconveniences due to the "*enlarged visual field, increased intimacy*" that the ROW provided. The same homeowners also ranked the risks from power lines far below other environmental hazards which, it could be argued, imply that benefits such as increased privacy and a green corridor, can also outweigh concerns about possible heath risks.

3.4.10. Visual Impacts on Value -v- Health Risk Concerns

Gregory and von Winterfeldt (1996)[111] attempted to disentangle public concern of health effects from other possible impacts on value, such as visual contamination' to assess the likely impact on house price. Whilst finding that the available evidence suggests a value decline of between 5-10%' they stated that it "*remained difficult to disentangle the EMF portion of that decline from other causes*" and suggested that even if there "*truly are no adverse health effects, the fear of these effects may cause reductions in property values and had already caused the possible stigmatisation of transmission lines*" (*ibid*).

Due to the problems of trying to separate health effects from other effects on amenity, Mitteness and Mooney (1998)[112] chose not directly to address this issue in their attitude study, but to allow respondents to voice their own opinions on the causes of any negative effects. Their survey concluded that buyers of homes near power lines in Minnesota and western Wisconsin perceived the greatest value diminution (7.6%). Appraisers and existing homeowners living near HVOTLs perceived a similar loss in value of approximately 4%, which was lower than suggested by other previous studies (Callanan and Hargreaves[109]; Gregory and Von Winterfeldt[111]). Interestingly, owners who were in the process of selling homes close to HVOTLs stated that value was reduced by only 3.3% (see Figure 3-1). Marketing times were also found to be negatively affected, and

[lxvii] A later paper produced by Bond and Hopkins (nee Callanan) (2000), "The Impacts of Transmission Lines on Residential Property Values: Results of a Case Study in a Suburb of Welling NZ." Pacific Rim Property Research Journal Vol. 6,No 2:52-60) used an improved methodology to analyse the same data. The results were essentially the same.

results indicted that proximate residential units "*w[ould] require an additional 62.1 days on the market to achieve a sale*" (Mitteness and Mooney[112]).

Figure 3-1: Value and Marketing Time

Survey Sample	% Who believe PLs have an impact	Value Impact	Increased Marketing Time
Homeowners on PLs	36%	-4.1%	N/A
Buyers near PLs	66%	-7.6%	N/A
Sellers on PLs	50%	-3.3%	67% say yes
Appraisers	83%	-4.1%	82% say yes x = 62.1 days

Source: Mitteness and Mooney (1998)

To date, there have been no published studies undertaken which have explored the impact of HVOTLs on residential house prices in the UK. In addition, there have been relatively few opinion studies conducted in comparison to research undertaken in the USA, Canada and New Zealand which have examined the attitudes of property professionals, lenders, house buyers, sellers and occupiers towards electricity distribution equipment (Syms[3]; Gallimore and Jayne[5]; Jayne[6]; Dent and Sims[29, 106]). Dent and Sims, 1999 study used the work of Kung and Seagle[104] as a foundation for their survey of 360 members of Residents' Associations in the West Midlands area of the UK. Residents were asked their opinions regarding eleven possible contaminants, to avoid focusing specifically on power lines as the issue under investigation. There was a 30% response rate, suggesting that the public generally regard HVOTLs and substations as contaminants, due largely to health concerns (see Figure 3-2). Respondents were also asked whether, or not, they would buy a house in close proximity to HVOTLs, under-ground lines and sub-stations. Predictably, the majority of respondents said no (88%, 57% and 77% respectively). Removing the HVOTLs from sight reduced the negative response by around 10%.

A similar questionnaire, sent to 200 valuers in the same area, produced a 24% response rate. Replies indicated that buyers and surveyors viewed HVOTLs and substations as an environmental contaminant. Both groups indicated that they were less negative towards the presence of an underground line, perhaps indicating that the degree of negativity expressed was influenced by the 'visual' presence of electricity distribution equipment. Although, buyers expressed more concern about the visual impact and the possible health risks than surveyors.

Although the analysis of data in this study considered only frequencies as an indication of the strength of opinion towards electricity distribution equipment, the results generally supported those found in other recent studies (Bond and Hopkins 2000[113]; Jayne[6]), where a more robust methodology (regression analysis) was used. It did not however, address the likely impact on value, which is explored in the current research.

Figure 3-2: Classed as a Contaminant

Classed as a Contaminant	Yes	No	Visual	Noise	Health
High Voltage Overhead Power-lines	87%	13%	48%	8%	72%
High Voltage Under-ground Power-lines	38%	62%	2%	3%	70%
Sub-Stations	73%	27%	38%	8%	73%

Another UK study (Gallimore and Jayne[5]) attempted to test how far the perceptions of valuers influenced the attitudes of the purchaser; in other words, whether the diminution of value was due to professional valuation advice borne out of valuer caution to avoid professional negligence claims or due to genuine market perceptions? Both groups were asked to rank a number of everyday risks including HVOTLs. The results revealed that valuers were marginally more concerned than the public (the mean factor score for valuers = 1.42, public = 1.16). Interestingly, when both cohorts were asked to rank each other's view of the risk from HVOTLs, the results were virtually the same; suggesting that both cohorts consider the view they hold to be the same as that of other people. They concluded by stating that, "*if valuers' perceptions of this risk exceed the public's then there is the danger that valuers may amplify the public's level of fear in formulating their advice* "(*ibid*).

Jayne[6] returned to this issue in a study supported by the RICS Research Foundation. After conducting a 'risk perception' analysis, he concluded that perceptions of HVOTL risks varied broadly within the population, although the results do show a "*general sensitisation of the public to the risk of HVOTLs.*" However, the potential impact on house prices was not explored. Analysis revealed some possible determinants (heuristics) of probable market response; gender, age, second child and region, but not socio economic grouping. Other factors potentially influencing a buying decision included "*visual intrusion, local planning proposals and even the lending policies of funding institutions.*" He concluded that valuers might be helped when interpreting market behaviour by understanding "*the nature of the public's perceptions of the risks of HVOTLs*".

In an effort to help "*guide future research*", Elliot and Wadley (2002)[114] designed a conceptual model which would enable the "*study of electricity lines as they influence property,*" to be compartmentalised into three 'causative domains'; (EMF-(health); Design-(visual impacts); Engineering-(noise) and should then highlight the factors that lead to power line stigma and value diminution. Their paper included an overview of existing literature in terms of issues raised, rather than an in-depth evaluation of each study, thus providing a framework for the evaluation of existing studies, rather than suggesting a methodology for the future evaluation of the effect of distribution equipment on the property market.

3.5 CONCLUSIONS OF THE CHAPTER

Whilst using transaction data are undoubtedly the most reliable method of determining the likely effects on the value of property (land and residential units) near HVOTLs, particularly when a hedonic approach with multiple regression analysis is adopted, this is only possible when there are sufficient data available for such an analysis[lxviii].

By comparison, perceptual studies rely on the personal experience and opinions of the participants, rather than transaction data, and have shown that they can provide a reasonably accurate estimation of the impact of HVOTLs on transaction price (Bond and Hopkins[113]). In addition, perceptual studies have the ability to highlight, and measure, the degree to which an individual variable contributes towards any negativity expressed by participants. However, care should be taken when relying on the results of past studies as an indicator of likely market reaction. The findings from many studies have proved to be somewhat misleading, due to the tendency of participants, buyers in particular, to express a great deal more negativity towards HVOTLs than is reflected in the price they are willing to pay for proximate units. This dichotomy might be due, in part, to the questionnaire design, which generally failed to ask participants to express their negativity in value terms. Bond and Hopkins study addressed this issue by asking participants how much impact they thought the proximate HVOTL had on house price. The results were then compared with actual transaction data, for the same location, which showed close similarities between estimated value effects and actual value reductions (*ibid*).

3.5.1 Summary of the Perceptual Literature Review

The literature reviewed in this chapter has considered a number of interrelated subject areas, which help to explain the complexity surrounding public perception towards HVOTLs. This includes literature on risk analysis, land and property contamination, stigma damage and compensation, health studies and previously conducted perceptual studies. Relevant literature has been reviewed from each subject area, highlighting a number of 'key' issues relating to the impact of public and professional perceptions towards electricity distribution equipment on the property market.

A) Risk analysis, Contamination and Stigma Damage

Risk analysis studies have identified a number of factors (referred to as heuristics) that can influence a person's estimation of risk. (For instance; age, gender and number of children) Two such heuristics; freedom of choice and uncertainty (the degree of uncertainty associated with the risk to health or equity), have been found to have a high degree of influence on the degree of

[lxviii] This approach is difficult to adopt in the UK due to the lack of available transaction data.

negativity expressed by the public, regardless of personal factors (age, gender etc), towards environmental features.

Freedom of Choice: Research has found that an imposed risk creates more negativity and opposition than one which is freely taken such as the risk of lung cancer from smoking. Studies (Kasperson[15]; Slovic[12]) suggest that the public will accept very high levels of risk providing the decision is not imposed on them. Whilst people generally have a choice over whether they live next to a HVOTL or not, there are three foreseeable situations in which their choices may be limited.

i) Existing HVOTLs may be upgraded, resulting in higher EMF exposure levels for existing residents; greater visual impact if the pylon size is increased to cope with the upgrade; and possible negative impacts on the value of their home (leading to negative equity if the market impact is severe).

ii) Low cost housing placed near HVOTLs which due to the rise in house values may be the only available 'affordable' home for first time buyers.

iii) Social housing placed closest to HVOTLs: Occupants of social housing have generally have little or no choice over the location of their home and so may be forced to accept a unit close to a HVOTL.

Uncertainty: Environmental features associated with a possible risk to health or equity can cause stigma (see 3.1 above), especially when the risk is uncertain. Property related stigma, has been found to cause value diminution and an increase in marketing time.

B) Potential Health Risks

A variety of adverse health effects have been linked with exposure to EMFs from living near HVOTLs and sub-stations, however, no causal link has been established. The most often cited health risks are:-

i) Childhood leukaemia. Health studies have repeatedly identified an increased risk of living near HVOTLs and developing childhood leukaemia.

ii) Neurodegenerative Disease. An increased risk of Alzheimer's Disease has been associated with occupational exposure to EMFs.

iii) Reduced Melatonin Production. Exposure to EMFs from any source reduces melatonin, which helps detoxify the body and prevent cancer.

C) Perceptual Research

The majority of perceptual studies have been undertaken in the USA and Canada with a smaller number in New Zealand and Australia. By comparison, there are only 3 published studies in the UK. All three focused on HVOTLs in terms of perceived risk compared to other environmental risks. Two studies highlighted a number of 'heuristics' which could influence public attitudes towards HVOTLs. These were age, gender, number of children and location. All studies identified that house prices were perceived to be negatively effected by proximity to electricity distribution equipment. The reasons for any negative value impacts were usually cited as:-

i) Perceived health risks due to visual presence.

ii) Visual unsightliness, particularly of the pylon.

iii)Public negativity towards HVOTLs.

3.5.2 The Gap in Knowledge and Direction of the Current Research.

The Gap in Knowledge: In the United Kingdom, only three opinion studies have been undertaken and published in this area. One investigated HVOTLs in relation to other environmental risks (Syms[3]) and two established public and professional perceptions towards them (Gallimore and Jayne[5]; Jayne[6]). The results suggested that both the public and property professionals view HVOTLs with some degree of negativity, but did not established whether market resistance translated into lower house prices, or whether any negativity is a function of visual proximity or the perception of health risks. This may be due to the fact that unlike the USA, Canada, Australia and New Zealand (where most research has been undertaken) there are few available transaction data within the United Kingdom to enable such a valuation study to be conducted. Perceptual research is, therefore, the only available method of analysing the impact of HVOTLs and other environmental features on the property market.

Direction of the Current Research: An analysis of the literature has indicated that perceptual studies may be able to provide an accurate assessment of value diminution providing they are conducted using a well-established research methodology (Bond and Hopkins). Since one of the central problems faced by researchers within the UK is the lack of available transaction data, a key element of the thesis is to use perceptual research within a qualitative and quantitative methodological paradigm to generate data, which will establish perceptions of value diminution (property valuers, agents and occupiers). The results will then be compared with a benchmark generated from a suitable source of transaction data which will, in theory, establish the likely impact on the price of homes sited close to HVOTLs within the UK.

The following section of this thesis (Part Two) presents the empirical research undertaken to fulfil the central aims of the research and test the hypotheses stated in Chapter One: 1.5. The first chapter (Chapter Four) discuss and justify the choice of research strategy, which has been developed from an analysis of the literature. The data are gathered under the headings of 'Valuation' data or 'Perceptual' data, and the analyses of these data are presented in Chapters' Five and Six. The results from the different methods adopted as part of the research strategy are compared, and final conclusions drawn in Chapter Seven.

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Independent Expert Group on Mobile Phones (IEGMP http://www.iegmp.org.uk/)
Henshaw D. at Bristol University http://www.electric-fields.bris.ac.uk

Part 2

Empirical Research

Chapter Four

Methodology

4.0 INTRODUCTION TO THE CHAPTER

The stated aim of this research is to determine the impact of HVOTLs on the value of residential units in the United Kingdom. This chapter explains the research strategy and choice of methodology designed to achieve this aim.

4.1 THE RESEARCH PROCESS

Wright states that the purpose of research is to "*answer some question(s) about the world*"(Wright, 1997[1]). Bryman and Cramer (1996[2]) describe undertaking research as a process initiating in a "*theoretical domain*" followed by a number of logical steps (Figure 4-1). In practice, there are "*grounds for doubting that research always conforms to a neat linear sequence*" (Bryman 1988[3]); however, a model of the research process does provide a useful framework prior to empirical work. Thus the research process adopted for the thesis is as follows:

I. Finding a focus for the research and formulating a theory to explain the relationship between the presence of HVOTLs and the value of residential units.
II. The development of research questions and hypotheses.
III. Designing the research methodology to answer research questions and test hypotheses (Operationalization; Bryman 1988[i]; Bryman and Cramer[2]).
IV. Selection of the subjects of the research and case study locations.
V. Collection and analysis of the data.
VI. Relating the findings back to the research questions and hypotheses.
VII. Firming up research questions and further data collection.

This chapter follows the above stated process. A summary of the research process and a description of the two main traditional research paradigms are given to explain and justify the research methodology adopted for the thesis. Finally, the data will be analysed and conclusions drawn in the subsequent chapters.

4.1.1 Finding the Focus for the Research

The first stage of the research process was to undertake an initial review of the literature which revealed the following factors:

i. Studies to determine the impact of electricity distribution equipment on value of proximate[ii] residential units had been conducted in the USA, Canada, New Zealand and Australia (see Chapter Two and Three generally). No research had been undertaken in the UK.

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[i] This is the translation of the hypothesis into variables from which the objects of the research differ. Bryman[3]

[ii] Proximate is deemed to be within 400m of a line or pylon

Figure 4-1: A Model of Three Approaches to the Research

Purpose of each step in the research process	General Approach Wright 1997	Quantitative Approach Bryman 1988	Qualitative Approach Bryman 2001	
Establishing the gap in knowledge and the focus for the research.	Literature search	Literature search	Literature search	
Establishing the research environment to enable the research to be conducted	The critical situation devised	Deducing a number of hypotheses to explain behaviour	General research questions	
Designing the study to enable data to be collected and analysed to answer the research question/s	The technical details of the research, including choice of methodological approach, selection of research participants and case study location and the method of analysis.	Expressing these hypotheses in operational terms ↓ Operationalization of the hypotheses ↓ Selection of the subjects of the research ↓ Designing a research methodology to test the hypotheses	Selecting relevant sites and subjects	
Testing the research design and analysis tools (troubleshooting)	Pilot study	Pilot study		
Data collection	Conducting the research	Conducting the research	Collecting the data	
Use of statistical package	Entering the data	Entering the data	Interpretation of data	Collection of further data
Choosing appropriate statistical tests to establish research validity	Statistical analysis and interpretation	Statistical analysis and interpretation	Conceptual and theoretical work	Firming up the research question(s)
Writing up stage	Presenting findings	Relating the findings back to confirm or reject the hypotheses	Write up findings / conclusions	

Adapted from Wright[1]; Bryman[3] and 2001[7]

ii. A substantial number of scientific studies had investigated the potential health effects from exposure to electric and magnetic fields from power lines, with unclear and conflicting results. This had led to-

iii. A publicised link between living near HVOTLs, childhood cancer and a number of other adverse health effects that could negatively affect public and professional perceptions towards residential units close to HVOTLs.

iv. HVOTLs and supporting pylons had been focused on almost exclusively by researchers investigating this issue in other countries and appeared to generate more concern than other aspects of distribution equipment.

This identified that there was a gap in knowledge and provided a focus for the research, which was to establish the impact of electricity distribution equipment on the value of residential units within the UK.

4.1.2 Literature Search and Review

The initial review of the literature was followed by an extensive literature search involving a much wider subject area. This was to enable the potential impact on the residential housing market from adverse public perception due to the publicised association with a health risk to be fully explored. Secondary data were collected from a variety of interrelated subject areas, including literature on contaminated land and buildings; property stigma damage; planning policy and development guidelines; behavioural studies and risk analysis; scientific research; studies to examine attitudes (professional and public) toward the presence of HVOTLs and previous research undertaken to establish the impact on value using actual transaction data (see Chapters Two and Three).

The product of this wider literature search:

i. confirmed that no prior research had been undertaken to establish the impact on residential house prices within the UK.

ii. established the current level of knowledge within this research area.

iii. identified the factors that may contribute towards value diminution.

iv. provided a foundation for the development of a theory of the relationship between the presence of HVOTLs and house prices in the United Kingdom (see Chapter One, figure 1-5), and

v. provided direction on the research design and methodology for the thesis.

The literature confirmed that no prior research had been undertaken within the United Kingdom and therefore the purpose of the research design was to provide such data and analyses. The literature search also highlighted a number of factors relevant to the current research. Firstly, previous research, undertaken outside the UK, generally focused on the physical distance from the

HVOTL or the power line 'right of way.' The potentially negative effects from the visual encumbrance were rarely taken into consideration (Colwell, 1990[4]; Rosiers, 2002[5]). Secondly, whilst all studies using a hedonic model with multiple regression analysis found some evidence of value diminution, there seemed to be no general consensus of what the impact on value might be.[iii] Thirdly, it was common practice for researchers to conduct a parallel study of public attitudes at the same time as valuation research.[iv]

In order to fulfil the aims of the research, six objectives were formed which, following revision as a consequence of information gained from the existing literature, are as follows:

Objective 1. To determine the key factors influencing the value and marketability of residential units in close proximity to HVOTLs, and, to examine how these factors affect the behaviour of market participants.

Objective 2. To establish the perceived impact of HVOTLs on the value of residential units.

Objective 3. To determine whether there is a measurable correlation between the physical distance of HVOTLs and value, and visual encumbrance and value.

Objective 4. To establish the degree to which attitudes can be relied upon to provide an accurate determination of the value of residential units in close proximity to HVOTLs (This objective requires an alternative data source for a comparative analysis).[v]

Objective 5. To establish a set of criteria for measuring the likely impact on the value of such residential units.

Objective 6. To establish the impact of the presence of a HVOTL on house prices in the UK.

4.1.3 The Development of Research Questions and Hypotheses

It became apparent in the early stages of this thesis that the greatest barrier towards undertaking the current research was the lack of available transaction data. In addition, further enquiries revealed that it would be prohibitively expensive to obtain an adequate supply of transactions undertaken within England, to enable the impact on house price to be established (the price of this data has just been drastically reduced and, at the time of writing, a single transaction can be purchased from the Land Registry for £2). This investigation was complicated further by the alleged[vi] relationship

[iii] This may have been due to differences in research methodology in particular the lack of commonality between the external variables included in the model for analysis.

[iv] More recent opinion studies suggested that the degree of negativity expressed by homeowners in a survey did not appear to be supported by the behaviour of buyers towards HVOTL proximate property.

[v] This is an important aspect of the research, as residential property transaction data are publicly unavailable in England and therefore cannot be analysed to establish the impact from environmental features such as HVOTLs.

between living near HVOTLs and childhood cancer. This relationship had the potential to influence house price either as a direct result of risk driven buyer behaviour or due to the perceptions of valuers when making an assessment of the value of HVOTL proximate homes (see Chapter One: 1.0; Chapter Two generally and Chapter Three: 3.4).

The lack of available data coupled with the publicised relationship between living near HVOTLs and childhood cancer presented many research questions[vii] and few clear hypotheses[viii] to test in order to fulfil the research objectives set down in Chapter One: 1.5.

4.1.4 Research Questions

The following research questions have been developed to gain a clearer understanding of certain aspects of the research.

I. What are the key factors influencing the purchase decisions of buyers/potential buyers of homes near HVOTLs?

II. Do buyers and residential valuers (Chartered Surveyors and Agents) perceive that the presence of HVOTLs has a negative impact on the value of proximate residential units? If so:
   i. which aspect(s) of the HVOTL cause(s) value diminution?
   ii. to what extent is value reduced?
   iii. do buyers, surveyors and agents share the same opinions?

III. Are there any indications of attempts by developers/builders to mitigate perceived loss of value caused by HVOTLs?

IV. How, in the absence of property specific transaction data, can perceptions of value loss be tested to establish whether they reflect actual behaviour in the property market?

4.1.5 Hypotheses.

The initial hypotheses were revised to embrace new information generated by the literature search and exploratory interviews. The following hypotheses are tested by this research and may be divided thus:

[vi] Research papers, and media attention; Journals, Newspaper articles, TV programmes. See Chapter Three.

[vii] Research questions are designed to help achieve the aims of the research when there are no clear hypotheses to test.

[viii] The following hypotheses are designed to limit the scope of the enquiry to the interaction of certain variables. The criteria which distinguish hypotheses from research questions and other types of statement are that they are assertions and not suggestions (Bryman and Cramer[2]). They should be limited in scope and contain statements about the relationship between certain variables.

Hypothesis 1. Chartered Surveyors would perceive a greater negative impact on the value of residential property than Estate Agents due to PS 3.7 (RICS Red Book).

Hypothesis 2. Surveyors and Agents who had no experience of valueing HVOTL proximate residential units would perceive a greater degree of value diminution than those familiar with the valuation of this type of unit.

Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential units than physical proximity.

Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line.

Hypotheses 1 and 2 test the influence of perception on the value and desirability of HVOTL proximate residential units. Valuers and agents may have different opinions of the impact of HVOTLs on house price, which may reflect the difference between their professions or a lack of professional experience that may result in overestimating the negative impact on value.

Hypotheses 3 and 4 test the relationship between the physical presence and the visual aspects of HVOTLs and value. This will reveal whether on not the market is influenced by proximity to the HVOTLs or the visual characteristics of distribution equipment (the pylon). This is particularly relevant for future development, as it will indicate whether or not screening or other methods of reducing the visual impact of the line and pylon will mitigate any negative effects.

As stated in Chapter One 1.5, the null hypothesis format is not used, due to the way in which the hypotheses have been constructed. Therefore, the real hypotheses are tested and accepted, or rejected, depending on the results of the analyses in Chapters Five and Six.

4.2 CHOICE OF RESEARCH STRATEGY

Once the focus of the investigation has been clearly established, consideration must then be given to the overall research paradigm. The choice of paradigm depends upon the nature of the problem to be investigated which will dictate, to a large extent, the method used to collect data. Data collection methods include, observation, (either as a participant or observer) documentation, visual material and interviews[ix] (Bryman[7]; Knight[10]).

[ix] There are several interviewing styles available to the social researcher, including unstructured, moderately structured, highly structured and highly structured standardised; however, a highly structured approach is more usually associated with a qualitative approach (*ibid*[10]; Bryman[7]).

The two main traditional research paradigms (Table 4-1) used by the researcher when developing a research strategy are, qualitative research and quantitative research (Creswell 1994[6]; Bryman[3]; Wright[1]).

4.2.1 Quantitative Research

Quantitative research is termed the traditional, positivist, experimental or empiricist paradigm (Creswell[6]). It is deductive, seeking to test theories by identifying and explaining relationships (correlations) between specific variables, usually in terms of *"cause and effect"*. The information produced is "*hard, reliable data,*" (Bryman 2001)[7] which is both predictive and explanatory.

Table 4-1: The Two Traditional Research Paradigms

Qualitative Research	Quantitative Research
Research problem: How? Why?	**Research problem:** Who and how many? What and how much?
Literature Review: Exploratory-what variables are involved? Can lack a theoretical base Research questions are developed	**Literature review:** Explanatory-what are the relationships between the variables? Which ones have been previously identified and measured? The development of hypotheses
Paradigm: Phenomenological / interpretive	**Paradigm:** Positivist / confirmation or rejection
Methodology: Ethnographies, grounded theory, or case study	**Methodology:** Experiment or survey

Adapted from Perry 1996[x]

Research methods within the quantitative paradigm generally consist of two types; experiments or surveys (Creswell[6]). Robson (1993)[8] includes a third method; case studies. Experimental designs are suitable when the researcher can manipulate conditions either in the laboratory or in the field of study to determine the effect on the experimental subjects, whereas surveys either administered through a questionnaire or a structured interview are used to gather large amounts of information relating to the research focus simultaneously (Fowler 1993)[9].

A quantitative methodological investigation is approached using a deductive form of logic where concepts, variables and hypotheses are chosen before the study begins and remain fixed throughout. The type of data gathered is usually in numerical form, which is then analysed to establish patterns or correlations between variables and the results are presented by a variety of means, including charts, graphs, tables and statistics.

[x] Cited in Daly 2000

4.2.2 Qualitative Research

Qualitative research by contrast, is termed the constructivist, naturalistic or interpretative paradigm (Creswell[6]). It is inductive, with theories emerging from an investigation (Grounded Theory), rather than seeking to prove or disprove a previously defined construct (hypothesis testing) and is particularly useful as an exploratory tool when there is little or no information about the particular phenomena under investigation (Knight 2001).[10] The four qualitative research designs frequently found in social research are Ethnographies[xi], Grounded Theory[xii], Case Study[xiii] and Phenomenological Studies[xiv]. Although, only grounded theory and case study approaches are utilised in the thesis.

The main aim of a qualitative approach is to provide information that leads to *"patterns or theories that help explain a phenomenon"*(Creswell[6]), by "*...viewing events, actions, norms, values etc., from the perspective of the people who are being studied*" (Bryman[3]). However, this characteristic has been criticised by some researchers "*as subjectivist and even journalistic*" (Miller and Dingwall 1997[11]).

The concepts, variables and hypotheses which emerge from a qualitative investigation can form the basis for further research using a quantitative approach to test the strength of the relationship (correlation) between the variables (Bryman[3]; Knight[10]). In this instance, Grounded Theory[xv] is the most appropriate tool available to the researcher (Glaser and Strauss, 1967[12]; Bryman and Burgess, 1994[13]; Walliman, 2001[14]).

[xi] Ethnographies: A flexible approach involving the study of an intact cultural group in a natural setting, during a prolonged period of time by collecting observational data. This type of research evolves over time (Wallen and Fraenkel 1991; Grant and Fine 1992; Creswell 1994).

[xii] Grounded Theory: Theories, hypotheses or research questions are derived using multiple stages of data collection and the refinement and interrelationship of characteristics of information. (Strauss and Corbin 1990; Creswell 1994)

[xiii] Case Studies: The researcher explores the phenomenon (the case) bounded by time and activity. Detailed information is collected using a variety of data collection methods over a sustained period of time (Merriam 1988; Yin 1989; Creswell 1994).

[xiv] Phenomenological Studies: Human experiences are examined through the detailed descriptions of the people being studied. (Nieswiadomy 1993)The procedure involves studying a small number of subjects through extensive and prolonged engagement to develop patterns and relationships of meaning (Dukes and Oiler 1986).

[xv] Grounded theory is basically concerned with "*the discovery of theory from data*" (Glaser and Strauss[13]), rather than starting with an existing theory and designing the research to prove or disprove it. The overall aim of the process is to develop a theoretical hypothesis from field data. These data are put into a range of categories devised by the researcher and followed by further research to establish the true meaning and importance of the various categories. The interconnectedness and the theoretical implications are tested, leading to the further development of hypotheses, continued data collection and the subsequent development

The distinction between the two paradigms provides "*a useful means of classifying different methods of social research*" (Bryman[3]) and the basis of each approach can be summarised by:-

Quantitative approach = Theory ——→ observation/findings

Qualitative approach = Observations/findings ——→ theory

In practice, however, there is considerable debate amongst social scientists about the validity and usefulness of the data produced by these approaches in isolation from one another. Brewer and Hunter (1989)[17] suggest that as differences between qualitative and quantitative approaches can be viewed as technical rather than epistemological, a combination of the two methods specifically designed to 'fit' the study in question is frequently preferable to one or other of them. Webb (1966)[15] suggests that social scientists are likely to have more confidence in findings derived from more than one form of investigation.

4.2.4 Triangulation

A multi-method approach enables the results of an investigation to be triangulated. The theory behind the multi-method approach is that quantitative and qualitative methods can be utilised as different approaches to the same research problem and regarded as "*complementary, rather than rival,*" (Firestone, 1987)[16] "*providing that the researchers are perfectly clear about how different research methods contribute to the overall research strategy*" (Knight[10]). Existing literature would indicate that a number of researchers have already "*recognised that there is much to be gained from a fusion of the two research traditions*" (Bryman[3]) combining both approaches to form a multimethod approach (Brewer and Hunter).[17] This approach is particularly useful when attempting to measure some phenomena. "*Triangulated measurement tries to pinpoint the values...more accurately by sighting in on it from different methodological viewpoints*" (*ibid*). If the results from each approach yield similar answers then the analyst can be more confident of having obtained a valid result (Creswell[6]).

4.3 RESEARCH STRATEGY ADOPTED FOR THIS RESEARCH

The strategy adopted for the current research is now justified (Figure 4-2).

4.3.1 Perceptual Research

The first part of this research was designed to achieve research objectives 1 and 2 and therefore focused on investigating the attitudes and perceptions of property market participants towards HVOTLs near residential units. This part of the enquiry adopted a combination of qualitative and

of a theory, with the process repeating itself. Thus the theory is grounded on evidence from the field (Bryman quantitative strategies to enable emerging variables and hypotheses to be tested on a wider sample and so result in a greater degree of homogeneity.

Exploring opinions, attitudes and feelings is at the core of qualitative research and, as such, justifies the use of unstructured interviews; one of the primary methods of data collection within a qualitative framework, as the initial approach towards data gathering. The main aim of conducting unstructured interviews was to identify key variables which would enable a survey to be developed to test the research questions and hypotheses on a wider sample of the population. Bryman explains that the *"survey's capacity for generating quantifiable data on large numbers of people ... in order to test theories or hypotheses has been viewed by many practitioners as a means of capturing many of the ingredients of a science"* (Bryman[3]).

The survey approach to quantitative data collection contrasts with the experimental designs more readily associated with the traditional form of quantitative research. In an experiment, there are at least two cohorts of randomly selected participants, an experimental group and a control group. The logic of the experimental design is that one group is exposed to a stimulus (the independent variable) whilst the control group is not. *"Any observed differences between the two groups is deemed to be due to the independent variable alone, since the two groups are identical in all other aspects"(ibid)*. By comparison, a social survey *"commonly refers to the collection of standardised information from a specific population"* (Robson[8]). The researcher does not manipulate any of the variables of interest and data are collected simultaneously.

As it is rarely possible to survey all members of a specific population, a random sample considered to be representative of the sample population is chosen. The ability of a survey to enable certain predictions to be made about a particular sub-set of the population *"depends crucially on choosing a representative, non-biased sample"* (*ibid*).[xvi]

4.3.2 Levels of Measurement.

To enable responses to attitude statements to be measured and analysed quantitatively, some method of measuring the response must be devised. The usual method of achieving this is use of an attitude scale. The chief function of an attitude scale is to divide people roughly into a number of broad groups with respect to a particular attitude. This enables comparisons to be made between other variables in the survey. Likert scales are regarded as *"the most popular scaling procedure in use today"* (Oppenheim, 1992[18]) and have been applied to the appropriate questions within the surveys undertaken as part of this research.

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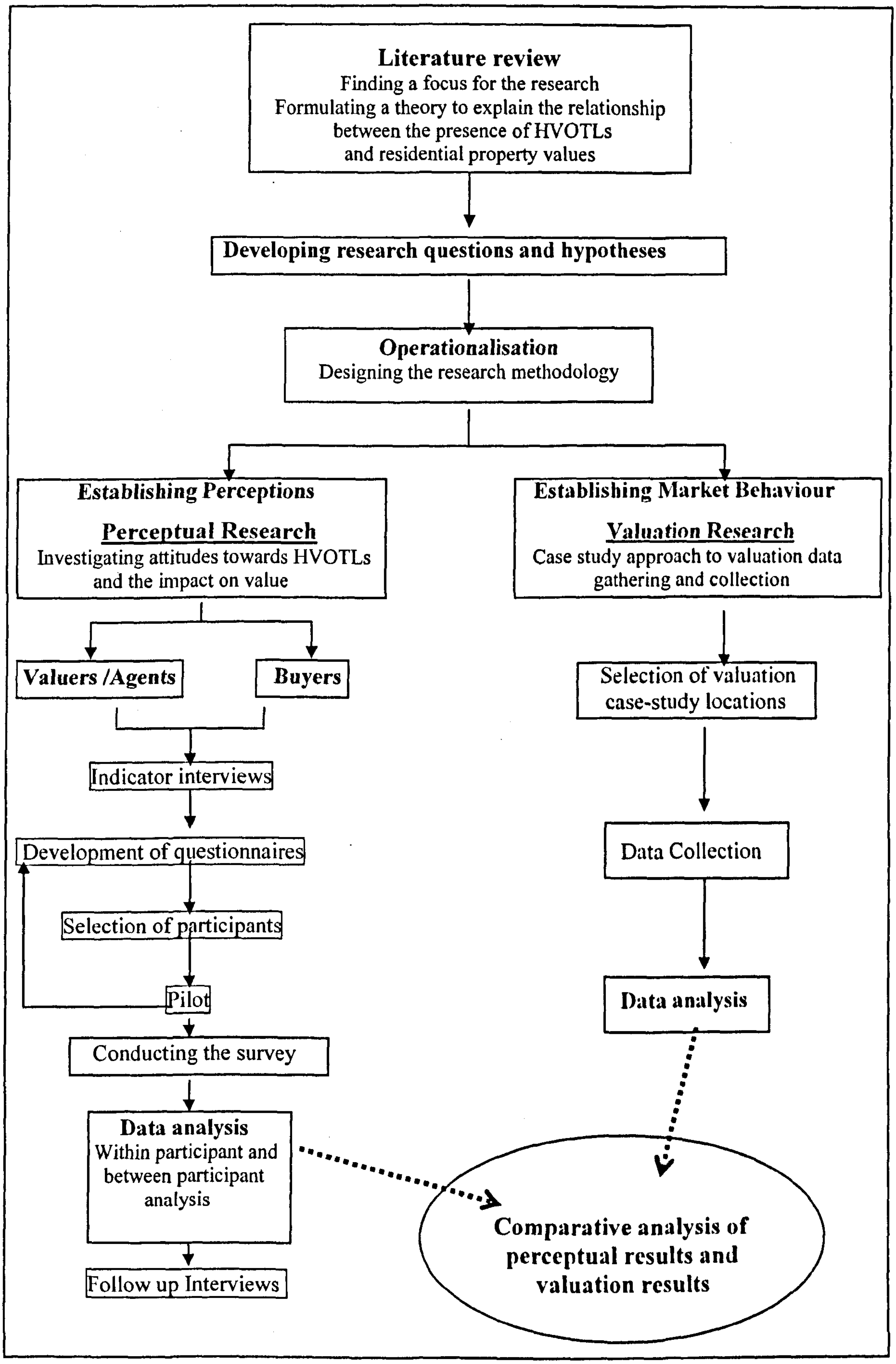
and Burgess, 1994[13]; Walliman, 2001[14]).

Figure 4-2: Design of the Research Methodology for This Thesis



xvi A good explanation of sampling and sample procedures can be found in Byman and Cramer[2].

Likert scales can be strictly interpreted as an ordinal level of measurement, although researchers often treat the data produced from attitude scales as interval or ratio. Traditionalists argue that this is *"questionable in most circumstances"* (Wright[1]), as an ordinal level of measurement simply produces a clear ranking of the responses, whereas interval data imply an equal distance between each point on the scale. Whilst there are clearly differences between ordinal and interval data, in practice Wright suggest that *"it often does not make a large difference which one is used"* (*ibid*). In addition, some research questions actually stipulate some notion of distance, for instance; 1(strongly agree), 2(agree), 3(neither agree nor disagree), 4(disagree), 5(strongly disagree).

A useful distinction between the two is offered by Wright (*ibid*). *"If you can mix up the order of the values without changing their meaning, then you have nominal data."* Bryman and Cramer[2] offer two types of interval variable; a 'true' one, where the distances between categories are equal, and another in which the *"variables strictly speaking are ordinal, but which have a large number of categories, such as multiple-item questionnaire measures"* and are therefore *"assumed to have similar properties to 'true' interval variables" (ibid)*.

Where appropriate, a five point Likert scale was adopted, although for certain questions, a sliding ten-point scale was substituted to enable respondents to rank the degree of impact from 'No Impact' (0) to a 'Very Large Impact' (10). Both scales were on a continuum and anchored at either side and could therefore be justified as interval scales.

Having initially adopted a qualitative framework to provide information leading to the development of a survey, the data produced were analysed using qualitative methods described in Chapter Six. This enabled the results to be compared and tested against a source of transaction data, to determine the relationship between opinions of market behaviour and the actual behaviour of market participants.

4.3.3 Valuation Research

The second part of the research was designed to achieve research objectives 3 and 4, and required identification of a suitable source of transaction data, then gathering the appropriate data to enable the potential impact on house prices to be established. This part of the research was specifically aimed at examining 'how much' the presence of HVOTLs affects selling price and finding out whether, or not, there was a measurable relationship between proximity (distance from the HVOTL) and value or visual encumbrance and value.

The data collected using this methodology were largely numerical and therefore analysed using quantitative methods of analysis. The analysis is described in Chapter Five.

4.3.4 Research Approach

Due to the fundamental differences in the type of data gathered to achieve the aims and objectives of the research, a combination of methods within the two research paradigms was the most appropriate methodological approach. This research strategy is known as a multimethod approach seen as a form of triangulation (Creswell[6]). The multimethod approach quite simply uses a combination of qualitative and quantitative approaches to data gathering and analyses to overcome the weaknesses and limitations of using only one method (Brewer and Hunter[17]). The benefits of using a number of different approaches to investigate the same research problem to enable cross validation of results justifies the use of this approach. Figure 4-2 explains use of this approach within the current research.

The following sections have been divided into two parts. The first deals with facets of the research under the heading of 'perceptual research', the second part deals with data on the market value of residential units in close proximity to HVOTLs and is referred to as 'valuation research'. The research methodology and data gathering are now discussed in the following sections.

4.4 UNDERTAKING THE PERCEPTUAL RESEARCH

The literature search established some initial criteria to enable a methodology to be designed to obtain the required data. First, previous literature suggested that there were two subsections of the population whose opinions and attitudes influenced the value and marketability of HVOTL proximate residential units (see Chapter Three: 3.4). These groups were house purchasers; referred to here as buyers[xvii], and residential valuers[xviii] (Bell, 1999[19]).

The literature established that it was possible to ask valuers direct questions about the impact of various detrimental conditions, including HVOTLs (see Chapter Three: 3.4.1), on the housing market without inadvertently increasing negative attitudes and, as a consequence, causing greater value loss. Thus it was possible to explore, in particular, 'which factors' influenced buyers when making their purchasing decisions; 'how much' impact the relationship between perceived health risks and living near HVOTLs had on the desirability of proximate residential units and; 'what effect' HVOTLs had on value.

Asking homeowners similarly direct questions had been found to increase negative public attitudes through raising awareness of the publicised link between HVOTLs and cancer, thus resulting in a

[xvii] The market value of any given supply of property is, in theory, based on the behaviour and demands of buyers (Bell[19]).

[xviii] A valuer's assessment of market value relies on an implicit knowledge of the key factors influencing the value of property in their location. Valuers, however, also have the ability to influence the market, rather than give advice which reflects it, particularly if they perceive the public to be more concerned about an environmental feature such as HVOTLs than the public actually are (see Bell[19]; Gallimore and Jayne[23]).

self-prophesying investigation (see Chapter Three: 3.4.9). Therefore, to avoid the risk of a spurious result, the two cohorts required slightly different approaches towards data gathering. The data gathering approach adopted for each cohort is explained in detail below.

The most frequently used method to gather this data was found to be a survey, using a postal questionnaire. Whilst there were problems with low response rates (Oppenheim, 1992[18]), this method was perceived to be the most effective way of generating sufficient data to enable a degree of homogeneity to be established (Bond and Hopkins, 2000[35]; Dent and Sims[26]).

Having established that a) house-buyers and valuers were the most appropriate data source and that b) conducting a postal survey would provide suitable data to establish a degree of homogeneity, a number of exploratory interviews were conducted to inform the design of the postal survey. Further information would be sought from the electricity utilities, local Government Planning Departments, lending institutions, and residential property developers through the use of face-to-face or telephone interviews, to determine their influence on the residential housing market.

4.4.1 Exploratory Interviews

The literature search had included the results from a number of perceptual surveys undertaken by researchers investigating phenomena such as the perceived risk associated with different environmental features, or more specific perceptions of property contaminants including HVOTLs. These studies appeared to focus heavily on public, rather than professional perceptions. Many were found to be surprisingly direct in their approach towards examining buyers' perceptions of the publicised link between HVOTLs and cancer[xix] and, in addition, the impact which this had, or could have, on purchasing decisions. These surveys and questionnaires provided a pre-tested foundation for this survey.

To inform further the design of a standardised questionnaire, a number of exploratory interviews were conducted.

4.4.2 Objectives of the Exploratory Interviews

"*The purpose of the exploratory interview is essentially heuristic: to develop ideas and research hypotheses rather than to gather facts and statistics*" (Oppenheim, 2001).[20]

With this in mind, the objectives of the interviews were threefold.

i. To provide further data on the perceived effects of electricity distribution equipment in the United Kingdom.

ii. To clarify the direction of the research and refine the objectives and hypothesis.

iii. To build up an 'inventory' or 'checklist' of items which could be tested further in the field (*ibid*).

4.4.3 Selection of Interviewees

Several surveys, Syms (1996[21]), Dent and Sims (1998[22]), Gallimore and Jayne (1999[23]), and Jayne (2000[24]), have found differences between public and professionals' perceptions of the effect of environmental contaminants, including electricity distribution equipment, on residential values and a small number of studies have contrasted the opinions of homeowners who live near power lines with those further away (Kinnard, 1967).[25] There has not however, been a study to determine whether there is a difference between the opinions and perceptions of the only two professional bodies whose members are recognised as being qualified to undertake professional property valuations in the United Kingdom. These are the Royal Institution of Chartered Surveyors (RICS) and the National Association of Estate Agents (NAEA). (In addition, there are a large number of independent estate agents who are neither members of an association nor hold any professional qualification, although they usually employ the services of a qualified valuer when needed).

It was possible that differences would be observed between the perceptions of estate agents, who appraise a property and then arrive at the asking price and the perceptions of Chartered Surveyors, who follow the guidelines laid down by the RICS (The Red Book) when they undertake a survey of the property usually on behalf of the mortgage lender to ensure that the property represents suitable security. It was hypothesised that the inclusion, until recently, of PS 3.7 (see Chapter One 1.0) which stated that public perception may affect the future value and marketability of property near HVOTLs, might lead surveyors to be more cautious in their estimation of selling price (See Chapter Three 3.4.10 and Chapter Four 4.4.6). Since both Surveyors and agents are in a position to influence property values, establishing their perceptions toward the impact of a HVOTL on house price was highly relevant to this research.

4.4.3.1 Valuers

<u>Chartered Surveyors</u> undertake a large number of professional services, including residential property valuation (often undertaken as part of a Homebuyer's Survey) and will take into consideration structural defects and external environmental factors which may impact on future value or marketability. They will also advise on the development of land crossed by, or in proximity to, electricity distribution equipment and, therefore, their opinions and perceptions are of particular value, as they will influence the way in which this type of land maybe developed.

[xix] See for instance, Mitteness and Mooney[27]

Estate Agents are arguably more familiar with the residential housing market as, by the nature of their profession, they deal with residential transactions and marketing in their local area on a daily basis.

The RICS Year Book and local property papers provided a list of Chartered Surveyors and Estate Agents. Potential interviewees were randomly selected from the list and contacted through telephone calls (cold calling). Those contacted were asked if they had valued property in proximity to HVOTLs and whether they, or a colleague, would be willing to give an interview. Few felt able to participate, citing busy schedules as the main reason for refusal. Willing participants were generally more amenable to giving information over the phone. Face to face interviews were scheduled at the offices of willing participants.

4.4.3.2 Buyers

The results from two earlier studies conducted by the author and co-author Peter Dent (Dent and Sims, 1998[22]; 1999[26]) in addition to previously conducted studies (Priestley and Ignelzi, 1989[28]; Bond, 1995[29]; Gallimore and Jayne, 1999[23]; Mitteness and Mooney, 1998[27]) formed the basis for the 'buyers' questionnaire. This was supported by information generated by exploratory interviews with valuers. It was felt that interviewing buyers at this stage would not provide a positive contribution to the research.

4.4.4 Conducting the Valuers Interviews

To maximise the potential to generate information and, in addition, avoid interviewer bias, interviews were unstructured. Participants seemed generally unwilling to have the interview recorded, which presented some problems, as it was difficult to keep the interview flowing whilst writing down information; therefore few notes were taken during the interview. Notes were written up after interviews, which was not ideal and resulted in the loss or abbreviation of some information. Interviews with agents were frequently interrupted, as they were generally unable to devote a fixed period of time to an interview. To address this issue, follow up visits and phone calls were made to a number of willing interviewees for gain further information and advice, particularly during the development of the questionnaire. This provided a remedy for any failings in the quality of information provided in earlier phone and face-to-face interviews due to inadequate methods of recording information or interruption.

4.4.5 Analysis of the Content of the Interviews

Analysis was conducted using a Grounded Theory approach, where information generated from interviewees was compared, enabling conceptual categories to emerge. The central themes were explored further and the following theories emerged to explain the relationship between the presence of HVOTLs and proximate residential house prices.

The visual presence of the HVOTL (the line and in particular the pylon) was the aspect of electricity distribution equipment that concerned buyers most. It was this aspect that reduced the pool of buyers, increased marketing time and resulted in value diminution. The effect of value loss was two-fold. First, it resulted in a number of sellers suffering a loss in value that could not be remedied and occasionally, residential units were blighted. Second, the length of time a property is on the market was often increased which represented an indirect loss to the owner, although all agents interviewed stated that a unit would eventually sell if the price was 'right'. This meant that some buyers were able to purchase a house, perhaps larger or in a more desirable location, than they could otherwise not afford.

Interviews provided an 'item pool' of factors affecting buyers' purchasing decisions which could be included in the postal survey for further testing.

Several interviewees reported observing changes in the way land crossed by HVOTLs was developed for residential use in the last 5-10 years. Most notably the fact that, whereas older estates did not appear to differentiate between the type of housing built near HVOTLs, and that built further away (which often meant they had no view of the HVOTL), new estates appeared to place low cost and social housing next to pylons. Interviewees also noticed an increased use of power line corridors (ROWs[xx]) and screening. They suggested that this was possibly due to an effort on the part of the builder/developer to reduce any negative impacts on value. These issues were added to the 'item pool' for further testing.

Several agents and one surveyor provided some anecdotal evidence suggesting that lending institutions (in particular the Halifax Building Society) were reluctant to lend on residential units with a line passing directly overhead. This information could not be verified, as none of the Institutions contacted (the Halifax, Nationwide, Bradford and Bingley, Abbey National, Northern Rock) were prepared to place on record their policies regarding lending on residential units in close proximity to HVOTLs. This issue was added to the 'item pool' for further testing.

In addition, in one location only, several estate agents stated that, as the HVOTL (which ran through their local residential estate) was to be removed shortly, house prices in that location had begun to rise. The electricity utility was contacted and stressed that there were no plans to remove the line in the foreseeable future. This line was subsequently dismantled in 2004.

4.4.6 Difference Between the Cohorts

There were some observed differences between the opinions of agents and surveyors which initially came to light following an interview with a surveyor from Greens Ltd. in Sutton Coldfield and subsequent interviews with two agents (who were also members of the NAEA) from branches of Greens Agency department. Estate agents are essentially 'marketing the unit', whereas surveyors establish the 'value of the unit',[xxi] usually for mortgage purposes. Whilst this seemed to imply that a surveyor determines the market value, it appears that, in practice, surveyors are generally reluctant to adjust the asking price once a residential unit is on the market, unless there is evidence of a structural defect. This may be due to the fact that residential units are normally already advertised for a given price by the time their professional expertise is required to make a detailed assessment of the condition of the building, essentially to ensure that the property represents suitable security for lending purposes. The differences in both the approach and purpose of valuations conducted by surveyors and agents suggested that their assessment of the impact of HVOTLs on selling price and marketability might differ. Therefore their respective opinions required further investigation.

4.4.7 Developing the Questionnaire

A number of questionnaire designs were considered, based on the work of previous researchers in this area. For instance; Mitteness and Mooney (1998)[27]; Priestley and Ignelzi, 1989[28]; Kinnard, 1967[25]; Bond, 1995[29] and Gallimore and Jayne, 1999[23]. On the whole, they dealt with buyer surveys rather than professional attitude surveys and provided limited guidance to aid the development of a self-administered questionnaire for buyers and valuers. Therefore, several text book were relied upon to provide direction (For instance; Oppenheim, 1992[18]; Fowler, 1993[9]; Walliman, 2001[14]; Creswell, 1994[6]).

The type of survey design will affect whether or not the data produced are capable of showing causal relationships, correlations or associations between independent and dependent variables. A number of guidelines for choosing the correct survey design are offered by Oppenheim, in particular 'analytical' surveys specifically set up to explore the associations between variables (see Table 4-2) and 'descriptive' surveys such as those used in opinion polls and censuses, which are designed to 'count' and not *"explain anything or to show a causal relationship between one variable and another"* (Oppenheim[18]).

[xx] See Chapter One:1.1.3.

[xxi] A quote from Rupert Southall, a partner with John Shepherd, Chartered Surveyors and Estate Agents.

Table 4-2: Survey Designs for Analytical Studies

	Little is known	Well researched domain
No control over events	Cross-sectional design Natural experiments Retrospective	Factorial designs Multivariate analysis including multiple regression
Power to control events	Planned prospective follow-up with control sample	Before-and-after designs (matched-groups) Effects and intervention studies

Adapted from Oppenheim[18]

Questionnaire design addressed a number of issues especially the issue of circularity, raised by Gallimore and Jayne (1999[23]). The use of psychometric testing could address this problem (Slovic, 1987[30]; Kasperson, *et al.*,1988[31]), although it also resulted in a complex and lengthy questionnaire. Since the number of questions had been found to have an inverse relationship with the response rate (Clarke, 1972[32]), the use of psychometric testing was perhaps more suited to a face-to-face or telephone interview. The use of a self-administered questionnaire would eliminate the problem of interviewee bias and enable data to be collected from a large number of respondents by mail, with fewer financial or time constraints than using interviews. One drawback with this was the issue of poor response rates, particularly amongst the general public. This was highlighted by previous research and statisticians (*ibid*; Oppenheim, 1992[18]). In addition, there was concern that using a postal questionnaire to gather data on buyers' perceptions might highlight issues associated with HVOTLs and increase any negativity towards them. By comparison, surveyors and estate agents in the UK were, or should be, aware of the issues associated with the presence of HVOTLs near residential units due to the concern expressed by the RICS when Practice Statement 3.7 was issued (see Chapter One: 1.0). Whilst their professional advice is likely to reflect personal perceptions to some degree, their response to a well-designed questionnaire should provide a reasonable indication of the likely value effects without creating more negativity towards HVOTLs and increasing the risk of circularity.

The practical answer to the problem was the construction of two questionnaires, one for valuers in which research questions could be addressed directly and the other designed for buyers, where questions could be asked in a less obvious manner.

The development of the questionnaires, sample selection, conduct of the survey and analyses for both groups are dealt with separately below in the following sections headed Professionals' Survey and Buyers Survey.

4.5 PROFESSIONAL SURVEY

4.5.1 Questionnaire Design

The 'Valuation' questionnaire was designed to produce data which were inferential, rather than causal, and included elements from descriptive and analytical survey designs (Oppenheim, 1992[18]) to allow certain variables (responses to questions) to be cross tabulated. For instance; 'whether the participant had any experience of valuing property near HVOTLs' and 'their assessment of the degree of value diminution caused by the presence of an HVOTL'. This would enable relationships between variables to be identified.

Having considered a number of different options, the most appropriate questionnaire for the valuers' survey was found be a simple one page questionnaire (Appendix III). This was constructed using a five point Likert scale and a ten-point sliding scale where appropriate[xxii] (See 4.3.2: Levels of Measurement) This enabled responses to be statistically analysed using frequency, multiple regression and correlation analyses to allow the results to be compared with a source of transaction data at a later stage in the research. Profile questions were included to establish the respondent's level of professional experience in relation to their responses towards specific questions. The dependent variable 'Value' was included to allow the relationship with the independent variables (the 'item pool' established though the literature review and exploratory interviews) to be explored and correlation, association and causality established.

An 'online' version of the questionnaire was designed, using click boxes for responses but was later abandoned when respondents' email addresses were not readily available.

The questionnaire was to be self-administered, which presented a number of issues over which the researcher had no control. These were:

1. There was no control over who answered the questionnaire.
2. The questions may be inappropriately answered due to 'lack of interest.'
3. A poor response rate was associated with using this method to survey the population.

It was, however, considered to be the most appropriate method of undertaking this type of research, when there are time and financial constraints which prohibit large-scale face-to-face administration of the questionnaire (Oppenheim, 1992[18]; Bryman, 2001[7]).

4.5.2 Piloting

Oppenheim[18] states that *"in principle, almost anything about a social survey can and should be piloted"*. This involves testing the survey on a small number of participants from the sample population, entering the data onto the chosen statistical package and conducting the analysis to iron out any problems prior to the fieldwork.

[xxii] A more detailed explanation of Likert and other attitude scales can be found in section 4.2.5: 'Levels of Measurement' above, in addition to Oppenheim, (1992)[18]; Bryman, (2001)[7]; Robson, (1993)[8], and other social survey methodology texts.

Whilst RICS members had been found to be more willing to participate in surveys, estate agents had been found relatively less willing to spend time on academic research (Dent and Sims[22; 26]). Their approval of the questionnaire prior to commencement of the survey was therefore very important. The decision was made to pilot the questionnaire on members of the NAEA. Ten questionnaires were sent out asking for comments on the layout, content and relevance of the questions, the ease with which they could be answered and the time taken to complete. Six members responded, with only minor criticism and an additional variable for inclusion. The data were entered onto SPSS version 10, a popular statistical package used by the Social Science Department at Oxford Brookes University, and a comparative analysis of the means undertaken. The numbering of the Likert scales was altered slightly to make the data input more logical, however, no further problems were encountered. The revised questionnaire was circulated amongst staff in the Department of Architecture at Oxford Brookes University. No further changes were required. A covering letter was written for inclusion with a reply paid envelope.

4.5.3 Sample Selection

When the researcher cannot study all people in all locations or in all time periods relating to the problem or research question, a representative sample is used to "*transform the research question into a feasible empirical study*" (Henry, 1990[33]). This survey used a stratified random sample from two subsets of the population.

4.5.3.1 Group 1: RICS Members

The RICS was contacted and asked to help the research by generating a random selection of 500 property surveyors who practised in the United Kingdom. Despite verbal assurances of help, emails remained unanswered and no list was received. A sample was randomly selected from the hardback version of the United Kingdom RICS Members List.

This was undertaken by selecting a name from alternate pages (the list contained 1090 pages), starting at a page selected by throwing two dice (The starting page was 7 [5 and 2]). Each page had three columns and a name was chosen by selecting the next one from each column alternately (i.e. page 7= 3rd column, 15th name; page 9= 1st column, 16th name; page 11=2nd column 17th name and so on). If the subject chosen practised outside the UK, the next available subject was selected.

4.5.3.2 Group 2: Estate Agents

An NAEA members list was available but at a prohibitive cost. A list of members was also available, free of charge, on the NAEA website and catalogued by region and electoral ward throughout the UK.

To achieve a random sample though-out the UK, members were selected from cities and towns, according to population size, using information from the Government's statistics web site and a contact (who wished to remain nameless) at the Halifax Building Society. He had stated that in his experience, the value of residential units near HVOTLs, were significantly reduced only when there was a choice of similar units in the same location. He suggested that units in more rural locations tended to be 'unique' (in other words, there were few substitute units available) and would therefore not suffer from value diminution in the same way as urban locations. In addition, most new residential development near HVOTLs has taken place within cities and on the edge of existing housing estates in urban areas. Therefore rural areas were avoided and two categories of location were introduced; category a) cities or towns with a population greater than 100,000 and category b) larger areas with a population in excess of 200,000.

From towns and cities in category a), three names would be randomly selected from the NAEA web site, whilst those in category b) four names would be selected. Where an NAEA member was not available, estate agents holding no professional qualification or affiliation to a recognised professional body were selected from the appropriate (area) Yellow Pages. A total of 34 agents who did not appear to have any affiliation with a recognised property organisation were selected.

4.5.4 Sample Size

In principle, a representative sample of any population should be drawn so that every member of that population has an equal probability of being included in the sample. This is not always possible in practice due to time and financial constraints. However, sample size is not necessarily the most important consideration. Oppenheim[18] states that, *"a sample's accuracy is more important than its size"* to achieve an acceptable response rate for a statistical analysis that could be considered statistically significant. One way of assessing the sample size was to ensure that it was theoretically possible to fill each cell in an analytical table with five cases (Brooker, 1997[34]). As the questionnaire was designed using a five point Likert scale, every variable would require up to 25 respondents. There were 28 variables requiring over 700 responses. In previous surveys undertaken by the author (Dent and Sims)[22, 26] a response rate of between 24% and 30% was achieved from postal surveys of professional attitudes. This would mean that nearly 6000 questionnaires would have to be sent out, with a repeat mail shot dealing with non-response, to achieve a desired response rate of 700 from each group. This was impossible to achieve within the financial and time constraints imposed by the research. After consultation with other researchers, statisticians and supervisors at Oxford Brookes University, 100 responses from each group were established as acceptable. Due to the anticipated response rate of between 25 and 30%, it was decided that a sample size of 500 from both groups should produce the desired response rate for a meaningful analysis which could be considered representative of the opinions and perceptions of the 'average' residential valuer in the UK.

4.5.5 Conducting the Professional Survey

Each individual selected from both groups, received the same questionnaire and letter. The only difference occurred when the name of the individual was unknown, then the letter was addressed to, 'The Valuer' (Appendix III). Each reply envelope was given a code, hidden within the address on the envelope, to enable those who had not responded to be identified and contacted rather than repeating the entire exercise.

4.5.6 Dealing with Non-Responses

The first postal survey produced 189 responses from RICS and 97 from agents. A second letter and questionnaire was sent out to all non-respondents asking for their co-operation (Appendix III). This resulted in a further 68 responses from RICS members and 105 from agents (in total 257 RICS members and 202 agents). In addition, several questionnaires were returned, due to the recipient having changed jobs or moved premises. The issue of non-response was addressed in a number of follow-up phone calls to determine the likely reason for failing to return the questionnaire. This was to ensure that there were no fundamental differences in the group that returned the questionnaire and those who did not, which might result in a spurious result (Bryman 2001[7]). The main reason why RICS members did not respond appeared to be directly linked to whether or not they undertook residential valuations. In contrast, agents were found to be fairly reluctant to spend time undertaking a survey.

4.5.7 Data Entry

All the data were entered onto an SPSS spreadsheet for a 'within participant' and 'between participant' analysis of the results. Data were analysed using frequency, correlation, tests of association (ANOVA) and causal modelling where appropriate. The analysis is dealt with in Chapter Six.

4.6 BUYERS' SURVEY

The literature search had revealed a general problem with conducting a perceptual study involving the general public. In the past, surveys conducted by property researchers (Bond and Hopkins, 2000[35]; and Chapter Three: 3.4), had shown that respondents generally indicated a greater degree of negativity towards electricity distribution equipment (HVOTLs in particular) than was reflected in the price they were willing to pay for proximate property. As such, an analysis of public perceptions would not advance existing knowledge of this issue in the United Kingdom unless structured in such a way as to link attitudes to economic considerations. This issue was a key factor in the development of the buyers' questionnaire.

4.6.1 Questionnaire Design

The design of the buyers' questionnaire (Appendix IV) was a more complex undertaking than the professional questionnaire, due to the risk of raising awareness of the publicised adverse health effects associated with living near HVOTLs and subsequently creating negative impacts on the property market which did not previously exist. The initial problem this presented was, 'how to ask questions that would answer the research questions without causing an effect?' Earlier surveys by the author (Dent and Sims)[22, 26] had approached this issue by using a 'mixed bag' of environmental features frequently found in, or near residential areas. This avoided focusing specifically on HVOTLs, although whilst providing some good information on the attitudes of the public towards these features, the questionnaire design did not allow the research area to be explored in any detail. Another alternative was to use psychometric testing, which had been established as an effective method of dealing with this issue (Slovic, 1992[36]; Syms, 1996[21]; Gallimore and Jayne, 1999[23]). It was, however, not suitable for a short questionnaire to be administered via a postal survey with a desired minimum response rate of 100.[xxiii] A compromise therefore had to be reached.
Several formats were tried and discounted including the use of separate questionnaires for case and control groups.[xxiv] The approach taken was developed with the help of staff in the Department of Psychology at Oxford Brookes University.[xxv] This was to use five variables; HVOTLs, pylons; substations; mobile phone base stations and telephone lines, to avoid focusing exclusively on HVOTLs and pylons. With the exception of telephone lines, all were associated with electric and magnetic fields (EMFs) and therefore linked to publicised health risks. They had also received some media attention over the past year (see Chapter Three generally). Telephone lines, whilst having a similar physical appearance to electricity lines, had never been linked with a health risk or received any adverse media attention and were therefore ideal as a benchmark.

Questions were designed to a) profile respondents into age groups, number and age of children at home, length of time living at that address etc., to identify factors (heuristics) that may influence respondents' attitudes. b) Explore attitudes using a five point Likert scale as a tool to measure the level of influence that each variable had on the participant. A second or 'follow-up' questionnaire

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[xxiii] This number of respondents was considered acceptable for a statistical analysis which would produce a result that could be considered representative of the random sample of the population selected (See 4.5.4. Sample Size).

[xxiv] Residents near HVOTLs = case, and not near = control.

[xxv] Dr R. Lindsay, Principal Lecturer in the Department of Psychology and Wakefield Carter, Psychology Computer Officer, Dept of Psychology).

was designed to examine opinions expressed earlier (in the first survey) in economic terms. This presented subjects with a hypothetical situation and asked them to express any negativity towards the presence of an HVOTL in terms of a willingness to pay to have it removed. Both questionnaires were to be sent to occupiers of single-family dwellings respectively near and not near HVOTLs.

4.6.2 Piloting

The first questionnaire was tested on a pilot sample at the Department of Real Estate and Construction at Oxford Brookes University. Participants were asked for comments on the layout, content and relevance of the questions and time taken to complete the questionnaire. No major criticisms were received, although the wording was felt to be slightly ambiguous on questions 2 and 5 and these were changed accordingly. However, this did not test the likely response rate from a postal survey. Dent and Sims[22, 26] used members of local Residents' Associations in Birmingham to avoid the low response rates generally associated with postal surveys (Oppenheim[18]); however, it was debateable whether this qualified as a representative sample of the population. The obvious answer was to field test the questionnaire by conducting a small postal survey. A residential estate was selected in the West Midlands where single-family homes could be found sited respectively near and not near a power line and pylon. The questionnaire was posted to 25 houses with a pronounced view of the line and pylons, and 25 houses with no view. A reply-paid envelope and covering letter (Appendix IV) approved by supervisors were included, explaining the research in terms of a general opinion study exploring attitudes towards environmental features recently highlighted by the media. Six replies were received from the occupiers of homes classified 'not near' and nine from the occupiers of homes 'near' the HVOTL. Whilst there were too few respondents to draw any robust conclusions about the possible outcome from undertaking a survey of this type, the pilot study indicated that, a) respondents were more likely to live near HVOTLs and b) the response rate was likely to be around 25%. Increasing the response rate could be achieved by using the same sampling method as Dent and Sims,[22, 26] however, this also increased the risk of obtaining a biased result. The decision was made to use the existing method of distribution, followed by a number of semi-structured interviews with residents in the same area, if deemed necessary.

The expected low response rate raised another area of concern with the planned follow up questionnaire, namely that respondents might be even less inclined to complete a second questionnaire. The data to be collected by the second questionnaire were an important element of the thesis as it was designed to establish buyers' attitudes in economic terms. The decision was therefore made to combine all questions into one questionnaire. This added one extra question to the first questionnaire, whilst still restricting the length to two sides of A4 paper. This was approved by the supervisors and tested on the staff at the offices of AGI Media Ltd., in

Birmingham. All questionnaires were completed and returned with minor alterations to the layout, questions and attitude scale numbering, to help entry of the data onto SPSS for analysis. The final questionnaire was coded according to its distribution location, a covering letter approved and printed and a reply paid envelope included (see Appendix IV).

4.6.3 Sample Selection

The 'Valuation' study locations discussed below provided the optimum sites for the distribution of the buyers' perceptual survey. Four residential housing estates containing mid-priced, mixed housing type, single family homes were selected; two in Scotland, one in Worcestershire and one in the West Midlands, using the criteria described below in section 4.8 'Valuation Research'. Three locations were case locations with residential units respectively near, and not near HVOTLs, and one control, where there was no visible or proximate HVOTL.

First, roads were zoned according to physical and visual proximity to the pylon.[xxvi] Then names and addresses of residents were obtained from the electoral register in the local libraries and the Register of Sasine in Scotland. The electoral register was found to be inaccurate, as units built within the last five years were frequently completely omitted. Therefore letters were addressed to the occupier to avoid returns due to wrongly addressed envelopes. Subjects were selected by a process of stratified random sampling from each zoned area, resulting in the selection of equal numbers of subjects from within 100m of the HVOTL; within 200m of the HVOTL and at least 200m away from the HVOTL. (This had been identified by past research as the distance at which any value diminution was negligible. See Chapter Two)

4.6.4 Sample Size

The sample size was selected following the pilot and after consultation with supervisors, researchers and statisticians at Oxford Brookes University. A response of 100 was determined to be the minimum number acceptable for the type of statistical tests planned in the analysis of the data.

4.6.5 Conducting the Research

The type of mid-value, mixed house type residential estates found in Scotland were typically smaller than those in Worcester and West Midlands; therefore, 100 questionnaires were sent to both locations in Scotland. 300 were sent to sites in Worcester and the West Midlands. In total, 800 questionnaires were sent out with an estimated response rate of 20%.

[xxvi] It was assumed that as pylons support power lines, anyone having a view of a pylon would also have a view of the line.

4.6.6 Response

From the Scottish case and control locations, 23 replies were received from the case (Blackwood) and just three from the control (Westerwood). 47 replies were received from Walmley in the West Midlands and 39 from St Peters in Worcester. Where possible, questionnaires were cross-referenced to determine the address of the respondent, so that their names could be excluded from the second mailing.

4.6.7 Dealing with Non-Response

To deal with the issue of non-response, a new letter was drafted asking for help and sent along with a copy of the questionnaire to 150 randomly-selected addresses in both case study locations in Worcester and the West Midlands. All non-respondents in the Scottish case and control locations were sent the new letter and a copy of the questionnaire. This resulted in a further 14 responses from St Peter, 11 from Walmley, seven from Blackwood and 2 from Westerwood. No further steps were taken to gather data through this medium and a number of semi-structured interviews were planned and conducted. These are dealt with in section 4.6.9 below.

4.6.8 Data Entry

All data from the questionnaires were entered onto an SPSS spreadsheet for a within-participant and between-participant analysis of the results. Analysis was undertaken using frequency, correlation, tests of association (ANOVA), and causal modelling where appropriate and is dealt with in Chapter Six.

4.6.9 Follow-up Interviews

A number of interviews were conducted as a further means of exploring buyers' attitudes towards the presence of the HVOTL which enabled the results from different gathering mediums to be triangulated. The objective was to conduct unstructured interviews under the heading of 'what residents liked and disliked about their neighbourhood'. If the required information was not volunteered, a semi-structured approach was adopted. Subjects were selected through cold calling rather than by prior appointment. They were informed that Oxford Brookes University[xxvii] was conducting research to determine what occupiers liked and disliked about the features associated with their neighbourhood and asked if they would be willing to take part in an informal interview.

[xxvii] Initially, the body undertaking the research was introduced as the Department of Real Estate Management at Oxford Brookes University. This appeared to confuse people as Real Estate Management was not

4.6.10 Undertaking the Interviews

The method of obtaining face-to-face interviews was referred to as 'cold calling'. This involves knocking doors of occupiers in the selected location until a willing and suitable (the home owner or adult occupier) interviewee is found. Most occupiers were reluctant to submit to an official interview; however, some were willing to volunteer all the necessary information on the doorstep in a less official manner. Subjects were encouraged to talk about why they moved to the estate and what they liked / disliked about living there. The features of the estate including the HVOTL were only mentioned if the respondent did not volunteer the information. The details and content of the interviews are discussed in detail in Chapter Six (see also Appendix XIII).

4.7 INTERVIEWS WITH PROPERTY MARKET PARTICIPANTS

A number of property market participants were interviewed to inform the results of the research.

4.7.1 Residential Developers

To gain a more rounded view of the issues relating to the development of land crossed by HVOTLs, a number of residential developers were contacted and asked to participate in an informal interview. This was to establish developers' policies towards building homes on this type of land. The House Builders Federation provided a list of more than one hundred house builders, many of whom were small local builders, who constructed or refurbished a small number of homes each year. Therefore only large, well-known residential developers were targeted[xxviii]. Interviews took the form of semi-structured telephone interviews and were based around the following questions.

1. Do you buy and develop land where HVOTLs are sited?
2. Do you move the line or build around it?
3. Do you impose any restrictions on; a) how close you build, and b) the type of housing you build?
4. Do you use power line corridors or screening?
5. How do you use the area under the line in your scheme? For instance: play areas, green space or parking.
6. Do you ever have any problems selling property next to HVOTLs?

Selected developers were contacted, by phone, and asked to participate in a brief telephone interview. Willing participants were each asked the same six questions (above). The content of the interviews are discussed in Chapter Six (See also Appendix XIII).

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understood and required explanation. By contrast, 'Planning' and 'Architecture' were terms that the public instantly recognised and could relate to.

4.7.2 Local Government Planning Departments

Planning departments in the case study locations were contacted for information on their Development Plans or other supplementary planning guidance policies towards granting planning permission for residential development near HVOTLs. This was to determine whether there were any planning policy differences which may restrict or affect the way in which land crossed by HVOTLs was developed in the case study locations. Without exception, they stated that they had little reason to refuse planning permission and that they followed the guidelines laid down by central government in PPG3, which placed no development restrictions on this type of land. Other comments made included some anecdotal evidence to suggest that developers often reduced the selling price of new homes near HVOTLs to promote a sale,[xxix] and that builders consulted with the relevant electricity utility to discuss safe clearance distances from lines and the provision of access to equipment for future maintenance[xxx].

4.7.3 Electricity Utility

An open-ended question based interview was conducted with Liz Mayel and Catherine Lowe; Head of Planning and Development, National Grid Company (NGC)[xxxi] on the 4th April 2003. Copies of the Buyers' and Valuers' questionnaire in addition to the most recent conference paper had been sent, in advance, with an invitation from the author to comment on their contents. It was hoped that a more relaxed and open atmosphere may have been generated by taking notes rather than recording the interview. It is difficult to know whether this actually made any difference. The interview lasted approximately one hour, was unstructured, and gave an interesting insight, from the utility's perspective, into the problems caused by the absence of development controls on land where electricity distribution equipment is sited. The content of this interview is discussed in Chapter Six (see also Appendix XIII).

The electricity utilities have provided a number of documents referring to the planning and development of land near HVOTLs and other distribution equipment. They have their own EMF Department who respond to the concerns of residents and will go out to measure levels in buildings in response to requests. They are guided by the NRPB, who advise the electricity utility and the government on safe EMF exposure limits. Their advice permits development directly beneath overhead lines. The problems that such development can create for the Utilities were highlighted

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[xxviii] Four large residential development companies consented to an informal interview.

[xxix] A planning officer from the North Lanarkshire Planning Department, Worcestershire Planning Department and Birmingham Planning Department.

[xxx] Birmingham Planning Department, Worcestershire Planning Department.

[xxxi] NGC is now referred to as National Grid Transco.

during an interview with Ian Lee, Finance Manager for Power Projects, PowerGen, West Midland.[xxxii] His views are discussed in Chapter Six (see also Appendix XIII).

4.8 VALUATION RESEARCH

The main aim of the valuation research was to achieve research objective three and test hypotheses III and IV by establishing the likely impact of HVOTLs on the market value of residential property. This would enable a comparative analysis to be undertaken between the results of the 'Perceptual' research and the 'Valuation' research and to establish the degree to which attitudes can be relied upon to provide an accurate determination of the value of residential units in close proximity to HVOTLs, thus achieving objective 4 of the research.

4.8.1 Barriers to the Valuation Research

The most efficient method of determining the effects of environmental features on house price is through the analysis of sales transaction data. This relies on the *'availability of an adequate volume of good quality transaction and appraisal data ... '* (Syms, 1996[21]). Transaction data is available for research purposes in America, Australia, Canada and New Zealand but not in the United Kingdom. This presented a barrier to the investigation which needed to be overcome if the research was to have a solid econometric or statistical foundation.

Without a suitable source of transaction data, the research conclusions would be based on the value judgements of the property market participants, which would place limitations on the usefulness of the results to the property industry.

4.8.1.1 Available Transaction Data within the UK

Access to selling price data is very limited within England, due to the confidentiality surrounding property transactions. There are three sources available to the researcher. The first is the Land Registry, where all land and property transactions are recorded. Although information is not yet freely available, details relating to single properties can be requested and obtained (at the time of conducting the research) at an approximate cost of £10.00 per property[xxxiii]. The cost of obtaining sufficient data to undertake the analysis required for this thesis was prohibitive.

The second data source is The National House Price Index. This is generated by the Halifax and Nationwide Building Societies and is based on mortgage completions. This information is analysed

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[xxxii] Ian Lee is responsible for financing the maintenance, replacing and siting of Power Gen's equipment and provided some factual and anecdotal information during the interview Appendix XIII: Interview No., 31.

[xxxiii] Transaction date is now available at £2-00 per property from the online Land Registry services.

using a 'hedonic' approach and generates a mean value for different house types in a specific location throughout the UK for the National House Price Index and is publicly available.

The third source of transaction data can be obtained from the Council Tax, which is a combination of the old rating system and the *"discredited community charge"* (Syms, 1996[21]). The rateable value of property is determined through its market value at a given date. This value corresponded with a rating band and determined how much the owner should contribute to the government. However, rating bands are too wide to allow small changes in value to be apparent, particularly when dealing with residential units in the middle and upper price brackets. [xxxiv]

Additional sources of information can be found on the internet[xxxv], where average house prices are approximated, based on post code and housing type. This information is ideal as a guide to the average house price in different locations but is unsuitable for use in the current research, as it is too general.

The data required for the valuation case study include detailed information on:

1. property characteristics, (e.g. type of house, number of bedrooms)
2. transaction price (the price property was exchanged for)
3. the surrounding environmental features (immediate views e.g. lake, woodland, houses, etc) and
4. HVOTL specific data (physical proximity to line and pylon, visual encumbrance, etc)

Collecting data at this level (the micro-spatial level) for each case included in the analysis would enable differences in the value of each house type to be identified, relative to the physical proximity and the visual encumbrance of the HVOTL, thus establishing a causal relationship to be established through the use of multiple regression analysis.

All three sources of transaction data were inadequate for the intended research, therefore another source of data had to be identified.

4.8.1.2 Solving the Problem of Inadequate Data

A number of approaches were considered whilst seeking a resolution to the problems caused by a lack of available transaction data. One such approach was the use of visual simulation techniques

[xxxiv] For instance; property worth £350,000 and £1,000,000 in 1991 would have had the same rating band and paid the same rates. (Syms, 1996).

[xxxv] For instance www.upmystreet.com and www.naea.co.uk

tested by Dent and Sims in their earlier work. This had proved to be an excellent method of obtaining data on the likely value effects from different types of distribution equipment (Dent and Sims, 1999[26]) and pylon design (Bishop *et al.,* 1985[37]). However, the data produced were not in sufficient detail to be of use to the current research and were still based only on the opinions of the participants (residential property valuers).

Two separate approaches were decided upon. The first was based on the experimental research pioneered by Black and Diaz (1994[38]) and used the concept of their negotiation experiments as a starting point to develop a method of gathering data which would simulate real behaviour within the market. A similar negotiation experiment between members of staff at Oxford Brookes University[xxxvi] and willing surveyors and agents was considered. However, there was concern that, as participants would be responding to a hypothetical situation, they might not behave in the same manner in 'real life' and as such the results may be considered less than accurate.

4.8.1.3 First Approach

The approach taken was a live experiment, in that it took place in a case study location, without manipulating or controlling the research environment.

Detail of houses 'on the market' were collected from estate agents and monitored for any price change, for a period of two years at three separate locations within the UK. Previous research had established that any negative impacts on selling prices from proximate HVOTLs diminished to nothing at a distance of 200m from the HVOTL. Therefore conducting a comparative analysis of residential units, on the market, within a housing estate where an HVOTL was present, would show;

a) agents' and valuers' perception of likely value impacts, although according to information from estate agents, it is normal practice for agents to put property on the market above the expected transaction price to 'test the market' (Greens Estate Agents Ltd, Walmley; Bairstow Eves Estate Agents Ltd, Sutton Coldfield and Paul Carr Estate Agents Ltd, Sutton Coldfield).

b) whether pressure from the market would force the price down to generate sufficient interest in the property to promote a transaction.

It was acknowledged that, whilst providing another medium to explore agents, perceptions of the impact on value, this approach would only give an indication of the likely impact on the selling price of different house types.

xxxvi Excluding staff from the Department of Real Estate Management.

4.8.1.4 Second Approach

The second approach was to identify an alternative source of transaction data which could be considered representative of the UK market. Data could then be collected and analysed using the relevant statistical tests and compared with the results of the first method of valuation data collection using the 'on the market' details from estate agents.

4.8.1.5 Establishing a Suitable Source of Transaction Data

Transaction data were available from several case study locations within the USA, Canada, Australia and New Zealand. However, there were concerns that data from these sources might not be considered sufficiently comparable to the UK market. Further enquiry established that transaction data were available in Scotland, due to differences between Scottish and English law governing the registration of property. All property transactions completed in Scotland were recorded in the Register of Sasine and were available, by request, from Paisley University in Glasgow. Some differences were expected between housing markets in Scotland and England; however, these were likely to be less apparent than if data were obtained from the USA, Canada, Australia or New Zealand. Finding a suitable location within Scotland was therefore the preferred option.

4.8.2 The Addition of a New Research Objective

This data source had a significant impact on the objectives of the research, due to the fact that, until this point, it had not been thought possible to establish the <u>actual impact</u> of HVOTLs within the United Kingdom with any degree of certainty (due to the lack of UK specific transaction data). This was now possible, although it could be argued that transaction data from Scotland might not be representative of property throughout the United Kingdom and therefore would be incapable of providing the data necessary to determine the actual impact of HVOTLs with any degree of comparability. This potential criticism could be dealt with by using both approaches (collecting estate agents data and using transaction data from a suitable case study location) with the same method of data gathering and analysis and finally triangulating the results. As a result, any impact on the validity of the research could be minimised.

4.8.3 Valuation Research: Data Collection Methodology

When valuing residential units, it is normal practice for valuers within the United Kingdom to use the comparable method of valuation. This approach relies on obtaining "*information about the characteristics, as well as the price, of each house sold*" (The Halifax House Price Index: Technical Details. Flemming and Nellis, 1997[39]). This information provides the valuer with a starting point or anchor (Diaz, 1999[40]) on which to base an initial valuation. However, consideration should also be given to the impact of *"various physical and psychological factors that may affect the perception of product attributes by the most probable buyers of a particular product"* (De Lisle, 1985).[41]

4.8.3.1 Hedonic Approach

The transaction price of each house will reflect the value placed on the particular set of locational and physical attributes it possesses. As each house sale takes place in terms of a single transaction, the implicit price placed on each attribute (characteristic) is not observed. Residential buildings may be priced differently due to a number of house specific characteristics (e.g., type of house, number of bedrooms) and locational characteristics, for example, proximity to a landfill site, or having the benefit of good schools within walking distance.

Breaking down property its main characteristics allows the influence of each attribute on the total price to be determined through the use of a statistical package capable of performing multiple regression analysis. This is referred to as the *"hedonic approach to price measurement in which goods are not valued for themselves as such but for the set of attributes which they possess"*(Flemming and Nellis[39]).

When conducting property research where transaction data are available, the accepted method of conducting a robust analysis of valuation data is to adopt a hedonic approach (Rossini 2002[43]; Priestley and Ignelzi[28]; Bond and Hopkins 2000[35]; Rosiers[5]). This methodology is particularly useful when determining the impact on value from a contaminant or detrimental condition, as it enables the combination of property specific variables and external or condition specific variables for every unit under consideration to be analysed by establishing a model, determining the parameters and then evaluating the result using multiple regression analysis (Kauko, 2002[42]).

Rossini states that the hedonic approach *"affords the opportunity to quantify external costs"* (Rossini *et al.,* 2002[43]) from any number of environmental features; providing such features can be expressed in numerical form, such as time or distance (Theriault and Rosiers, 2003[44]), noise, measured in decibels (Rossini[43]), or visual encumbrance (Sims, 2003[45]; Bond, 2003[46]). Rosiers suggests that when quantifying a negative externality such as the effect of an HVOTL, a 'micro-spatial' approach should be taken to data collection, so that the variables could take account of the degree of visual encumbrance caused by the presence of the HVOTL and its supporting structures, in addition to other environmental features such as the landscape and surrounding topography as these features had the ability to either *"... enhance or reduce negative externalities"* (Rosiers[5]).

4.8.3.2 Establishing A Causal Relationship

Once the data has been collected, the most appropriate and popular (Lee, 1999[47]) method of determining whether a causal relationship exists between price (Y) and property or locational characteristics (X) is by conducting a correlation and regression (also referred to as econometric) analysis. Regression analysis calculates the effect of movement in an independent variable (X) on the dependent variable (Y) such as the relationship between price and demand. The mathematical formula produced by regression analysis explains 'how much' the movement in the dependent variable is caused by the independent variable. When the relationship is between two variables, a simple linear regression is used. Multiple regression analysis is used when there are more than two variables. This test identifies the relationship between variables; correlation analysis is the statistical test used to determine the strength of the relationship between each independent variable and the dependent variable.

Conducting a regression analysis of property specific, locational and HVOTL-specific variables, using price as the dependent variable had been found to be the most appropriate statistical method to determine whether or not a causal relationship exists between the presence of HVOTLs and the value of proximate residential property (Bond and Hopkins[35]; Kroll and Priestley, 1992[48]; Rosiers[5]; Colwell, 1990[4]).

4.8.4 Methodological Approach Adopted For The Valuation Research

Having considered the methodological approaches adopted in the literature and currently used to determine the National House Price Index, the following methodology was established as the most appropriate for the collection and analysis of data for the valuation research.

The use of a hedonic approach and an inflation index[xxxvii] to calculate the present value, with data obtained at the micro-spatial level and analysed using multiple regression and correlation analyses.

4.9 ESTATE AGENTS 'ON THE MARKET' DATA COLLECTION

Generating 'on the market' house price data necessitated finding a suitable case study location.

4.9.1 Selecting The Case Study Locations

Appropriate locations were chosen by squaring off a large area of the UK, using a 1998 edition of an A-Z road map. The selected area was as far north as Liverpool and south to Swindon, as far west as Shrewsbury and east to Northampton. Ordnance Survey Maps were used to identify the location

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[xxxvii] All data were adjusted using the relevant inflation multiples provided by the Halifax Building Society which can be found on their website: www.hbosplc.com/economic/historical_data.xls

of HVOTLs and then larger scale Landranger maps were used to identify areas where overhead power lines ran over buildings. Not all towns had overhead lines running into built up areas. Of the towns that did, more detailed maps were used to determine whether or not buildings were residential, commercial or industrial. Some areas were obviously industrial and therefore easily discounted, although it was not possible to determine whether buildings were commercial or residential without the use of plot maps which were expensive. As an alternative, the remaining towns in the sample area were visited to determine whether or not they were suitable locations for a valuation study.

4.9.1.1 The Criteria Used To Select Case Study Locations.

Using the same criteria for the selection of all case study locations was important, as this would dictate the degree of homogeneity produced by the research and establish the future use and relevance of the findings to other areas of the United Kingdom.

Criteria for site selection:

I. Property should be mid price range, mixed housing type, situated on a residential estate built within the last 20 years.
II. There should be a choice of house types respectively near and not near pylons and overhead lines.
III. Overhead lines and pylons must not be visible all over the estate and there should be a choice of each house types with either a 'view' or 'no view' of either line or pylon.
IV. The majority of residential units must be for the owner-occupier market (although a degree of social housing was expected).
V. There were no other environmental features within the neighbourhood that would be considered highly likely to have a detrimental impact on house values in that area.

It was not possible to obtain details of each unit as it came onto the market directly from the selling agent, as insufficient agents felt able to send information out for the two-year data gathering period. Therefore, local property papers were used to obtain information. The details included in different property papers varied from a full address, (including, house number and road) to just the postal district. This meant that frequent phone calls to agents or visits to the case study locations would be necessary to obtain the address of each unit advertised for sale.

Ideally, the desired locations would have included housing estates in the Midlands, Northwest and South West England where, in theory, any regional differences would have been identified. However, because of the physical constraints of visiting towns up and down the country, boundaries were placed on the selection areas.

4.9.1.2 Initial Sites Selected.

Seven potential sites were selected using the above criteria. These were; Blackbird Leys, (Oxfordshire); Fairford Leys, (Bucks); Didcot, (Oxfordshire); Monkspath, (Solihull); Walmley, (West Midlands); Haydon, (Swindon); St Peter the Great, (Worcestershire).

4.9.1.3 Excluded Sites

Blackbird Leys was considered but discounted due to several reasons. First, due to Oxford's severe housing problems at the time the estate was developed, the Council sought *"to ensure that a minimum of 50% of the dwellings fall within the category of social housing at prices or rents that can be afforded by those people in housing need"*(Development Guidelines for the Blackbird Leys Development). The houses built on the estate reflected this. Second, there was a very large and highly visible sub-station on one of the major routes into the estate.

Fairford Leys and Haydon were both new estates, construction was still in progress and there were few second-hand properties on the market. It was difficult to obtain the selling price of new homes, as, according to sales persons in show-homes at both locations, transaction prices varied considerably and were determined through individual negotiations with the purchaser.

At Didcot, the HVOTL was visible throughout the estate and therefore no comparison could be made between residential units having a view and those having no view of either line or pylon.

Collecting data from Monkspath was abandoned after it became apparent that agents were informing potential buyers that the HVOTL was due to be dismantled. According to agents in that location, this news reduced any negativity expressed by potential buyers and therefore negated much of the value diminution created by the HVOTL. Continuing to collect data from this location could have resulted in a spurious result. Interestingly, despite assurances from the electricity etility that there were no plans to remove the HVOTL, the line was recently dismantled, apparently as a result of wayleaves being withdrawn by all residents in that location. An employee of the electricity utility who is responsible for the maintenance and replacement of equipment suggested that it could be more costly and certainly more time consuming to apply to the Secretary of State for a necessary wayleave (a process which required dealing with each wayleave [every property] separately) than to re-site the line underground.

4.9.1.4 Selected Case Study Sites

The location in Walmley was, in fact, two housing estates on either side of the main Walmley Road. Both estates are crossed by the same 132kV HVOTL. To distinguish between the estates, they will be referred to hereafter as North Estate and South Estate.

North Estate, was substantially developed between 1980 and 1982 and is a mixture of social and private housing and includes six small apartment blocks and old people's sheltered accommodation built in 1977. The southern area of the estate (nearest the HVOTL) was extending during the late 1990s. The power lines run from east to west through the southern section of the estate, over private housing, with the exception of privately-funded old people's sheltered accommodation. Lines and pylons are not visible from all residential units, although pylons are fairly prominent along the main route into the estate. Only houses and flats situated south of the apartment blocks were included in the case study, as residential units north of this point were predominantly social, rented or lower priced accommodation and were therefore unlikely to produce data relevant to this investigation. This generated approximately 235 mid-price range, mixed-style, residential units for inclusion in the study. This location was used by Gallimore and Jayne in 1999, as part of their study[23].

South Estate, (known as New Hall) was substantially developed between 1998 and 2000 by Bryants, Bovis, and Lovell. There are just over 850 homes, of which nearly 800 are mid price, mixed range, residential units. Lovell developed the land under and adjacent to the HVOTL. Part of the agreement between Lovell and the Planning Department included incorporating social housing into the scheme. Most of the social housing has been placed closest to the HVOTL and pylons, although none directly beneath the line, due to a self imposed 10m building exclusion zone either side of the centre of the line. Whilst houses are not built directly beneath the HVOTL, the line still crosses over gardens. In 1999, local homeowners formed the New Hall Consortium and served notice on the local electricity provider (then Midlands Electricity Board) instructing them, based on the negative impact on amenity, to re-site overhead lines away from houses on the estate. No action has been taken to date and the HVOTL is still in situ.

The HVOTL crosses over the eastern corner of the south side of the estate, then continues along the southern border and ends, with a large terminal tower, in a communal green space on the west side (See Appendix V). The line goes underground at this point and a larger tower is required to support it (NRPB).

The location is proximate to the local town shopping centre (within walking distance), several local schools, has good motorway links and is serviced by public transport. House prices in this location are generally above the national average (www.upmystreet.com and the National House Price Index).

St Peter the Great is situated south of Worcester city centre. The early part of the development was undertaken in the early 1970s before the siting of the HVOTL. The HVOTL was erected prior to the more recent development and was originally planned to be closer to existing residential units.

Due to complaints from local farmers, the line was erected further south (City of Worcester Development Services: St Peter the Great Progress Report April 1998). Since 1983, this area has been substantially developed for residential use and only recently completed, with around 2500 mid price, mixed range, residential units on 81.79 hectares of land. The Land Registry has a record of 60 social residential units located within the Parish of St Peters. However Worcester Planning Department had no record of where these units are sited.

The area currently under investigation is somewhat smaller and located at the southern end of St Peter, separated from the rest of the estate by a main road (See Appendix VI). This part of the estate was developed during the last ten years. There is a Tesco store and a group of local shops within walking distance. The M5 is easily accessible and there is a good bus service into Worcester city centre. A sub-station situated at the southern end of the estate is surrounding by an area of land currently used for allotments and a 'kickabout' grassed play area. A 132kV line runs along the southern boundary of the estate and through the middle of the final phase of the development situated in the southeast corner of the estate (St. Peter The Great Progress Report, April 1998[49]). As the location is slightly hilly, there are a substantial number of homes with no view of either line or pylon.

Both locations, Walmley and St Peters, satisfied the site selection criteria set out above.

4.9.2 Data Collection

Details of houses 'on the market' were initially received from agents on a weekly basis. Subscriptions for local property papers were obtained in both locations to provide an additional source of information. After a period of three months, information from agents diminished and property papers became the most reliable, and therefore preferred, method of obtaining details of residential units 'on the market'.

4.9.2.1 Property Details

Property specific details included house type, tenure, number of bedrooms, bathrooms, toilets, central heating, parking, the presence of a garden, plot size and asking price. Few agents gave the full address which necessitated a phone call followed by a visit to the site to confirm that the address and property details matched[xxxviii]. Prices were monitored over time and any adjustments logged. As a number of previous studies had found that builders compensated owners of HVOTL proximate homes by giving them larger plots, the area of each property (buildings and land) was measured, using plot maps from The Stationery Office.

[xxxviii] On several occasions the wrong address had been given over the telephone, possibly as a result of agents frequently using the 'on the market price', to determine the location of the property within the estate.

4.9.2.2 Locations Details

Details of the surrounding topography were obtained from site visits. This was an important part of the data set as the surrounding landscape had been found to have an effect on the degree of influence HVOTLs had on value. For instance, Rosiers found that the benefits of having a woodland or open view could reduce the impact of HVOTLs on the selling price, due in part to the increased privacy (Rosiers[5]). The Bond and Hopkins[35] study took place in a hilly area which affected the visual impact of the HVOTLs, with some physically close houses having no view of the line or pylon and other houses much further away having a pronounced view (*ibid*). The impact on value in these studies had been found to be related to the visual impact and not physical proximity to the HVOTL.

4.9.2.3 HVOTL Details

HVOTL specific details were obtained from a number of site visits to establish the visual impact of the line and pylons and through the use of plot maps generated by The Stationery Office to measure physical distance to the line and the nearest pylon.

4.10 TRANSACTION DATA COLLECTION

4.10.1 The Location of the Scottish 'Transaction Data' Case Study.

The first part of this study required use of the same criteria to select the estate agents' case study location to find a location within Scotland where two similar estates were situated; one with an HVOTL which would be considered suitable for the case study location and one without an HVOTL (either proximate or visible) to act as the control, to avoid the potential effect of regional house price differences.

Ordnance survey maps were used to identify locations in Scotland where HVOTLs passed over buildings. These areas were, Glasgow (south, east, north-east and central Glasgow), Edinburgh (south and east) and along the east coast of Scotland up to Aberdeen. At this stage, it was not possible to tell whether buildings sited near HVOTLs were commercial or residential and each location was visited to determine its suitability. This resulted in two possible locations fitting the site selection criteria established earlier: one in Aberdeen situated in the north-east of Scotland and the second situated north-east of Glasgow, in Cumbernauld. It was decided that, due to time and distance considerations for future site visits during the data gathering process, the location in Cumbernauld was more suitable for the case study.

4.10.1.1 The Case Study Site

The location in Cumbernauld was a mid-price range, mixed residential development consisting of 664 residential units, built over an area of 4200sq metres in a suburb of Glasgow known as

Blackwood. The location is slightly hilly, with open land to the north and west giving a pronounced view of several pylons; a lake (reservoir) to the south, also with a pronounced view of several pylons, and open fields with a football stadium/ sports training academy to the east. There are no shops on the estate and residents either rely on the local bus service or own a car. This is apparently a normal feature of housing estates in more urban areas of Scotland[xxxix]. A 275kV high voltage overhead power line runs through the centre of the estate, dividing it into two neighbourhoods; referred to in this study as the east and west sides. The HVOTL runs from north to south in a corridor of land that varies between 40m and 70m from the boundary fence of abutting property and continues along the north-eastern border of the estate. Residential units with either views of the lake or open land also have a clear view of the power line and several pylons. The west side of the estate consists of 75 units of social housing and 143 low to mid-range mixed residential units built within the last 12 months. Transaction data for this part of the estate were, therefore, very limited and excluded from this study. The east side consists of 446 mid-range mixed residential units built between 1994 and 1995 resulting in 593 sales transactions. All units are between 33m and 440m away from the HVOTL either having no view of a pylon, or a slight, moderate or pronounced view of one or more pylons running through the estate or across open land on the northern, southern and western boundaries. Each transaction (rather than each residential unit) represented a case. This resulted in 472 cases having some view of a pylon/s from either the front or rear of the house (See Appendix VII).

4.10.1.2 Control Location

A second location was identified to act as the 'control,' to compare the value of similar residential units on an estate free from the presence of an HVOTL. This could provide evidence that 'all' house types in the case study location suffered from some diminution due to the presence of the HVOTL. The 'control' location was situated 5 miles north of Blackwood (the case study location) in a residential area known as Westerwood, (Cumbernauld). Both estates were of approximately the same size, with residential units of a similar age, type and design and the general features of the estates fitted the case study location criteria, with the exclusion of the HVOTL. Plot maps for the selected case study locations were obtained from The Stationery Office.

4.10.2 Data Collection

Obtaining property specific data proved more difficult than anticipated. Whilst the Scottish Property Register (Register of Sasine) held details of each transaction (the date of sale, buyer and seller), it did not collect data on property specific characteristics. As virtually all units in the study

[xxxix] Information gained from telephone conversations with a Planning Officer at the North Lanarkshire Planning Department.

area had been constructed between 1995 and 1996, the developers no longer held records of individual house types and the North Lanarkshire Planning Department held only limited information which had been archived, making access difficult. A sympathetic planner in the Lanarkshire Planning Department was able to find sufficient information to enable transaction data for the case study location to be analysed using a hedonic approach. However, this person was not able to provide the same information for the control location in Westerwood. Without this information, a comparative analysis could not be undertaken between case and control. The control was abandoned and comparative data obtained from the National House Price Index for that location.

Using information gained from the Lanarkshire Planning Department, plot maps and a number of visits to the site, sufficient property details were obtained which, whilst not ideal, provided enough data to enable an analysis to be undertaken[xl].

Data collected for this analysis were grouped as:

Property Details: Property specific details included house type, number of bedrooms, parking, the area of each property (buildings and land measured using plot maps from The Stationery Office) and transaction price.

Locational Details: Details of the surrounding topography were obtained from site visits and variable were created to show whether the unit was sited on a hill (and therefore might have a a more pronounced view of the HVOTL), on flat ground or in a valley. Whether the unit had a view of the lake, open green space, woodland or other houses.

HVOTL Details: HVOTL specific details were obtained from a number of site visits to establish the visual encumbrance of the line and pylons and the physical distance to the line and nearest pylon.

4.10.3 Preliminary Data Analysis

Variables were classed as either measurement variables (which included continuous variables for house-price, plot size, distance to power line and pylon, and discrete variables for the number of bedrooms, bathrooms, toilets and parking spaces) or dummy variables for all other data. Once the data had been coded and entered into a file on SPSS 10[xli], it was essential to look for suspect variables and errors (Chatfield and Collins, 1992[50]). A frequent printout was obtained for each variable in order to check for out of range values; for instance, if a two had been coded as 20, the

[xl] An explanation of the variables used in this analysis is given in Chapter Five.
[xli] SPSS10 is widely used at Oxford Brookes University and was to be the most appropriate statistical tool for the analysis of the 'Valuation' and the 'Perceptual' data.

coding error was discovered and corrected. Once the data had been checked for errors and edited where required, the analyses could be undertaken.

Data analysis, results and conclusions are discussed in the following chapters. (Chapters Five, Six and Seven)

4.11 CONCLUSION OF THE CHAPTER

The aim of this chapter has been threefold:

1. to state the aims, and objectives of this thesis and to explain the development of the research questions and hypotheses.
2. to examine the different research strategies available to the researcher, and
3. to use this information in conjunction with knowledge gained from the literature review, to design the most appropriate research strategy which will generate the data necessary to answer the stated questions and hypotheses (see section 4.1).

4.11.2 Summary of the Research Strategy

The impact of a HVOTL on house price (or asking price) is currently estimated by valuers and agents within the UK and is based on available comparable evidence, local knowledge, current state of the market, personal knowledge, experience, and the purpose of the valuation[xlii]; perceptual research will provide opinions of value impacts, which can then be measured against evidence of the actual impact on house price generated from a suitable source of transaction data, thus testing the accuracy of estimated value impacts.

Following a rigorous examination of the literature and the methodological approaches available, a suitable research strategy was designed (Figure 4.2) which will generate data to fulfil the aims and objectives of the research as stated above and in Chapter One: 1.5.0.

Due to the fundamental differences in the type of data gathered to achieve the aims and objectives of the research, a combination of methods within the two research paradigms was considered to be the most appropriate methodological approach. This research strategy is known as a multimethod approach (Creswell[6]; Brewer and Hunter[17]).

4.11 3 Valuation Data Collection

In order to achieve research Objectives 3, 4, 5, 6 and test Hypotheses 3 and 4, a quantitative approach is adopted to gathering valuation data from three case study locations using a hedonic

[xlii] A valuation undertaken to determine the asking price of a house is not the same as one undertaken by a professional valuer, normally for mortgage purposes. The later will be expected to take into consideration factors, which may have a negative impact on future value or marketability. RICS (Chapter One: 1.0).

methodology[xliii] within a micro-spatial framework. This approach has been found to improve the accuracy of such research, by including other relevant locational variables within the analysis (Rosiers[5]), thus improving the performance of the regression models.

Analysis of the literature identified this approach as the most efficient and therefore, arguably, the most accurate method of determining the impact of a HVOTL on house prices (*ibid*; Rossini 2002[43]; Bond and Hopkins, 2000[35]).

4.11.3.1 Transaction data were found to be available for all residential units sold in Scotland. This information was, however, linked only to an address and not to any property specific details such as; house type or number of bedrooms. These details were obtained through other sources[xliv] and provided information which, whilst fairly basic, was sufficient to conduct a causal analysis.
Initially, two suitable locations were selected in Scotland, one near a HVOTL (case) and the other out of sight of a HVOTL (control). This was to enable a 'within case study' and a 'between case study' analysis. Due, however, to problems obtaining property specific data, the 'control case study' was abandoned and comparable data obtained from the National House Price Index for that region.

4.11.3.2 Asking price data was collected from two locations in England; Walmley and St Peter, where property specific data was readily available from local estate agents[xlv]. To enable between comparative analysis to be undertaken, all locations were selected using the same criteria with data gathered and analysed using an identical methodological approach.
The literature had identified multiple regression analysis as the most appropriate method of establishing causality when analysing data generated using a hedonic approach (Rossini, 2002[43]; Colwell, 1990[4]).
The analysis and conclusions of the valuation study is presented in Chapter Five.

4.11.4 Perceptual Data Collection

Opinions, attitudes and perceptions[xlvi] towards the presence of HVOTLs near residential units and the likely impact on house prices, were gathered from members of the RICS (valuers), members of the NAEA (agents), National Grid Transco, Power Gen, local planners in Birmingham, Worcester

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[xliii] A hedonic approach is currently used to generate the National House Price Index in the UK.

[xliv] North Lanarkshire Planning Department, plot maps and site visits.

[xlv] Transaction data are restricted due to confidentiality laws.

[xlvi] Collectively referred to as 'perceptual data.'

and North Lanarkshire, residential developers and occupiers. This data collection and analysis was undertaken to achieve research Objectives 1, 2, 4 and test Hypotheses 1 and 2.

Analysis of the literature and methodological approaches identified two suitable research designs; grounded theory and case studies. Data were gathered within these two research designs, through the use of structured postal surveys designed using Likert scales to enable a quantitative analysis of the responses; semi structured and unstructured face-to-face and telephone interviews.
A grounded theory strategy was adopted towards undertaking the indicator interviews to enable initial themes to be established and provide focus for the further development of the postal survey. In addition, this strategy generated additional information that could not be generated through the use of postal surveys. The analyses of these data is presented in Chapter Six.

4.11.5 Triangulation of the Results

Using a multimethod approach enables the results to be triangulated (Creswell[6]), thus overcoming the weaknesses and limitations of using only one method, particularly when the availability of data may be limited (Brewer and Hunter[17]). The benefits of using a number of different approaches enables cross validation of results and as such justifies the use of this approach to investigate the impact of HVOTLs on house price (Figure 4-1 and 4-2). Due to the differences in the type of data gathered for this thesis, the analysis and presentation of the results has been divided into two chapters. Chapter Five presents the analysis of valuation; Chapter Six presents the analysis of perceptual data. The results are triangulated in Chapter Seven: Section One and the research is concluded in Section Two.

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Relevant Web Sites

Inflation Index Multiples	www.hbosplc.com/economic/historical_data.xls
Regional House Prices	www.upmystreet.com

Chapter Five

Valuation Data Analysis

5.0 INTRODUCTION TO THE CHAPTER

Based on the previous chapters in this thesis, it would seem logical to present the analyses of perceptual data in this chapter. However, since the principal aims of this research are firstly; to establish the actual impact of a HVOTL on house prices and secondly, undertake a comparative analysis between perceived impacts using asking price data (Chapter Four: 4.9), opinion surveys and interviews (see Chapter Four: 4.4, 4.5, 4.6, 4.7) and real impacts of a HVOTL on house prices (see Chapter Four: 4.10), if was thought more appropriate to present the analysis of transaction date first thus providing the necessary data to enable the benchmark of value diminution to be constructed.

Therefore, this chapter explains the analysis of data obtained from three case study locations in the UK (Blackwood, Cumbernauld, Scotland; St Peter the Great, Worcester, England and Newhall, Walmley, West Midlands, England). The purpose of this analysis is to examine the impact of HVOTLs on the selling price and asking price of different types of residential buildings[i] relative to the physical or visual presence of a HVOTL. The results will provide the foundation for a table of likely value diminution, relative to the distance and visual impact of a proximate HVOTL. This, it is hoped, will provide a starting point for valuers and agents when marketing or undertaking the valuation of this type of residential unit.

It is important to note that there is a difference between the data obtained from the Scottish case study and the two English case studies presented here which, although fundamental to the accuracy of the final results, does not affect the validity of the research. This difference is that data from Blackwood in Scotland are transaction data, in other words; the price paid for each house is the result of negotiations between the buyer and seller and as such presents actual evidence of the likely impact of HVOTLs on the value of residential units and therefore provides a benchmark for the research.

By comparison, data collected from the two sites within England, are the 'asking prices' placed on the unit by valuers and agent who are under instruction from the vendor when a unit is advertised for sale. The data obtained from these two locations can, therefore, only offer a general indication of the likely transaction price of residential homes in proximity to HVOTLs within England.

5.1 BACKGROUND

A critical review of the literature established that the most appropriate methodology for this part of the research was based on the hedonic approach to price measurement. "*This involves selecting a*

[i] Flats, terrace, semi-detached and detached houses.

suitable case study area and time frame... "(Bond and Hopkins 2000[1]), determining the individual property and locational characteristics to be included in the analysis and then *"developing an appropriate explanatory model"* (*ibid*). This approach has been widely used by researchers investigating the impact of detrimental conditions on property values (Rossini, *et al.*,2002[2]; Priestley and Ignelzi, 1989[3]; Rosiers, 1998[4]; Colwell, 1990[5]; Callanan and Hargreaves, 1995[6]; Kauko, 2002[7]) and is currently used within the UK to calculate the Halifax House Price Index (Flemming and Nellis, 1997[8]).

5.1.1 Hedonic Modelling

As stated earlier, in Chapter Four: 4.8.3.1, the hedonic approach enables the impact from any number of environmental features to be quantified, providing such features can be expressed in numerical form such as; time, distance, noise levels, degree of visual encumbrance (Rosiers and Theriault and Kestens, 2003[9]; Rossini[2]; Sims, 2003[10]; Bond, 2003[11]).[ii] Each characteristic then becomes a function of price (P) and can be expressed as:

$$Pi = b_0 + b_1 X_{1i} + b_2 X_{2i} + \ldots\ldots b_j X_{ji} + ei$$

where the price (P) of each house (*i*) is a function of its characteristics X*i* and b_1, b_2.....b_j are the regression coefficients corresponding to the property and locational variables (X*j*).There are always several factors that will affect the total price but cannot be measured, in other words, the margin of error represented in the equation as *ei* (Fleming and Nellis[8]).

The break-down of a property into its constituent parts enables relationships to be identified between the movement of one variable (such as price) and a change in another (such as demand)[iii], and is at the heart of establishing a causal relationship. Lee states that, "*potentially, causal modelling can be applied whenever movement in the variable to be forecast* [is] *thought to be influenced by other variables,*" (Lee, 1998[12]) indicating that causal modelling could be applied to a very broad category, since most variables are influenced by some factor. In practice, house prices can be predicted by some, but not all variables, as some part of the house price will remain unpredictable. Whilst this approach may not be able to identify all causal relationships within a model, it can identify the leading indicators of change (*ibid*).

5.1.2 Data source:

Data were collected from all case study locations using a hedonic methodology and adopting the 'micro-spatial' approach, tested by Rosiers (2002[13]; see Chapter Four: 4.8.3.1), so that in addition

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[ii] An in-depth explanation of the data gathering process for the research is provided in Chapter Four.

[iii] See Table 1 which shows the variables used in the regression analysis for a clearer understanding of what is meant by a properties 'constituent parts.'

to 'property-specific' details, the variables could take a detailed account of the physical and visual impact of the HVOTL and other environmental features. Historical transaction data were collected for the Blackwood case study (see 5.3 below) from the Register of Sasine and included all residential units sold between 1994[iv] and 2002.

Asking price data for St Peter (see 5.4 below) and Walmley (see 5.5 below) case studies were collected from the property section in local newspapers, in addition to sales details obtained from local estate agents. These data were gathered for a period of two years.

5.1.2.1 Variables Used in the Analysis

Using this methodology for data collection meant that each transaction (case) could be broken down into 'property-specific', 'HVOTL-specific' and 'topography-specific' characteristics (variables)[v]. This enabled a between case study comparison to be undertaken to determine whether the results from each location shared similarities. The variables created for each case study location are shown in Table 5-1.

Table 5-1: Variables Included in the Regression Analysis for All Case Studies

	[shaded]	= Variable excluded from the analysis to act as a benchmark
Variable Name	**Variable Type**	**Explanation of Values**
DETACHED	*Dummy**	Detached house
SEMI	*Dummy*	Semi-detached house
TERRACE	*Dummy*	Terraced house
FLAT	*Dummy*	Flat
N.BEDRM	*Measurement*	Number of bedrooms
PARKING	*Dummy*	1=presence of a garage; 0= no garage
PLOTSIZE	*Measurement*	In square metres
VIEW	Dummy	1=lake or fields giving a clear view of several pylons 0=other houses
DATESOLD	*Measurement*	month and year of sale
VALUE	*Measurement*	£ unadjusted selling price
INFMULT	*Measurement*	Based on the Halifax House Price Index inflation tables for Scotland
VALNOW	*Measurement*	£ inflation adjusted selling price using Halifax Price Inflation Table
MPYL	*Measurement*	Distance to line in metres from the centre of the house
MLINE	*Measurement*	Distance to line in metres from the centre of the house
DISTPYL1	*Dummy*	The building is between 0-49m from the pylon
DISTLIN1	*Dummy*	The building is between 0-49m from the line
DISTPYL2	*Dummy*	The building is between 50-99m from the pylon
DISTLIN2	*Dummy*	The building is between 50-99m from the line
DISTPYL3	*Dummy*	The building is between 100-149m from the pylon
DISTLIN3	*Dummy*	The building is between 100-149m from the line
DISTPYL4	*Dummy*	The building is between 150-199m from the pylon
DISTLIN4	*Dummy*	The building is between 150-199m from the line
DISTPYL5	*Dummy*	The building is between 200-249m from the pylon

[iv] This location was largely developed between 1994 and 1995).

[v] HVOTL and topography variables were obtained from Ordnance Survey maps and site visits. See also Chapter Four: 4.10.2

DISTLIN5	*Dummy*	The building is between 200-249m from the line
DISTPYL6	*Dummy*	The building is between 250-299m from the pylon
DISTLIN6	*Dummy*	The building is between 250-299m from the line
DISTPYL7	*Dummy*	The building is between 300-349m from the pylon
DISTLIN7	*Dummy*	The building is between 300-349m from the line
DISTPYL8	*Dummy*	The building is between 350-399m from the pylon
DISTLIN8	*Dummy*	The building is between 350-399m from the line
DISTPYL9	*Dummy*	The building is more than 400m away from the pylon
DISTLIN9	*Dummy*	The building is more than 400m away from the line
VISLINE	*Dummy*	1= line visible from the front of the house. 0= not visible
REARLINE	*Dummy*	1= line visible from the front of the house. 0= not visible
VISPYL0	*Dummy*	Pylon not visible from front
REARPYL0	*Dummy*	Pylon not visible from rear
VISPYL1	*Dummy*	¼ pylon visible from front
REARPYL1	*Dummy*	¼ pylon visible from rear
VISPYL2	*Dummy*	½ pylon visible from front
REARPYL2	*Dummy*	½ pylon visible from rear
VISPYL3	*Dummy*	¾ pylon visible from front
REARPYL3	*Dummy*	¾ pylon visible from rear
VISPYL4	*Dummy*	1 pylon visible front
REARPYL4	*Dummy*	1 pylon visible from rear
VISPYL5	*Dummy*	1 pylon and part of another visible from front
REARPYL5	*Dummy*	1 pylon and part of another visible from rear
VISPYL6	*Dummy*	2 or more pylons visible from front
REARPYL6	*Dummy*	2 or more pylons visible from rear
FORSC	*Dummy*	The building has a screened view of the HVOTL from the front
FORS	*Dummy*	The building has a side view of the HVOTL from the front
FOR SF	*Dummy*	The building has a side facing view of the HVOTL from the front
FORF	*Dummy*	The building has a facing view of the HVOTL from the front
RORSC	*Dummy*	The building has a screened view of the HVOTL from the rear
RORS	*Dummy*	The building has a side view of the HVOTL from the rear
RORSF	*Dummy*	The building has a side facing view of the HVOTL from the rear
RORF	*Dummy*	The building has a facing view of the HVOTL from the rear
LNPLOT	*Measurement*	The natural log of plot size
LNPYLON	*Measurement*	The natural log of Metres to pylon
LNLINE	*Measurement*	The natural log of Metres to line

Dummy variables see footnote for an explanation[vi]

The visual impact of the line and pylon was calculated using a measurement scale specifically created for this research (see Appendix VIII). Measurements for each house were obtained following a number of site visits, where views were recorded from the front and rear of the building, then entered onto a data sheet designed for this task (*ibid*).

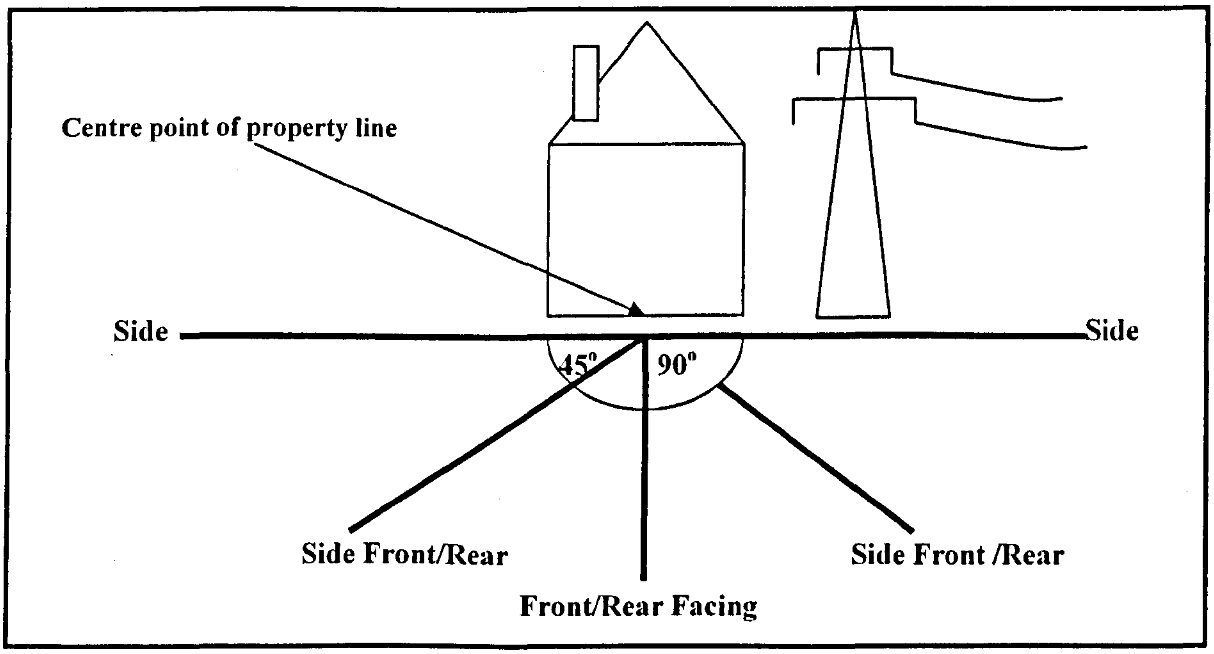
Each unit was assessed by standing on the pavement in front of the building at the centre point of the property boundary, and observing the view directly in front, (facing) then turning 45^0 to either

[vi] Dummy variables are coded either 0 or 1 (e.g., 0 = not visible; 1 = visible) and allow the incorporation of variables whose relationship with the dependent variable (e.g. selling price) may not be linear.

side to give a 'Side Front' view, followed by a 90^0 turn from the front to give a side view (Side) (see Figure 5-1). The rear view was assessed by taking as many observations as possible from the front or side of the building, without trespassing onto private land.

Other variables were constructed to represent the different features of the HVOTL, the views from front of each house, the selling and asking price and the inflation adjusted value (referred to as VALNOW) to enable data to be aggregated[vii].

Figure 5-1: Visual Measurements



5.2 MEASUREMENT AND DATA ANALYSIS

All data were entered into SPSS 10 (see Chapter Four: 4.10.3). Prior to conducting any statistical analysis, data were examined to check for any entering errors. Chatfield and Collins (1992[14]) state that '*having recorded the data it is then essential to look for suspect values and errors of various kind.*" Mistakes were corrected where necessary.

5.2.1 Choice of Statistical Tests

Data were analysed using descriptive statistics (frequency analysis and cross tabulation) or inferential statistics (correlation and causal[viii] analysis)

[vii] All data is adjusted using the relevant inflation multiples from the Halifax House Price Index to adjust all transactions to their relative values as of the first quarter of 2003.

[viii] Regression or econometric.

Measures of Central Tendency and Frequency Analysis were used to examine the type of residential units built, the plot size and the value of properties in relation to a number of different factors, for example, the mean value of a flat relative to distance from a pylon.

Cross tabulation uses frequency analysis to determine whether there is a relationship between two variables and was the tool used to determine whether a relationship existed between the type of house built and the physical distance from a pylon.

Correlation Analysis was performed before the regression analysis, as this examined the relationship between all variables used in the models and enabled variables that were very strongly related to one another to be identified and thus avoided the "*...problems of multicollinearity*" (Flemming and Nellis, 1997[8]) which would occur if they were included in the same regression analysis.

Multiple Regression or Econometric Analysis calculates the effect of movement in an independent variable (X) on the dependent variable (Y), such as the relationship between price and demand. The mathematical formula produced by regression analysis explains how much movement in the dependent variable is caused by the independent variable.
Stepwise is a tool used within multiple regression to exclude all variables not statistically significant according to the criteria entered into the equation[ix]. In addition, a variable is not entered if it would cause the tolerance of another variable already in the model to drop below the tolerance criterion. This enables the key determinants of the value of HVOTL proximate residential units to be identified and, for the purposes of this research, enables the author to determine whether or not a HVOTL can significantly influence value.

Analysis of Variance (ANOVA) is a robust test of departures from normality; in other words, it is a test of variance (also referred to as the F test). It is a method of testing the null hypothesis[x] by comparing the sample variance estimated from the group means to that estimated within the groups (Dancey and Reidy 1999[15]). The hypotheses tested by the current research (see Chapter One 1.5) are stated in a way that makes testing using the null hypotheses format inappropriate. Therefore they are tested to determine whether or not they are true or false statements of fact.

[ix] The SPSS default criterion level for variables in the model is probability of F <= 0.05 to enter and probability of F >= .100 for removal. This criterion was adopted for the analysis except where otherwise stated.

[x] A hypothesis makes a statement to be tested by the research, for instance; in the current research one hypothesis is that, 'The visual presence of a pylon has a greater negative impact on value than the line'. The null hypothesis is that, there is no difference between the impact of the line or pylon. If a difference is observed then the null hypothesis is rejected.

5.2.2 Conducting the Analysis

Each case study location has been analysed separately and a summary of the results provided at the end of the chapter. All data are first analysed using frequency analysis to explore the impact of a HVOTL on:

a) the selling price of different house types relative to distance.
b) the selling price of different house types relative to the visual impact and orientation of the line and pylon.
c) the type of residential unit built relative to distance from the HVOTL, and
d) the size of the plot relative to distance from the HVOTL.

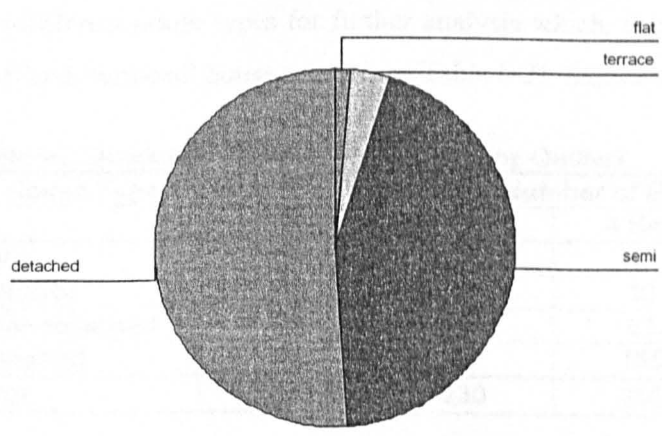
Developing on the basis of the results from this analysis, multiple regression will be undertaken to determine the significant factors influencing the price of residential units in close proximity to HVOTLs.

5.3 THE ANALYSIS OF SCOTTISH TRANSACTION DATA

The data presented and analysed in this section of Chapter Five is transaction data and as such represents the actual impact of a HVOTL on house values in the case study location (see Chapter Four: 4.10.1.1). The data includes all registered sales within the case study location and resulted in 590 sales transactions consisting mainly of detached and semi-detached houses (Figure 5-2 below).

All residential units are sited within a range extending from 33m and 440m from the HVOTL, either having no view of a pylon or a slight, moderate or pronounced view of one, or more pylons running through the estate or across open land on the northern, southern and western boundaries.

Figure 5-2: House Type



House Type	Count	Percent
Flat	8	1.4
Terraced	21	3.6
Semi	260	44.1
Detached	301	51.0
Total	590	100.0

These data are based on transactions (as previously justified[xi]) rather than individual residential units and has resulted in 472 cases having some view of a pylon/s from either the front or rear of

[xi] See Chapter Four: 4.10.1.1.

the building. The analysis was undertaken using a combination of property-specific, HVOTL-specific and location-specific characteristics. The variable VALNOW was constructed, using the relevant inflation multiples taken from the Halifax National House Price Index for Scotland[xii]. This would allow comparison between raw transaction data and aggregated transaction data.

3.3.1 Outliers: Data were checked for outliers (extreme values which provided an early indication that HVOTLs, pylons in particular, had a negative impact on value. Analysis of the outliers (total =13) revealed that 8 detached and 5 semi-detached new houses had been sold for prices between £17,000 and £29,900 from October 1994 to September 1996 which was less than half the price paid for similar units sold during that period[xiii]. During telephone conversations with planning officers from the North Lanarkshire Planning Department in March 2003, to gain the 'property-specific' data required to undertake this analysis, other anecdotal information indicated that, developers of the Blackwood estate had found some units particularly difficult to 'get rid of', due to the HVOTL. Since all units sold during that period were new and built by the same developer, it was unlikely that value diminution was caused by house specific differences. Analysis showed that all outliers, with one exception, were sited within 100m of a pylon or line and had a view of 1 or more pylons. These cases were therefore excluded from the rest of the analysis.

5.3.2 Descriptive Statistical Analysis

Data for each year were explored using frequency analysis. This showed that there were an insufficient number of cases within each house type to produce a statistically reliable result. Therefore, data were aggregated using an inflation multiple to adjust all transactions to their relative values as of the first quarter of 2003 (this would also eliminate changes that might occur over time due to factors such as public perception towards HVOTLs). Data were then subdivided into different house types for further analysis which, due to the small number of cases within the 'flat' and 'terraced' house categories (Table 5-2), focussed on detached and semi-detached houses.

Table 5-2: Breakdown of House Type Excluding Outliers

House Type	Number of Bedrooms					Total
	2 Bed	3 Bed	4 Bed	5 Bed	6 Bed	
Flat	3	5				8
Terraced		11	10			21
Semi-detached	26	163	61	5		255
Detached	3	51	165	49	35	293
Total	32	230	236	44	35	577

xii See 5.1.2.1 above.

xiii The mean price of all units sold during that time was £66,866.62.

5.3.2.1 Selling Price Relative to Physical Distance from a HVOTL

A comparison of the mean value of detached and semi-detached houses (Table 5-3) relative to proximity to the nearest pylon showed that, both house types suffered from a reduction in value compared to similar houses further away. Whilst the relationship between distance from the pylon and the impact on value is not linear[xiv] (Figures 5-3 and 5-4) it does show a reduction of between 10% and 17.7% for a semi detached house and 6% to 13.3% for a detached house sited within 100m of a pylon, in comparison to similar units sited more than 250m away.

In relation to distance from the line, Table 5-4 shows that the selling price of houses within 100m of the line are significantly lower than that of similar houses at least 300m away. Interestingly, houses within 50m of the line suffer from less value reduction than houses sited between 50 and 100m from the HVOTL[xv]. However, whilst there is no clear pattern of value loss, the results indicate that house prices continue to rise after distance of 200m (see Figure 5-5 and 5-6).

Disaggregated Data: The same tests were undertaken with data which were disaggregated into groups of annual transactions and house types, to allow an in-depth analysis of the mean value in relation to distance from the nearest pylon. This analysis showed a much clearer trend, particularly with regard to semi detached houses and indicated some pattern to the diminution suffered by certain house types. There were however, too few cases within each category to provide a robust result. Tables and charts from this analysis have been included in the appendices (Appendix IX).

Table 5-3: Selling Price in Relation to Distance from a Pylon

House Type £	>49m	50-99m	100-149m	150-199m	200-245m	250-299m	300-345m	350-399m
2 bed semi				**64171.75**	**66251.50**	**70563.6**	**66816.67**	**65498**
Count				**4**	**4**	**5**	**6**	**2**
Std. Deviation				7214.23	2543.39	6452.02	2200.59	1302.49
3 bed semi	**72913.43**	**66388.48**	**66007.66**	**67194.70**	**66642.05**	**70216.67**	**79203**	**73685.58**
Count	**7**	**23**	**29**	**33**	**22**	**3**	**12**	**19**
Std. Deviation	7927.14	5362.36	8615.32	13825.13	6557.09	1578.79	13794.18	5762.90
4 bed semi	**86698**	**65447.75**	**77982**	**73481.32**	**76411.29**	**82873.67**	**81958.86**	-
Count	**2**	**4**	**9**	**19**	**14**	**6**	**7**	-
Std. Deviation	3330.4	17520.03	4188.06	6953.66	3689.16	3424.05	2651.38	
3 bed detached			**57237**	**96824**	**90090.25**	**84606.5**	**93018.5**	**94279.18**
Count	-	-	**1**	**4**	**12**	**10**	**6**	**17**
Std. Deviation				13281.13	4539.18	11770.40	4256.64	5758.41
4 bed detached		**81738.91**	**81517.20**	**86863.03**	**95164.18**	**103000.9**	**98700**	**98945.8**
Count	-	**11**	**15**	**30**	**49**	**4**	**16**	**10**
Std. Deviation		24430.37	21066.99	18521.48	14580.63	34816.33	5405.97	3952.41
5 bed detached		**96879.75**	**97111.7**	**88697.12**	**93492.2**	**85423**	**98939**	**101087.7**
Count		**4**	**10**	**8**	**8**	**5**	**4**	**3**
Std. Deviation		3645.36	4955.78	20294.2	6922.57	30377.87	3540.98	153.08
6 bed detached	**96952**	**114792.7**	**103960.7**	**92768.5**	**103601.29**			
Count	**1**	**3**	**9**	**8**	**14**	-	-	-
Std. Deviation		4949.05	15192.64	8005.85	7672.36			

[xiv] The term linear refers to the pattern in the relationship between two variables. A positive linear relationship between the distance from a HVOTL and house value would indicate that as distance increased, value increased (see Dancey and Reidy 1999).

[xv] There were no 3 bed semi-detached properties sited within 150m of the line.

Figure 5-3: Impact of a Pylon on the Value of Semi-Detached House

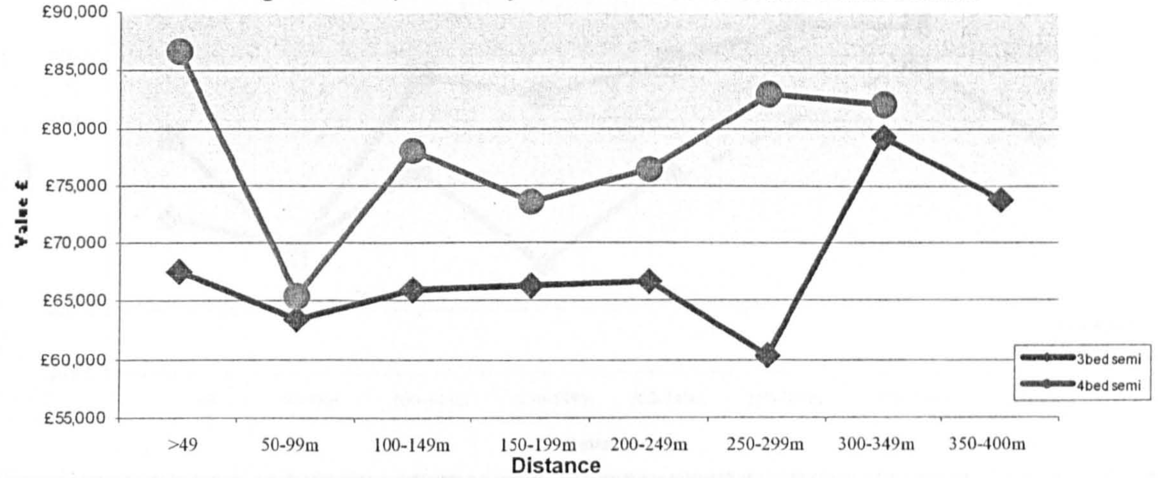


Figure 5-4: Impact of a Pylon on the Value of Detached House

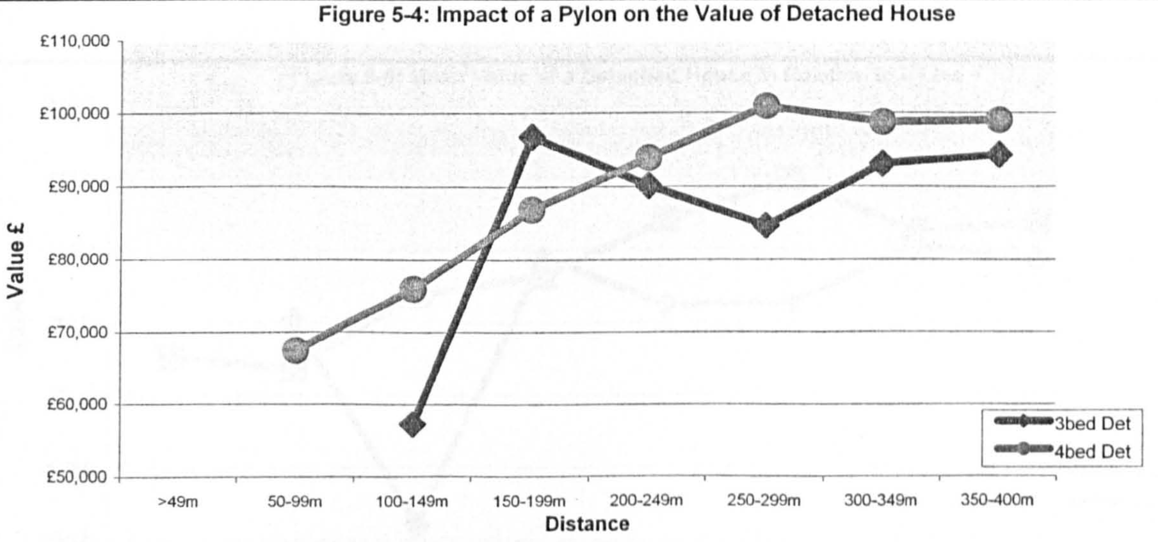
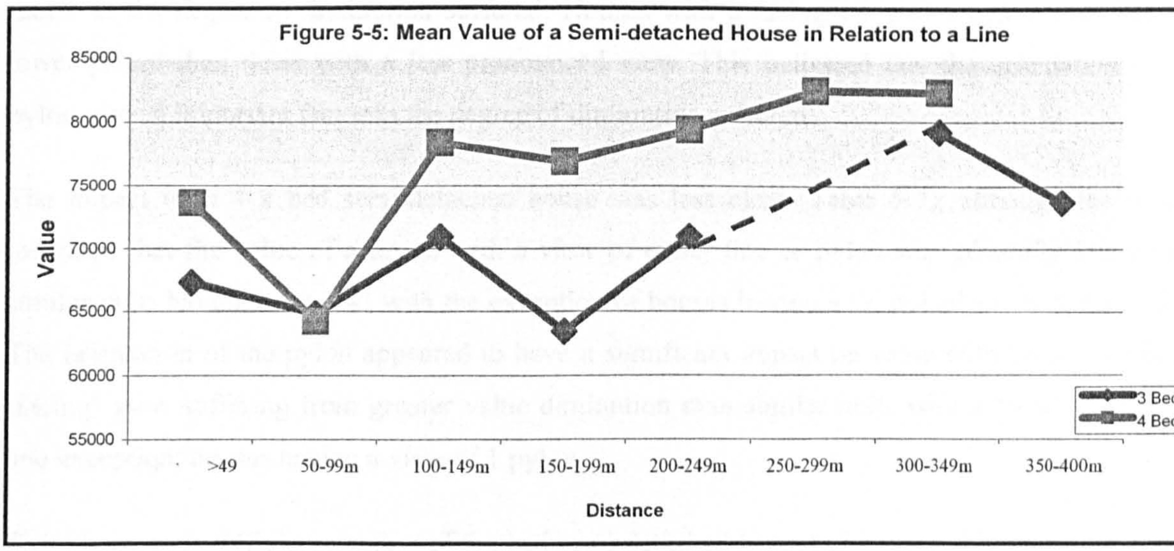
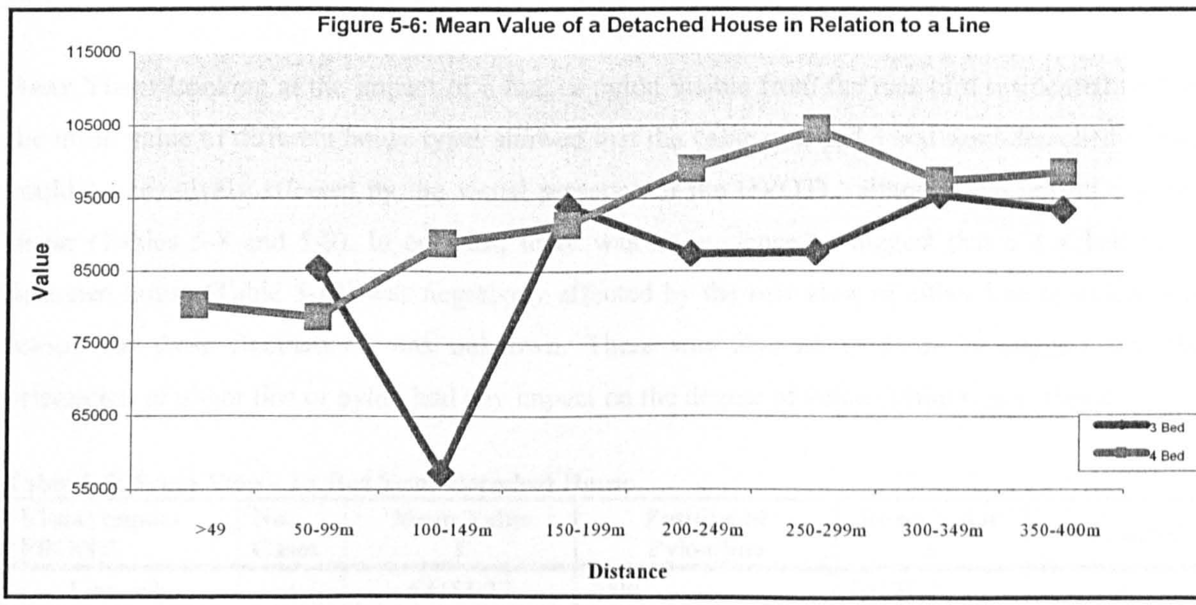


Table 5-4: Selling Price in Relation to Distance from the Line

House Type	>49m	50-99m	100-149m	150-199m	200-245m	250-299m	300-345m	350-399m
2 bed semi			**64171.75**	**68414**	**69171.25**	**68181.25**	**66759.86**	**64487**
Count	-	-	4	1	4	4	7	6
Std. Deviation			7214.23		7576.66	4203.27	2014.47	1950.03
3 bed semi	**67283.65**	**64804.16**	**70885**	**63458.25**	**70959.08**	-	**79203**	**73685.58**
Count	**31**	**31**	**23**	**20**	**12**		**12**	**19**
Std. Deviation	8416.63	8188.34	13058.81	8707.31	3839.36		1379.18	5762.9
4 bed semi	**73626.92**	**64227.4**	**78352.45**	**76855.83**	**79359**	**82437**	**82290.20**	
Count	**13**	**5**	**11**	**18**	**1**	**8**	**5**	-
Std. Deviation	11590.15	5858.53	3331.39	3758		3244.25	2727.96	
3 bed detached		**85400.50**	**57237**	**93930.14**	**87385.85**	**87621.33**	**95395.25**	**93443,9**
Count		**2**	**1**	**7**	**13**	**6**	**12**	**10**
Std. Deviation		990.66		10053.58	10660.19	7003.71	2691.15	7034.87
4 bed detached	**80316.89**	**78665.69**	**88862.28**	**91354.33**	**99032.35**	**104379.9**	**97410.8**	**98601.5**
Count	**9**	**16**	**18**	**39**	**43**	**22**	**10**	**8**
Std. Deviation	12855.79	20903.43	17463.7	20382.05	9617.33	7398.18	3275.26	4352.19
5 bed detached	**99306**	**91286.8**	**97576.3**	**92023.78**	-	-	**98939**	**101087.7**
Count	**1**	**10**	**10**	**9**			**4**	**3**
Std. Deviation		17687.4	5428.64	7831.95			3540.98	155.08
6 bed detached	**100509.9**	**114251**	**94183.14**	**103047.2**	**105372.4**	-	-	-
Count	**8**	**3**	**7**	**12**	**5**			
Std. Deviation	14246.19	7617.25	12982.75	7495.03	7848.3			





5.3.2.2 Selling Price Relative to the Visual Impact of a HVOTL

Data were analysed to determine whether value was affected by the visual presence of the HVOTL and its supporting structures and whether, or not, the orientation of the HVOTL had a significant impact on the result.

Semi-Detached Houses: The visual impact of a line and pylon had little impact on the value of a 2 x bed semi-detached house (Table 5-5) reducing value from £68181.25 for homes with a view of the line to £66213.9 for a view of 2 or more pylons. The orientation of the line or pylon had no obvious impact on the degree of diminution suffered.

The visual impact of a line and pylon on the value of a 3 x bed semi-detached house (Table 5-6) indicated that a view of ½ pylon, ¾ pylon or 2 or more pylons could reduce value by up to £12000, however, this impact was not linear. The orientation of the pylon was observed to be an important factor in the degree of diminution suffered. Houses with a facing view of a pylon were general lower priced than those with a less pronounced view. This indicated that the orientation of the pylon was an important factor in the degree of diminution suffered.

The impact on a 4 x bed semi-detached house was less clear (Table 5-7), although the results indicated that the value of a house with a view of either line or pylon was generally lower than similar units having 'no view' with the exception of houses having a '½ pylon' or '¾ pylon' view. The orientation of the pylon appeared to have a significant impact on value with houses having a 'facing' view suffering from greater value diminution than similar units with a 'side' view, with one exception; houses having a view of 1 pylon.

There were an insufficient number of 5 x bed semi-detached houses (5 houses, 4 having a view of 1 pylon) to determine the impact on the value of this house type.

Rear View: Looking at the impact of a line or pylon visible from the rear of a residential unit on the mean value of different house types showed that the value of 2 and 3 bed semi-detached houses could be negatively affected by the visual presence of the HVOTL, although the impact was not linear (Tables 5-8 and 5-9). In contrast, there was no evidence to suggest that a 4 x bed semi-detached house (Table 5-10) was negatively affected by the rear view of either line or pylon. The reason for these fluctuations was unknown. There was also no evidence to suggest that the orientation of either line or pylon had any impact on the degree of value diminution suffered.

Table 5-5: Front View - 2 x Bed Semi-Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
Line only	4	68181.25	Side	68181.25	4
1 pylon	11	64683.63	Side	65952.18	11
1+ pylon	1	68414	Facing	68414	1
2 pylons or more	10	66213.9	Side	64683.63	8
			Side Front	80093	1
			Facing	64577	1

Table 5- 6: Front View - 3 x Bed Semi-Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	8	72900.38			
Line only	25	67006.4	Side	63445.53	17
			Side front	74885	2
			Facing	74469.33	6
¼ pylon	10	61330.3	Side Front	70216.67	3
			Facing	57521.86	7
½ pylon	4	79315	Side	79315	4

¾ pylon	3	76604.67	Side	76604.67	3
1 pylon	69	69415.19	Side	69509.62	42
			Side Front	69077.5	20
			Facing	69813.43	7
2 pylons or more	45	69356.47	Side	88495	23
			Side Front	71774.36	11
			Facing	65172.18	11

Table 5-7: Front View - 4 x Bed Semi-Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	3	82140.67			
Line only	6	79453.83	Side	81127	2
			Side front	78617.25	4
¼ pylon	3	67329.33	Side	79359	1
			Facing	61314.5	2
½ pylon	3	81036.33	Side	81036.33	3
1 pylon	29	75051.21	Side	71847	11
			Side Front	77008.11	18
2 pylons or more	17	78185.18	Side	86698	2
			Side Front	75627.1	10
			Facing	79896.1	5

Table 5-8: Rear View - 2 x Bed Semi-Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	5	69019.8			
Line only	1	64577	Side	64577	1
¼ pylon	5	64469	Facing	64469	5
1 pylon	4	64171.75	Facing	64171.75	4
2 pylons or more	11	67276.73	Side	68452.33	3
			Side Front	67367	1
			Facing	66759.86	7

Table 5-9: Rear View - 3 x Bed Semi-Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	65	69043.85			
Line only	16	64593.63	Side	67211	1
			Side front	63443.67	6
			Facing	65069.44	9
¼ pylon	12	73679.58	Side	73679.58	12
½ pylon	6	60744.5	Side	60744.5	6
1 pylon	33	68562.91	Side Front	60744.5	8
			Facing	73933.72	25
2 pylons or more	34	67715.24	Side	67725	5
			Side Front	72162.67	3
			Facing	67200.19	26

Table 5-10: Rear View- 4 x Bed Semi-Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	17	76072.53			
Line only	11	78874.73	Side	78623.5	6
			Side front	81935	2
			Facing	77337	4
½ pylon	2	61314.5	Side	61314.5	2
1 pylon	3	81848.5	Side Front	72149	1
			Facing	86698	2
1+ pylon	4	72779	Screened	72779	4
2 pylons or more	24	77238.75	Side Front	78606.57	7
			Facing	76675.53	17

Detached Houses: There were too few 2 x bed detached houses (3 units, all having a view of more than 1 pylon) to determine the impact on this house type.

However, the results indicated that virtually all 3 and 4 x bed detached houses with a view of either line or pylon suffered from a reduction in value (Table 5-11 and 5-12). The impact was not linear and the orientation of the pylon did not appear to have a material impact on the degree of diminution suffered.

The mean value of larger detached houses seemed relatively unaffected by the visual presence of a line and pylon. However, there were exceptions and in some cases value was observed to increase as a view of the HVOTL became more pronounced. It is possible that a larger plot size[xvi] or increased privacy may have compensated owners for the visual encumbrance (Table 5-13 and 5-14).

Rear View: Examining the impact of a rear view of the HVOTL on the value of a detached house revealed that the transaction price of a house with a '¼' or '½ pylon' view was generally lower than a similar unit with a 'line only' view (Table's 5-15, 5-16, 5-17 and 5-18). Values were frequently observed to rise beyond this point, despite having a more pronounced view of 1 or more pylons.

Overview of the Visual Impact on Value: The results indicate that the selling price of houses having a rear view of a pylon was, on average 7.1% lower than comparable homes elsewhere on the estate. By comparison, having a front view was found to have a much greater negative impact, reducing selling price by up to 14.4%.

[xvi] See Figure 5-7 below.

Table 5-11: Front View - 3 x Bed Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	2	97567			
Line only	7	82805.43	Side	76204.33	3
			Side front	81604.5	2
			Facing	91808	2
¼ pylon	6	91984.83	Side	90878.5	4
			Facing	94197.5	2
½ pylon	6	90213.83	Side	94370	1
			Side Front	94884	1
			Facing	88007.15	4
¾ pylon	5	93313.6	Side	93313.6	5
1 pylon	24	94964.75	Side	93096.29	7
			Side Front	93372.25	7
			Facing	103571.5	3
2 pylons or more	7	83825.29	Side	100287	1
			Side Front	85440	4
			Facing	72365	2

Table 5-12: Front View - 4 x Bed Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	2	97745			
Line only	25	100248.1	Side	101137.9	12
			Side front	98892.63	8
			Facing	100281.2	5
¼ pylon	17	94217.47	Side	89962.56	8
			Facing	99004.25	9
½ pylon	11	99014.91	Side	99019.29	7
			Facing	99007.25	4
¾ pylon	8	95659.63	Side	92990.5	6
			Side Front	103667	2
1 pylon	32	94240.63	Side	97572.11	9
			Side Front	92489.63	19
			Facing	95062.00	2
1+ pylon	4	89542.5	Side	106270	1
			Side front	74834.8	2
			Front	102231	1
2 pylons or more	66	89845.64	Side	91780.14	7
			Side Front	87511.29	42
			Facing	94714.63	16

Table 5-13: Front View - 5 x Bed Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	2	65926.5			
Line only	6	93760.17	Side	92796.2	5
			Side Front	98380	1
¼ pylon	1	99885	Facing	93760.17	1
1 pylon	18	94945.33	Side	90007.57	7

			Side Front	97809.	10
			Facing	100870	1
2 pylons or more	13	95809.62	Side	97650	6
			Side Front	104598	2
			Facing	90085.8	5

Table 5-14: Front View - 6 x Bed Detached House

Visual impact FRONT	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon					
Line only	12	106063.8	Side	105468.5	8
			Side Front	104899.5	2
			Facing	109609	2
1 pylon	12	94173	Side	95880.17	6
			Side Front	92465.83	6
1+ pylon	1	119577	Side	119577	1
2 pylons or more	10	104712.4	Side	98169.6	6
			Side Front	96147.67	3
			Facing	120414	1

Table 5-15: Rear View - 3 x Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	6	90436.5			
Line only	9	90909.56	Side	95299	2
			Side front	90785	5
			Facing	86831.5	2
¼ pylon	6	93489.67	Side	93489.67	6
½ pylon	1	93937	Side	93874	1
¾ pylon	1	93874		93874	1
1 pylon	3	84609.33	Facing	84609.33	3
1+ pylon	2	87803	Side Front	87803	2
2 pylons or more	23	90760.3	Side	103571.5	3
			Side Front	88851.8	10
			Facing	88825.5	10

Table 5-16: Rear View - 4 x Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	20	868221.7			
Line only	37	101152.2	Screened	103835.2	15
			Side	104053.9	12
			Side front	87061.67	3
			Facing	96467.14	7
¼ pylon	3	96864.67	Side	96864.67	3
½ pylon	6	94370	Side	93571	5
			Facing	98365	1
¾ pylon	5	72008.8	Side	98501	1
			Side Front	46208	2

			Facing	84563.5	2
1 pylon	19	88093.47	Side	91071	6
			Side Front	68565.75	4
			Facing	94787.44	20
1+ pylon	9	94760.89	Side Front	104981.5	4
			Facing	86584.4	5
2 pylons or more	69	92743.33	Side	83494.22	9
			Side Front	96243.48	40
			Facing	89905.15	20

Table 5-17: Rear View - 5 x Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	7	87015.29			
½ pylon	1	98580	Side front	98580	1
¾ pylon	2	92525.5	Facing	92525.5	2
1 pylon	3	95171	Side Front	95171	3
2 pylons or more	27	95207	Side Front	96230	14
			Facing	94105.31	13

Table 5-18: Rear View - 6 x Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line, no pylon	12	102760.6			
Line	1	117650	Facing	117650	1
½ pylon	3	107255.7	Side	120414	1
			Facing	100676.5	2
1 pylon	2	107628	Side front	107628	2
1+ pylon	5	105622.4	Side front	114792.7	3
			Facing	91867	2
2 pylons or more	12	96135.83	Side	108449	1
			Side Front	94076	4
			Facing	95553.86	7

5.3.3 House Type and Plot Size Relative to Proximity to Line and Pylon

5.3.3.1 House Type

First, house type, relative to proximity to a pylon and line, was examined to determine whether developers had a tendency to place lower cost housing nearest either a pylon (Table 5-19) or a line (Table 5-20). The results indicate that flats tend to be built nearer lines rather than elsewhere on this estate. Perhaps of greater interest is the apparent willingness of developers to build semi detached and detached houses within 50m of a line; 46 semi-detached and 18 detached, compared to just 10 semi-detached and one detached houses within 50m of a pylon. This suggests that the presence of a pylon rather than a line may have had more influence over the type of house built on this estate.

Table 5-19: House Type Relative To Distance From A Pylon

Dist Pylon		House Type: Flat	Terraced	Semi	Detached	Total
400m	Count			20	3	23
	% within H. Type			7.7%	1.0%	3.9%
350m	Count			22	30	52
	% within H. Type			8.5%	10.0%	8.8%
300m	Count			29	27	56
	% within H. Type			11.2%	9.0%	9.5%
250m	Count			15	45	60
	% within H. Type			5.8%	15.0%	10.2%
200m	Count	5		40	84	129
	% within H. Type	62.5%		15.4%	27.9%	21.9%
150m	Count			57	50	107
	% within H. Type			21.9%	16.6%	18.1%
100m	Count	3	21	38	40	102
	% within H. Type	37.5%	100.0%	14.6%	13.3%	17.3%
50m	Count			29	21	50
	% within H. Type			11.2%	7.0%	8.5%
0-49m	Count			10	1	11
	% within H. Type			3.8%	.3%	1.9%
Total	Count	8	21	260	301	590
	% within H. Type	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	1.4%	3.6%	44.1%	51.0%	100.0%

Table 5-20: House Type Relative To Distance From A Line

Dist Line		Flat	Terraced	Semi	Detached	Total
400m	Count			15	2	17
	% within HS.TYPE			5.8%	.7%	2.9%
350m	Count			27	21	48
	% within HS.TYPE			10.4%	7.0%	8.1%
300m	Count			27	27	54
	% within HS.TYPE			10.4%	9.0%	9.2%
250m	Count			12	28	40
	% within HS.TYPE			4.6%	9.3%	6.8%
200m	Count			18	62	80
	% within HS.TYPE			6.9%	20.6%	13.6%
150m	Count	5		40	68	113
	% within HS.TYPE	62.5%		15.4%	22.6%	19.2%
100m	Count		3	38	39	80
	% within HS.TYPE		14.3%	14.6%	13.0%	13.6%
50m	Count		17	37	36	90
	% within HS.TYPE		81.0%	14.2%	12.0%	15.3%
0-49m	Count	3	1	46	18	68
	% within HS.TYPE	37.5%	4.8%	17.7%	6.0%	11.5%
TOTAL	Count	8	21	260	301	590
	% within HS.TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

5.3.3.2 Plot size and Proximity

Second, the relationship between plot size and proximity to the HVOTL was explored to determine whether, or not residential units close to HVOTLs had more land than similar units further away.

Comparing the mean plot size of all house types (Figure 5-7) indicated that semi-detached and detached houses closest to a pylon had a much larger plot size than similar houses further away. This factor was most obvious with semi-detached units and was explored further by examining the plot sizes of the two main house types on the estate. This revealed that 3 bed semi-detached houses did have a larger plot, especially those sited within 100m of the pylon (Figure 5-8). By comparison, the plot size of a four bed detached house was either the same or less than similar houses situated 200m away from the pylon. Interestingly, only one detached house was sited within 50m of a pylon (Figure 5-9) This was a 6 x bed detached house, at 37m away from a pylon with a plot size of 312sq.metres which sold for £79,995 in 1999 (A similar house sited at 83m from a pylon with a plot size of 325sq.metres, sold for £92,995 in 1995).

Figure 5-7: Blackwood Plotsize Relative To Distance From A Pylon- All House Types

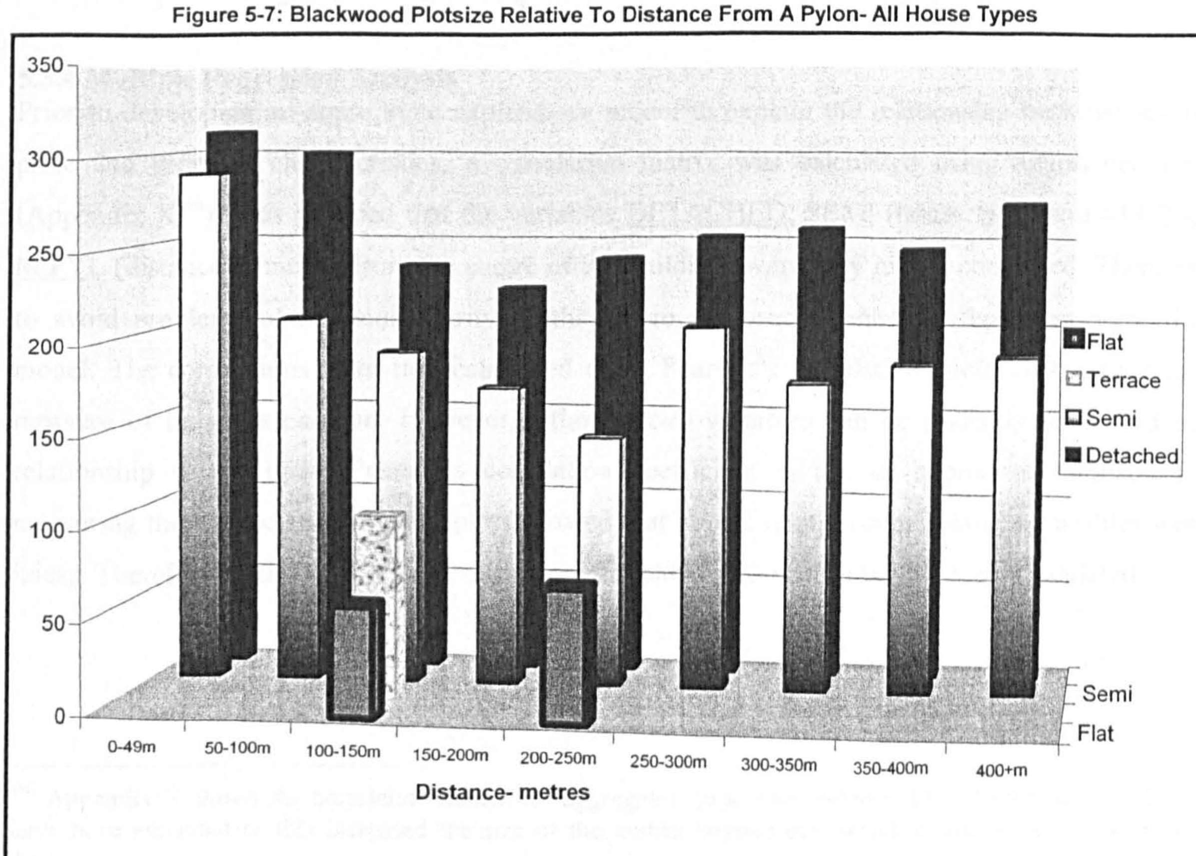


Figure 5-8: Plot size of a 3 x Bed Semi-Detached

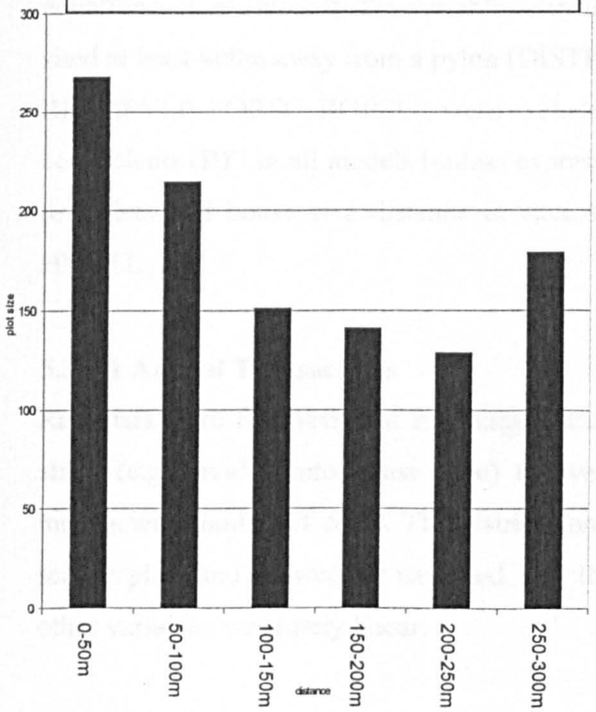
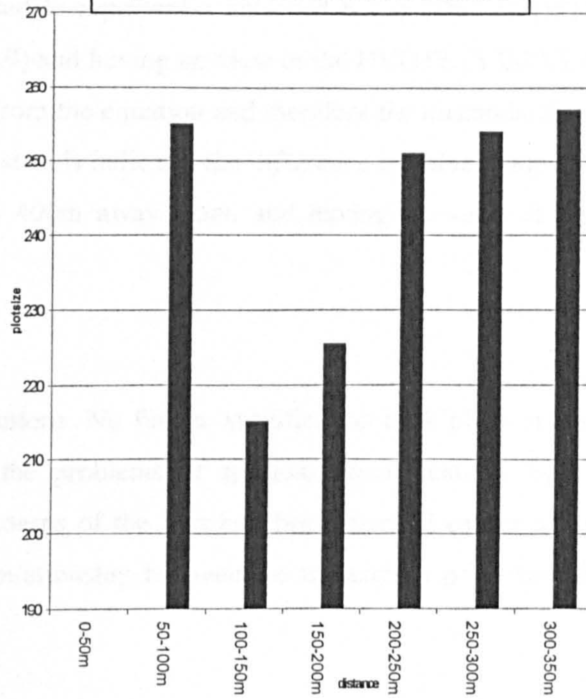


Figure 5-9: Plot size of a 4 x Bed Detached



5.3.4 Multiple Regression Analysis

Prior to developing an appropriate explanatory model to explain the relationship between selling price and property characteristics, a correlation matrix was calculated using aggregated data (Appendix X[xvii]). This revealed that the variables DETACHED, SEMI (house type) and M.LINE, M.PYL (distance in metres from the centre of the building) were very highly correlated. Therefore to avoid problems of multicollinearity[xviii], they were not used together in the same regression model. The correlations were first calculated using Pearson's correlation coefficient, which is a measure of linear association. However, although two variables can be perfectly related, if the relationship is not linear Pearson's correlation coefficient is not an appropriate statistic for measuring their association. Scatter plots showed that not all relationships between variables were linear. Therefore, both Pearson's correlation coefficient and Kendall's tau-b[xix] were calculated.

[xvii] Appendix X shows the correlation matrix for aggregated data. The variables DISPYL0-9 and DISLINE have been excluded as this increased the size of the matrix beyond that which could be displayed in this thesis.

[xviii] Multicollinearity occurs when two variables are very highly linked with one another, in other words, they are measuring the same thing. Removing one highly correlated variable when undertaking regression analysis produces a clearer result. (Dancey and Reidy[15])

[xix] Kendall's tau-b is a more appropriate test when the relationship is unlikely to be linear.

In all models, one dummy variable from each dummy set was excluded for computational purposes, this was to avoid the problems of indeterminancy of the ordinary least squares nominal equations. In all models, the variables constructed to represent a detached house (DETACHED) sited at least 400m away from a pylon (DISTPYL9) and having no view of the HVOTL (VISPYL0, REARPYL0, FORSC, RORSC), were excluded from the equation and therefore the unstandardised coefficients (B)[xx] in all models (unless expressly stated) indicates the difference in value compared to a detached house at a distance in excess of 400m away from, and having no view of, the HVOTL.

5.3.4.1 Annual Transactions

Raw data were first stratified into annual transactions. No further stratification took place at this stage (e.g. divided into house type) to avoid the problems of spurious results caused by an insufficient number of cases. The distribution patterns of the data had been checked earlier using scatter plots and showed, as expected, that the relationship between the transaction price and all other variables was rarely linear.

Many statistical tests are based on the assumption of normality which often leads to tests that are simple, mathematically tractable, and powerful compared to tests that do not make the normality assumption. Unfortunately, many real data sets are in fact not approximately normal. However, an appropriate transformation of variables can often yield a data set that does follow, approximately, a normal distribution. This increases the applicability and usefulness of statistical techniques based on the normality assumption. The Box-Cox transformation is a particularly useful method of transforming variables and can be used to determine the most appropriate functional form. However, where this test is not included as part of your statistical package (the Box-Cox test was not included in SPSS, the statistical package used for this research), another method can be applied to determine the appropriate functional form. This involved transforming the variables PLOTSIZE, MPLY and MLINE into different functional forms and testing the linearity of transformed variables using scatter plots. This showed that there was little difference between the linearity of standard or log-transformed variables.

[xx] Unstandardised coefficients (B value) only show the change in value from movement in each variable if all other variables are held constant. For instance, in Model 1 if another bedroom is added to the unit, value would increase by £4810.54 assuming everything else remained the same. The slope B can be converted into a standardised score Beta, (standardised coefficients) which express changes in the variable in terms of standard deviations. Therefore when value goes up by one standard deviation, the number of bedrooms increases by 0.327 standard deviations thus showing the relevant importance of movement in each variable in the equation. B and Beta equations have been included in each model. See also Dancey and Reidy[15] for a further explanation.

Multiple regression analysis was performed using linear and log-linear[xxi] functional forms to determine which form produced the best model. The most appropriate functional form was determined by the calculated Adjusted R Square[xxii] which showed how much of the dependant variable was explained by the independent variables in each model. The functional form producing the highest Adj. R^2 was adopted for each model.

A series of linear regressions were performed, starting with 'property specific' characteristics and adding the HVOTL characteristics variables, including F.OR (front orientation) and R.OR (rear orientation) to account for the position of the pylon or line. In all data sets, adding in the HVOTL variables increased the model's explanatory power. A model was calculated for each year, using stepwise regression to calculate the significant determinants of selling price.

Model 1 shows the main determinants of the value of all residential units sold in 1994 (112 transactions). Log linear functional forms were found to produce the most efficient model (Adj. R^2 .841) and showed that there was a positive correlation between distance from the pylon and selling price (LNPYLON t =3.664, sig = .000). Having a 'facing' or a 'side front' view of a pylon from the rear of the house had a significant and negative impact at the 95% significance level (RORF t= -3.803, sig= .000; R.ORSF t= -2.316, sig= .023), although by contrast, a rear view of the line was found to increase value (REARLINE t =2.823, sig = 006).

The development of the case study location was largely completed in 1995 and resulted in 160 sales transactions. In this model (Model 2) a standard linear form was found to produce the most efficient model (Adj. R^2 .529). The results again revealed a positive correlation between distance from the pylon and selling price (t= 2.591, sig= .010) although, the impact was found to be less significant than that which had been observed in Model 1. Constructing dummy variables to represent distance from the HVOTL in 50m bands enabled the impact, relative to distance, to be examined more closely and allowed significant zones to be pinpointed. The most negative impact on value was observed to be at a distance of between 200m and 249m from the HVOTL. Whereas, units sited within the range of 250m to 299m were, on average, £5060 more expensive than the same house type sited at a distance of 400m. The reason for this is not known.

[xxi] Transforming variables using natural logarithms can produce a more conservative t and p value and is used to reduce peaks in the results of the analysis.

[xxii] The Adjusted R Square (Adj. R^2) gives a more realistic estimate, than the R square (R^2), of the amount of variance in the dependant variable (e.g. price) which is explained by the variables included in the model (Dancy and Reidy[11]). For instance Model 1 Adj. R^2 .841 means that 84% of the variance in transaction price is explained by the variables in the equation. The nearer the Adj.R^2 is to 100%, the more efficient the model.

Compared to transactions in 1994, the orientation of a pylon visible from the rear of a house had no significant impact on value. Interestingly, the predictive power of the 1995 model was much lower at just over 50% compared to 1994 when the variables were predicting 84% of the total price.
In 1996 there were 78 transactions. Model 3 shows that the most significant variables to affect selling price were, number of bedrooms, plot size, having a rear view of either ½ or ¾ pylon and being situated between the ranges of 50-99m from the nearest pylon. Using log-transformed variables provided the best model, although, the overall performance of the model was still relatively poor, at 61%.

In 1997 there were 41 transactions. Once again, using log linear variables in the equation provided the most efficient model (Adj. R^2 .784). Model 4 shows that the number of car parking spaces (PARKING), house type (SEMI, TERRACE), plot size (LNPLOT) and being sited within 50m (DISTPYL1) of a pylon had a significant impact on value. The variable VIEW was constructed to account for homes either having a view of the lake (53 cases), woodland (four cases), or open countryside (19 cases). As the number within each category was relatively small, residential units were considered to have either a VIEW or NO VEIW if they looked out on to other houses (517) therefore having NO VIEW. It was hypothesised that having an open view would reduce any negative impact of the HVOTL on value, as Rosiers (2002[13]) observed. For this house type, having a VIEW was found to be significant and had a positive impact on value, despite the fact these particular units also had a clear view of two or more pylons.

Data from 1998 (23 transactions) provided the most efficient model predicting 88% of the transaction price from the variables (a standard linear form produced the best model). Model 5 shows that there is a positive correlation between distance from the pylon and selling price. Having a VIEW was also found to have a significant and positive impact on value, which may indicate that a view of open countryside, woodland or a lake, despite also including a view of two or more pylons, can reduce the negative impact of the HVOTL.

In 1999 there were 27 properties sold (Model 6). The main determinants of selling price were house type, being sited within the range of 200-249m from a pylon and the orientation of the HVOTL from the rear of the unit. All significant variables had a negative impact on selling price compared to a detached house sited at 400m away from the HVOTL having no view of either line or pylon.

Using log linear variables in Model 7, for year 2000 data (32 transactions), enabled 83% of the total selling price to be predicted by the following variables. Parking facilities (PARKING), distance to pylon (LNPYLON), plot size (LNPLOT), number of bedrooms (N.BEDRM), house type (SEMI) and view (VIEW). This last variable (VIEW) now had a negative impact on selling price (VIEW t=

-2.541, sig.= .018) unlike the main determinants of house price in 1997 and 1998. This may have been due to the fact that houses on the estate were several years old or that there was substitute housing available locally.

There were 59 transactions in 2001 (Model 8). The only significant variables were house type (SEMI, TERRACE) and the orientation of the HVOTL from the front of the house (FORSF). The three variables in this model were able to predict nearly 69% of the total selling price.

In 2002 (54 transactions) although more variable were found to be significant, the models ability to predict value declined from 69% in 2001 to 58% in 2002 (Model 9). The reason for this was unknown and it is possible, that other factors such as availability of substitute residential units and interest rates may have increased the degree of error within the models.

Model 1: 1994	Coefficients	Standardised Coefficients	T	Sig.
Adj. R^2 .841	B	Beta		
(Constant)	-18004.963		-1.246	.216
SEMI	-11242.878	-.437	-7.234	.000
FLAT	-12646.525	-.133	-2.742	.007
N.BEDRM	4810.540	.327	6.356	.000
LNPYLON	4184.138	.168	3.664	.000
LNPLOT	9658.962	.247	4.855	.000
RORF	-5011.973	-.188	-3.803	.000
REARLINE	3656.640	.130	2.823	.006
RORSF	-3198.336	-.106	-2.316	.023
		Model 2: 1995		
		Adj. R^2 .529		
(Constant)	44914.388		9.381	.000
SEMI	-12618.851	-.439	-6.874	.000
N.BEDRM	5717.009	.385	6.069	.000
METREPYL	21.388	.145	2.591	.010
DISTPYL6	5059.972	.120	2.083	.039
FORS	4118.330	.140	2.510	.013
DISTPYL5	-4401.571	-.112	-1.983	.049
		Model 3:1996		
		Adj. R^2 .614		
(Constant)	-34805.772		-2.781	.007
N.BEDRM	6874.438	.465	5.842	.000
LNPLOT	13854.278	.437	5.428	.000
REAPYL3	-32610.053	-.366	-4.836	.000
DISTPYL2	-9105.306	-.158	-2.098	.040
		Model 4: 1997		
		Adj. R^2 .784		
(Constant)	15562.287		.909	.370
PARKING	7471.892	.281	2.366	.024
LNPLOT	9832.342	.310	3.034	.005
VEIW	8594.737	.215	2.861	.007
SEMI	-10337.338	-.367	-3.363	.002
TERRACE	-11385.732	-.259	-2.449	.020
Model 5: 1998				
Adj. R^2 .880				
(Constant)	11273.946		1.970	.064
N.BEDRM	11171.562	.550	6.041	.000
METREPYL	47.833	.439	5.686	.000

PARKING	8858.481	.343	3.857	.001
VEIW	8215.241	.214	2.690	.015
Model 6: 1999				
Adj. R^2 .864				
(Constant)	80179.790		41.888	.000
SEMI	-17325.623	-.832	-9.158	.000
TERRACE	-23179.790	-.421	-4.486	.000
DISTPYL4	-9518.979	-.442	-4.312	.000
RORSF	-8095.863	-.341	-3.347	.003
		Model 7: 2000		
		Adj. R^2 .830		
(Constant)	-70236.029		-3.467	.002
PARKING	7880.928	.282	2.172	.040
LNPYLON	13613.854	.497	6.017	.000
LNPLOT	7885.958	.202	2.227	.035
VEIW	-11781.512	-.204	-2.541	.018
N.BEDRM	5999.365	.333	3.105	.005
SEMI	-6884.673	-.247	-2.539	.018
		Model 8: 2001		
		Adj. R^2 .685		
(Constant)	81671.764		44.251	.000
SEMI	-20414.651	-.763	-9.727	.000
TERRACE	-26506.764	-.441	-5.642	.000
FORSF	5524.020	.186	2.435	.018
Model 9: 2002				
Adj. R^2 .576				
(Constant)	65082.506		7.951	.000
SEMI	-19788.003	-.548	-5.782	.000
FLAT	-35782.228	-.268	-2.806	.007
DISTPYL4	-7536.124	-.156	-1.696	.096
PLOTSIZE	73.807	.301	2.937	.005
METREPYL	46.158	.266	2.772	.008

Dependent Variable: VALUE

5.3.4.2 Cross Sectional Analysis

An analysis of data from two time periods (referred to here as cross sectional analysis) was undertaken using data from the periods 1994-1997 and 1998-2002. This division was chosen firstly, because 1998 represented the midway point between 1994 and 2002 (the data collection period) and secondly, data prior to 1997 had produced fairly stable results in the regression analyses (Models 1, 2, and 3 above).

1994-1997: Using stepwise regression analysis, the significant determinants of selling price for transactions occurring during the period 1994 to 1997 (Model 10) were calculated and were found to be, SEMI, PLOTSIZE, N.BEDRM, METREPYL, TERRACE, REARPYL3, FLAT, DISTPYL1, DISTPYL6 FORSF, and PARKING

1998-2002: During this period (Model 11) the significant determinants of selling price were calculated as, SEMI, PLOTSIZE, METREPYL, N.BEDRM, PARKING, DISTPYL5, FLAT, FORSF, RORSF.

Despite slight changes in the significance of the variables included in each model, the main determinants of value remained fairly stable. This result indicated that using aggregated data, with an inflation multiple to re-calculate all transaction values to their equivalent value as of the 1st quarter in 2003, would not have a detrimental impact on the results. Thus data was aggregated for the final part of the analyses to produce a more robust result.

Model 10: Cross sectional analysis of data between 1994-1997. Stepwise regression

Model 10: 1994-1997	Coefficients	Standardised Coefficients	t	Sig.
Adj. R^2 .606	B	Beta		
(Constant)	41149.539		12.304	.000
SEMI	-10449.984	-.366	-7.822	.000
PLOTSIZE	26.445	.149	3.833	.000
N.BEDRM	4797.875	.320	7.871	.000
METREPYL	26.974	.186	5.329	.000
TERRACE	-13606.182	-.177	-4.567	.000
REAPYL3	-15158.130	-.123	-3.793	.000
FLAT	-11991.377	-.098	-2.747	.006
DISTPYL1	10736.203	.087	2.576	.010
DISTPYL6	3305.395	.072	2.134	.034
FORSF	-2313.679	-.078	-2.330	.020
PARKING	2593.667	.090	2.014	.045

Model 11: Cross sectional analysis of data between 1998-2002. Stepwise regression

Model 11: 1998-2002	Coefficients	Standardised Coefficients	T	Sig.
Adj. R^2 .620	B	Beta		
(Constant)	36355.000		6.790	.000
SEMI	-9469.621	-.300	-5.004	.000
PLOTSIZE	91.277	.364	6.941	.000
METREPYL	40.915	.256	5.556	.000
N.BEDRM	2293.564	.129	2.155	.032
PARKING	4634.368	.146	2.456	.015
DISTPYL5	6084.281	.158	3.394	.001
FLAT	-16576.188	-.129	-2.642	.009
FORSF	3653.519	.108	2.388	.018
RORSF	-3783.744	-.094	-2.015	.045

Dependent Variable: VALUE

5.3.4.3 Aggregated Data

Using aggregated data, a series of linear regressions were performed, starting with 'property specific' characteristics (Model 12), which explained 57% of the total house price and showed that all variables were significant.

Including 'HVOTL specific' variables (Model 13), improved the model's performance (Adj.R^2 = .608) and showed that there was a positive correlation between distance from both line METRELIN[xxiii] (t= 7.958 p= .000) and pylon METREPYL (t=7.558, p= .000) and selling price. This showed that values rose by £37 per metre as distance increased from the pylon and indicated that a house at 400m could sell for up to £14,800 more than house sited next to a pylon.

[xxiii] This model was not shown.

Adding in the visual impact (front and rear) of both line and pylon (Model 14) produced an interesting result. First, a view of a pylon from the rear of a house (REARPYL), or a view of a line (VISLINE) from the front of a house, had a significant and negative impact on value compared to a house having 'no view'. This impact was however, not linear with the greatest negativity observed on the value of homes having a ¾ pylon view. By contrast, having a side view (FORS) of either pylon or line or a rear view of the line (REARLINE), (compared to a screened view) significantly increased value at the 0.05 level (t=2.099, sig =.036; t= 2.742, sig = .006 respectively). This was a similar result to that observed by Rosiers'[13] and possibly indicated that an open view aspect or increased privacy had a positive effect on value.

Model 15, was calculated using stepwise regression analysis in which all variables must pass the tolerance criterion of 95% to be entered in the equation. In addition, a variable is not included if it would cause the tolerance level of another variable already in the model, to drop below the tolerance criterion. Using this method to calculate the significant determinants of house prices in Blackwood indicated that both physical distance (METREPYL) and a rear view of ¾ of a pylon (REARPYL3) had a significant and negative impact on selling price.
Since the distance to the pylon in metres had been found to be significant, the variable METREPYL substituted for dummy variables representing each 50m band from 0-400m from the nearest pylon. Model 16 shows the calculated impact on value within each 50m band and reveals that house price is most negatively affected between the ranges of 50-250m from a pylon. Of more importance to this research was the confirmation that negative impacts on value diminished (referred to as diminishing diminution by Neustein and Bell (1998[16]), as distance increased from the pylon[xxiv].

Distance from pylon	Band	£ Reduction
Between 50 - 99m	Band 2	= £10,787
Between 100 - 149m	Band 3	= £8670
Between 150 - 199m	Band 4	= £8194
Between 200 - 249m	Band 5	= £3395

Model 17 was calculated using log-transformed variables (PLOTSIZE, M.PYL, M.LINE). This marginally improved (a 1% increase) the performance of the model and increased the number of significant HVOTL variables. Variables representing both slight and prominent views of a pylon became significant (REARPYL6; REARPYL1) and, in addition, a rear view of the line (REARLINE) and a side view (FORS) of the HVOTL from the front of the house had a positive impact on value.

[xxiv] See Chapter Three: 3.2 and Neustein and Bell (1998) who investigated the effect of 'Diminishing Diminution'.

Whilst using an unencumbered house as a basis for calculating the impact of a HVOTL on value seemed to be the most logical choice, calculations were performed to test the affect of excluding other variables within each set of dummy variables on the performance of the model. In fact, using variables from each dummy set which represented a house next to a HVOTL, which had the most pronounced view of either line or pylon, was found to produce the most efficient model. In Model 18, the variables excluded from each dummy set were DETACHED, DISTPYL1, VISPYL6, REARPYL6, FORF, RORF, thus representing a detached house with a pronounced view of 2+ pylons. Model 18 showed that increasing the distance from the HVOTL, having a screened rear view of a pylon, a side view of a pylon from the front of the house, no rear view of a pylon and a rear view of the line increased value. Conversely, the most negative impact on value was found to be a partial view of a pylon (¾ pylon view). Also, houses at a distance of 400m or more, from the HVOTL were shown to be less expensive than similar units sited within the 400m of the HVOTL. This result may be due to the fact that only 23 cases were sited at a distance in excess of 400m, of which 20 were 2 x bed or 3 x bed semi detached houses.

This equation shows the main determinants of value for all property in the Blackwood location using aggregated data.

Value = f (SEMI, PLOTSIZE, N.BEDRM, METREPYL, TERRACE, FLAT, RORSC, REARPYL3, PARKING, FORS, DISTPYL9, REARPYL0, REARLINE, e).

Value = £44468 + -£12342 x semi, + £45 x plot size + £5186 x number of bedrooms, + £44 x per metre from the pylon, + -£15502 x terraced, + -£17534 x flat, + £8678 x rear screened view + -£14532 x rear view of ¾ pylon, + £3595 x parking, + £2823 x side view from front, + -£6446 x unit sited 400m or more away from the HVOTL, + £3324 x no view of a pylon, + £2709.717 x rear view of line, + error.

This equation shows that selling price is increased by £440 per 10m. Therefore, a unit sited at 400m should, in theory, be £17,600 more expensive than the same type of unit sited next to a pylon[xxv]. Having ¾ view of a pylon had a significant and negative impact on value compared to a unit suffering a more pronounced view. By contrast, having a screened or side view from the front and, in particular, the rear of a house, significantly increased value compared to a facing view. Having no pylon visible from the rear of a house increased value, as did having a view of line. This indicates that units having a pronounced view of the line may also have a more open view onto the ROW and therefore an increased level of privacy which can reduce the degree of value diminution suffered.

[xxv] The effect of diminishing diminution must be taken into consideration; in other words, as distance from the HVOTL increases, the negative impact on selling price is reduced until reaching a distance where there is no impact on value whatsoever (See Bell 1999 and Bond and Hopkins 2000[f]).

As it would not be possible to undertake a comparative analysis between results using this equation as it is based on a severely encumbered residential unit, the equation produced in Model 17 was adopted for this purpose and is shown here as a footnote[xxvi]

Model 12	Coefficients	Standardized Coefficients	T	Sig. (P)
Adj. R2 .567	B	Beta		
(Constant)	64871.221		20.265	.000
FLAT	-19772.600	-.133	-4.406	.000
TERRACE	-20082.639	-.217	-6.654	.000
SEMI	-14241.575	-.408	-10.088	.000
N.BEDRM	3716.692	.197	5.840	.000
PARKING	4132.546	.117	3.083	.002
PLOTSIZE	41.481	.178	5.422	.000
		Model 13 Adj.R2 .608		
(Constant)	51929.688		14.831	.000
FLAT	-16879.267	-.114	-3.927	.000
TERRACE	-15927.733	-.172	-5.433	.000
SEMI	-13106.089	-.375	-9.670	.000
N.BEDRM	4833.273	.256	7.734	.000
PARKING	3285.762	.093	2.559	.011
PLOTSIZE	44.345	.191	6.067	.000
METREPYL	36.927	.208	7.558	.000
		Model 14 Adj. R2 .616		
(Constant)	48571.046		9.699	.000
FLAT	-17772.741	-.120	-4.080	.000
TERRACE	-15541.014	-.168	-4.955	.000
SEMI	-12802.819	-.367	-9.034	.000
N.BEDRM	5058.290	.268	7.775	.000
PARKING	3590.370	.102	2.773	.006
REARPYL1	-9582.136	-.119	-3.318	.001
REAPYL3	-18662.918	-.126	-4.488	.000
REARLINE	3713.893	.102	2.742	.006
VISLINE	-4760.825	-.071	-2.106	.036
FORS	7664.502	.221	2.099	.036
METREPYL	42.383	.238	7.206	.000
PLOTSIZE	44.652	.192	5.983	.000
		Model 15 Adj. R2 .622		
(Constant)	52533.913		15.149	.000
SEMI	-13590.296	-.389	-10.088	.000
PLOTSIZE	43.063	.185	5.949	.000
N.BEDRM	4841.232	.256	7.831	.000
METREPYL	37.385	.210	7.732	.000
TERRACE	-16487.370	-.178	-5.677	.000
FLAT	-17503.687	-.118	-4.113	.000
REAPYL3	-14165.791	-.096	-3.669	.000
PARKING	3240.767	.092	2.552	.011

[xxvi] Value = f (SEMI, LNPLOT, N.BEDRM, LNPYLON, TERRACE, REAPYL3, FLAT, PARKING, FORS, REARPYL6, REARPYL1, REARLINE, e)
where,
Value = £37551.01 + £-12510.318 x semi, + £11910.31 x log of plot size + £4864.53 x number of bedrooms, + £8085.077 x log of metre from the pylon, + £-12549.85 x terrace, + £-17620.59 x rear view of 3/4 pylon + £-11989.62 x flat + £2928.51 x parking + £2580.07 x side view of the HVOTL from the front of the house + £-2921.36 x rear view of 2 or more pylons + £-5580.10 x rear view of ¼ pylon + £2165.33 x rear view of line + error.

		Model 16 Adj. R2 .622		
(Constant)	66130.583		21.693	.000
SEMI	-13598.532	-.389	-10.094	.000
PLOTSIZE	37.578	.162	5.037	.000
N.BEDRM	4918.630	.260	7.933	.000
TERRACE	-16456.046	-.178	-5.359	.000
FLAT	-18550.391	-.125	-4.373	.000
DISTPYL2	-10786.731	-.167	-5.972	.000
DISTPYL4	-8194.154	-.183	-6.155	.000
DISTPYL3	-8669.954	-.189	-5.938	.000
REAPYL3	-13842.864	-.093	-3.603	.000
DISTPYL5	-3395.196	-.081	-2.662	.008
PARKING	3249.723	.092	2.560	.011
		Model 17 Adj. R2 .624		
(Constant)	-37551.010		-3.154	.002
SEMI	-12510.318	-.358	-8.933	.000
LNPLOT	11910.305	.245	6.831	.000
N.BEDRM	4864.531	.257	7.872	.000
LNPYLON	8085.077	.239	8.131	.000
TERRACE	-12549.848	-.136	-3.894	.000
REAPYL3	-17620.592	-.119	-4.523	.000
FLAT	-11989.621	-.081	-2.591	.010
PARKING	2928.512	.083	2.296	.022
FORS	2580.067	.074	2.624	.009
REARPYL6	-2921.359	-.082	-2.866	.004
REARPYL1	-5580.097	-.069	-2.421	.016
REARLINE	2165.326	.060	2.176	.030
		Model 18 Adj. R^2 .638		
(Constant)	44468.436		11.879	.000
SEMI	-12342.346	-.353	-9.066	.000
PLOTSIZE	45.199	.194	6.311	.000
N.BEDRM	5186.208	.274	8.516	.000
METREPYL	43.778	.246	8.249	.000
TERRACE	-15502.435	-.167	-5.296	.000
FLAT	-17533.934	-.118	-4.148	.000
RORSC	8678.254	.085	3.080	.002
REAPYL3	-14531.840	-.098	-3.840	.000
PARKING	3595.206	.102	2.839	.005
FORS	2823.357	.081	2.943	.003
DISTPYL9	-6446.255	-.073	-2.519	.012
REARPYLO	3323.950	.092	2.955	.003
REARLINE	2523.825	.069	2.343	.019

Dependent Variable: VALNOW

Frequency analysis had shown that plotsize had a relationship with the distance from the HVOTL. However this type of analysis did not establish whether there was a causal relationship between the presence of the HVOTL and the size of the plot. Using regression analysis with plot size as the dependable variable[xxvii] showed that plot size was dependant on house type and number of bedrooms, distance from the nearest pylon and the visual impact of the HVOTL (Model 19). Plot size was only observed to be significantly larger if a unit was sited within the range of 0-49m from the nearest pylon and if a unit had a 'side facing' view of a pylon from the rear.

[xxvii] Natural log of plot provided the best model.

Model 19 Adj. R^2 .555	Coefficients £	Standardized Coefficients	t	Sig.
	B	Beta		
(Constant)	5.395		51.321	.000
FLAT	-1.105	-.362	-11.686	.000
TERRACE	-.829	-.435	-11.728	.000
SEMI	-.276	-.385	-9.031	.000
N.BEDRM	3.922E-02	.101	2.688	.007
DISTPYL1	.374	.137	3.612	.000
DISTPYL3	-.148	-.157	-2.259	.024
DISTPYL4	-.157	-.171	-2.444	.015
DISTPYL5	-.207	-.241	-3.411	.001
VISPYL2	-.133	-.074	-2.351	.019
VISPYL3	-.182	-.084	-2.503	.013
VISPYL4	-6.293E-02	-.084	-2.012	.045
REARPYL5	-.162	-.083	-2.377	.018
RORSF	.110	.129	2.386	.017

Dependent Variable: LNPLOT

5.3.4.4 Summary of Blackwood Aggregated Data

The results of the valuation study show that the presence of an HVOTL has a significant and negative effect on the value of proximate residential units, reducing the selling price of units within 100m of the HVOTL by 6 to 17% (an average of 11.5%). The presence of a pylon was found to have a more significant and negative impact on value than the line, and could reduce value by up to 20.7% compared to similar unit sited 250m away.

Having a view of a pylon from the front of the house had a more negative impact on selling price (14.4%) than a rear view (7.1%). The scale of value diminution did not follow a linear pattern and in some cases selling price appeared to increase with proximity to a pylon, which may have reflected an increase in the plot size of units closest to the pylon. It was expected that house prices would be less negatively affected by having either a lake view or countryside view, despite also having a clear view of a number of pylons, yet transaction price appeared to be more negatively affected. All negative impacts appeared to diminish with distance and were negligible at around 250m or more.

Comparison Between Local,\Regional and National House Prices:

House prices can vary considerably within, and between, different locations in the United Kingdom. It is therefore vital to take these variations into consideration when conducting a comparative analysis to establish the impact of a detrimental condition on house price. The indices produced by the Halifax and Nationwide Building Societies take such variations into consideration, thus enabling a comparison to be made between the average price of similar houses in the same region and house prices specifically in the case study location. This provides an indication of

whether, or not, the presence of a HVOTL on a housing estate is likely to reduce all house prices regardless of proximity or the visual impact.
Comparing the result with the Scottish Property Register and the National House Price Index[17] for that location revealed a significant difference between the impact on a semi-detached house and a larger detached house, particularly the way in which the value of both house types responded to distance from the HVOTL.

A pylon 50m from a semi-detached house reduced transaction price by 19% compared with comparable units in that location (although not on an estate crossed by a power line). At a distance of 300m from the HVOTL, house prices had risen to 1% above the national average for that location. By comparison, the selling price of a detached house in Blackwood was reduced by 38% at 100m from the HVOTL and at a distance of 300m was still found to be 30% lower in value than comparable units on another estate in the same region.

Testing the Hypotheses

The use of the null hypothesis format was found to be inappropriate due to the fact that it would prove 'no impact' and house prices were found to be greatly affected by proximity to the HVOTL. Therefore the real hypotheses were tested to determine whether they should be accepted or rejected. The hypotheses to be tested by the valuation research were:

Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential units than physical proximity.

Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line.

Hypothesis 3 The results of the regression analysis indicated that physical proximity had a greater negative impact on value than the visual impact and therefore Hypothesis 3 was rejected.

	F. Value	**Significance**	**Accept or Reject**
Hypothesis 3	Distance HVOTL = 9.54 Visual HVOTL = 2.77	.000 .011	Reject

Hypothesis 4. Frequency analyses indicated that the presence of a pylon had a more negative impact on value than the line. To further test this phenomenon, an analysis of variance (ANOVA) was undertaken which indicated that, whilst both line and pylon were significant at the 0.05 level, proximity to the line had a slightly greater impact on value (pylon: f value = 1.42, sig. = .030; line: f value = 2.03, sig. = .000). However, the impact of the line was positive, in other words, the

presence of the line increase value, whereas the pylon reduced value. Therefore the stated hypothesis was found to be true.

	F. Value	Significance	Accept or Reject
Hypothesis 4	Front Pylon = 1.42 Rear Line = 2.03	.030 .000	Accept *The line had a positive impact on value*

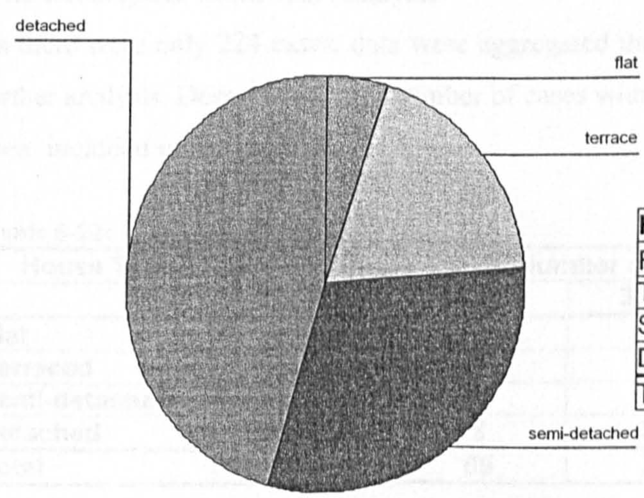
Undertaking a regression analysis with the relevant variables showed that a line at the rear of the house had a significant and positive impact on value (rear line: t value = 3.779, sig. = .000) and a pylon at the front of the house had a significant and negative impact on value (Front pylon: t value = 1.916, sig. = 049). Whilst the impact of the line was more significant, these results confirmed that the pylon had a greater negative impact on value and therefore Hypothesis 4 was accepted.

5.4 THE ANALYSIS OF ST PETER'S DATA

Unlike house prices in the Blackwood case study (which were the transaction price), the house price attached to each case in the St Peter case study location (see Chapter Four: 4.9.1.3) are the 'asking price' and therefore only representative of selling agents opinions of the highest achievable transaction price, in addition to instruction from the vendor, which can influence the asking price; particularly if a quick sale is required.

These data consist of residential units advertised 'for sale' in the local property papers[xxviii] over a period of two years[xxix] and resulted in details of 224 units, of which most were detached and semi-detached houses (Figure 5-10 below). 64 units had no view of either line or pylon and 95 units had a line view only. This resulted in 52 % of the cases in the St Peter data set having a view of one or more pylons.

Figure 5-10: House Type



House Type	Frequency	Percent
Flat	11	4.9
Terraced	42	18.8
Semi-detached	69	30.8
Detached	102	45.5
Total	224	100.0

5.4.1 Variables Used In The Analyses

'Property specific' characteristics were obtained from Agents selling details and included more variables than had been available for the Blackwood data. Therefore, in addition to the variables shown in Table 5-1 above (5.1.2.1), the following variables were included in the analysis of St Peter data (Table 5-21).

[xxviii] The Sutton Coldfield Observer and The Worcester Times (Thursday edition).

[xxix] Unlike transaction prices from house sales in the Blackwood location, it was not possible to collect historic data over a number of years. Therefore data for St Peter and the 3rd case study (Walmley) were collected over a two year period.

Table 5-21: Additional Property Specific Variables

Variable Name	Variable Type	Explanation of Values
N.BATH	*Measurement*	Number of Bath / shower rooms including en-suite.
N.TOIL	*Measurement*	Number of toilets
GARDEN	*Dummy*	Presence of a rear garden
CH	*Dummy*	Central heating

The analysis was undertaken using a combination of property-specific, HVOTL-specific and location-specific characteristics. The variable VALNOW was constructed, using the relevant inflation multiples[xxx].

5.4.2 Outliers

Initially, all data were checked for any entering errors and corrected where necessary. No outliers were identified.

5.4.3 Descriptive Statistical Analysis

As there were only 224 cases, data were aggregated then subdivided into different house types for further analysis. Despite the small number of cases within the 'flat' category (Table 5-22) they have been included in this analysis.

Table 5-22: Breakdown of House Type

House Type	Number of Bedrooms					Total
	1 Bed	2 Bed	3 Bed	4 Bed	5 Bed	
Flat	7	4				11
Terraced	3	36	3			42
Semi-detached	6	27	35	1		69
Detached		2	38	60	2	102
Total	16	69	76	61	2	224

5.4.3.1 Asking Price Relative to Physical Distance from a HVOTL

A comparison of the mean value of all house types relative to physical distance from the pylon was undertaken.[xxxi] This revealed that all house types suffered from a reduction in asking price compared to similar units sited further away from the pylon (Table 5-23). The relationship was not linear, as Figure 5-11 and 5-12 show, but does indicate up to a 20% reduction in the value of a semi-detached house and up to a 15% reduction in the value of a detached house sited within 100m of the pylon compared to a similar unit sited more than 250m away. There were insufficient data to determine the impact on flats and terraced houses with any degree of accuracy.

[xxx] VALNOW was calculated using the relevant inflation multiple obtained from the Halifax House Price Index to bring all transactions up or down to the corresponding value as of the 1st quarter 2003.

[xxxi] Two house types were excluded from the analysis, due to an insufficient number of cases (six 1 x bed semi detached and one 4 x bed semi detached houses).

The same tests were repeated to determine whether, or not, physical distance to the line had a similar impact to a pylon on asking price. The results suggest that the mean value of all house types is also negatively affected by the presence of the line. The impact is generally more pronounced for units situated within the first 100m. The impact of a line (Table 5-24) was shown to reduce asking price by up to 27% for a 1 x bed flat (although there were too few cases in this category to provide a conclusive result); up to 12% for a terraced house compared to one sited within the range of 200-300m from the nearest pylon; up to 17% for a semi detached house (Figure 5-13) and up to 19% for a detached house (Figure 5-14). The relationship between asking price and distance to the line appeared to be slightly more linear than the relationship between price and proximity to a pylon.

Table 5-23: Impact of a Pylon on the Mean Value of Different House Types

House Type	0- 49m	50-99m	100-149m	150-199m	200-249m	250-299m	300-349m	350-399m	<400m
4 bed-det		**195383.3**	**198432.6**	**194074.2**	**202397.4**	**201449.7**	**219043.2**	**222473.2**	**215152.2**
No. Cases	-	2	14	16	8	10	4	2	4
Std D		14447.96	17357.97	20722.6	21051.9	16744.5	28352.18	16520.42	11883.22
3 bed-det	**170385**	**164934**	**171354**	**170407**	**165256**	**193709**	**172620**	**171818**	**176939**
No. Cases	2	4	6	6	4	4	2	6	4
Std D	1206.0	4108.5	15281.1	10685.2	11627.2	24054.3	5709.2	22306.5	35879.5
3 bed-semi	**125378.4**	**136744.3**	**133004.4**	**136440.9**	**154907.9**	**138837.1**	**151459**	**132995.0**	**156700.1**
No. Cases	5	6	5	6	1	3	1	1	7
Std. D	15273.22	12894.3	9361.39	8680.87	-	16871.89	-	-	29619.05
2 bed-semi	**106311.9**	**115488.7**	**115012.2**	**112906.8**	**112655.4**	**108262.4**	**110371.2**		**120069.4**
No. Cases	3	8	5	3	3	2	1	-	2
Std. D	6413.35	8689.21	6428.79	8735.03	5684.37	6788.29	-		1328.23
Terraced	**104159.6**	**109082.6**	**107782.8**	**108633.6**	**115288.8**	**116701.2**	**106583.1**		
No. Cases	3	8	6	8	5	3	3	-	-
Std.D	6220.5	7451.19	9677.58	6599.10	9276.03	2863.47	7590.96		
1 bed Flat		**75995**	**82002.97**	**84925.42**	**90645.24**				**91120.74**
No. Cases	-	1	1	2	2	-	-	-	1
Std.D		-	-	7217.8	22479.86				-
2 bed Flat						**101514.9**	**89764.72**		
No. Cases	-	-	-	-	-	3	1	-	-
Std.D						7287.47	-		

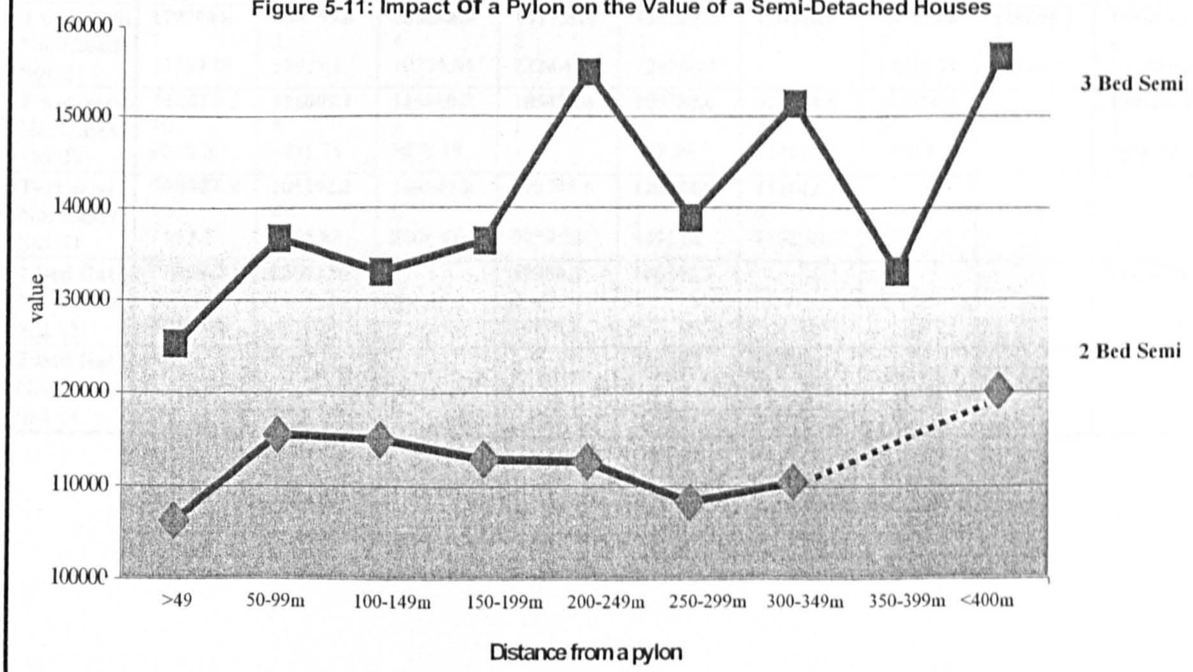


Figure 5-11: Impact of a Pylon on the Value of a Semi-Detached Houses

Figure 5-12: Impact of a Pylon on the Value of Detached Houses

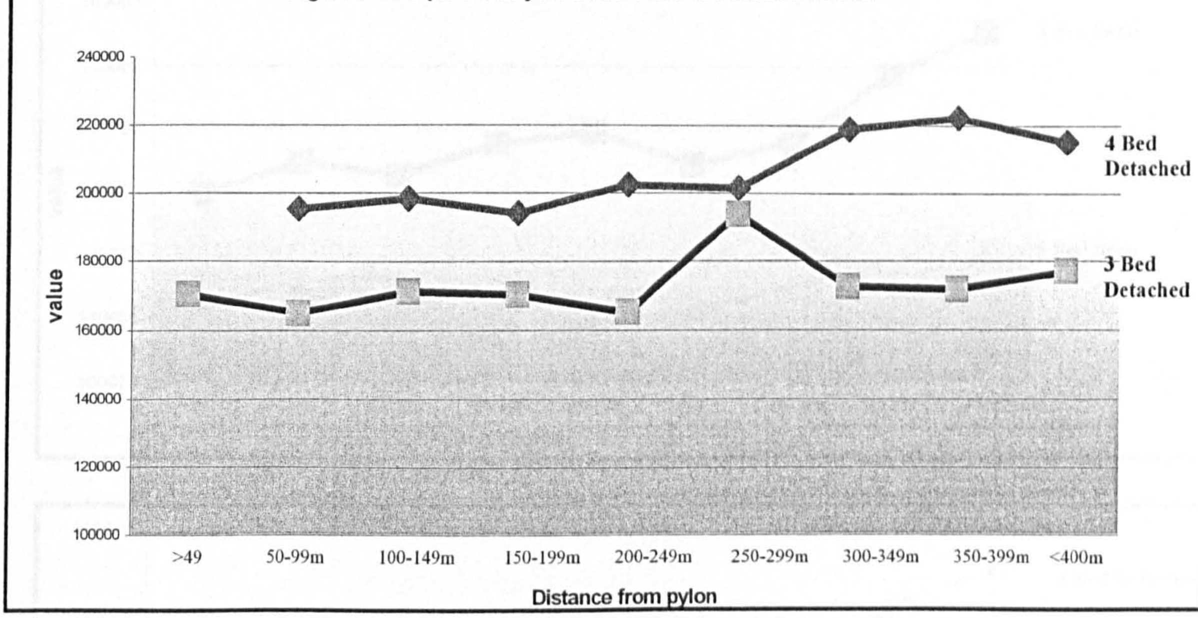


Table 5-24: Impact of a Line on the Mean Value of Different House Types

House Type	>49m	50-99m	100-149m	150-199m	200-249m	250-299m	300-349m	350-399m	<400m
4 bed-det No. Cases Std D	**187745.8** 2 3788.39	**194286.9** 8 29334.63	**200662.8** 10 14217.36	**198662.7** 14 19804.73	**202997.9** 9 21331.46	**207356.8** 9 24144.8	**205058.9** 3 5691.7	**222473.2** 2 16520.42	**230255.8** 5 35306.03
3 bed-det No. Cases Std D	**172654.2** 4 3411.06	**166678.1** 6 15455.41	**165273.9** 6 12450.53	**171838.4** 3 10046.44	**177832.3** 4 26125.54	**186424.7** 3 24359.16	**172619.9** 2 5709.25	**171818.2** 6 22303.58	**181430.3** 4 32679.77
3 bed-semi No. Cases Std. D	**129700.8** 7 15709.88	**134759.8** 5 11919.4	**132668.9** 4 10774.84	**137735.8** 2 2224.42	**139515.3** 5 12836.47	**134346.4** 1 -	**137886.6** 3 17325.58	**148690.5** 2 22196.7	**155419.1** 6 32232.94
2 bed-semi No. Cases Std. D	**112073.2** 10 9019.3	**116007.7** 5 4731.75	**116800.2** 3 8859.18	**105456.4** 1 -	**109389.6** 2 792.59	**111324.8** 2 11119.18	**114716.8** 2 2339.7	-	**120069.4** 2 1328.22
Terraced No. Cases Std. D	**106907.9** 10 7113.7	**105192.2** 4 8765.83	**108643.2** 6 9301.41	**110795.5** 7 5954.98	**120024.6** 3 4491.01	**111642.2** 6 7552.59	-	-	-
1 bed flat No. Cases Std. D	**77908.3** 2 2705.85	**82002.97** 1 -	-	**82389.3** 2 10804.3	**106540.9** 1 -	-	-	-	**91120.74** 1 -
2 bed flat No. Cases Std. D	-	-	-	-	**97594.2** 2 3739.53	**99560** 2 13853.3	-	-	-

Figure 5-13: Impact of a Line on the Value of a Semi-Detached Houses

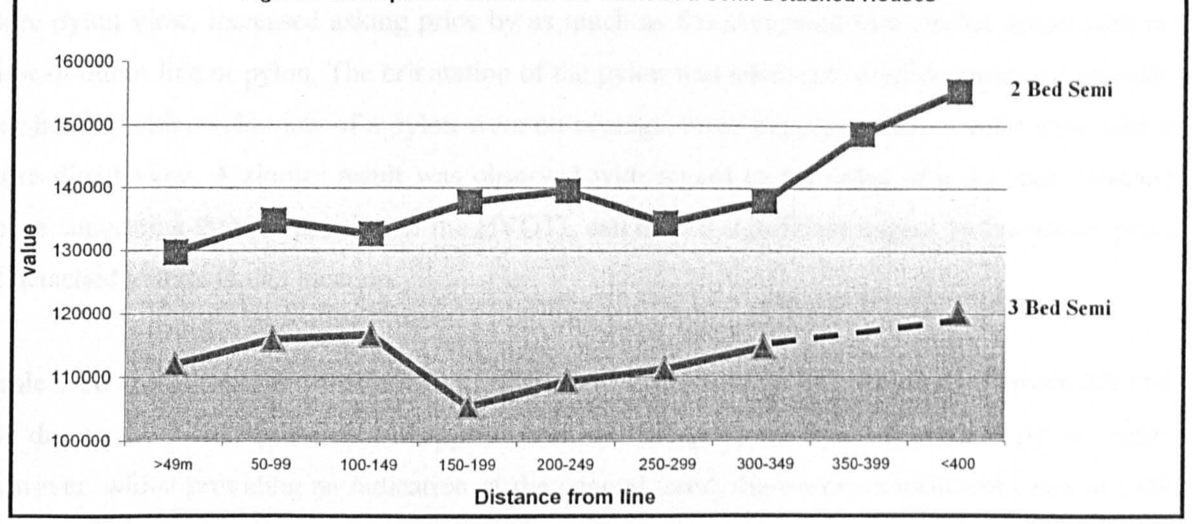
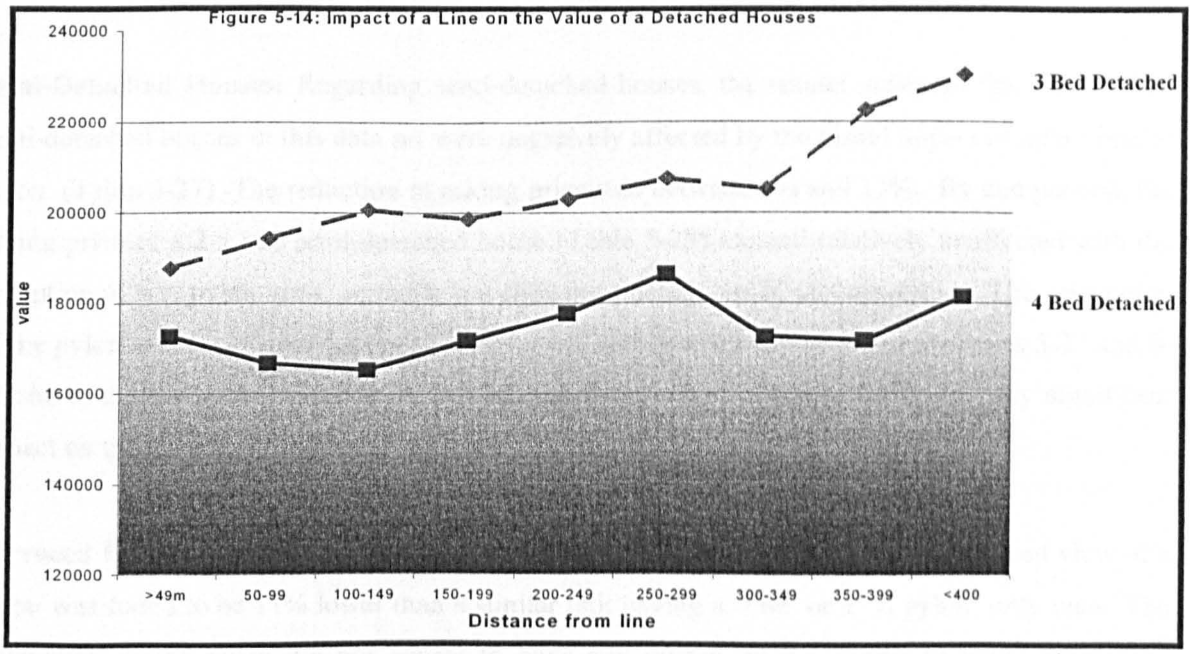


Figure 5-14: Impact of a Line on the Value of a Detached Houses



5.4.3.2 Asking Price Relative to the Visual Impact of a HVOTL

The visual impact of the line and pylon was measured using the same dummy variables as for the Blackwood data (see 5.1.2.1 above). Views were recorded from the front and rear of each house except where it was difficult to obtain the rear view. In this instance, rear views of both line and pylon were estimated. Measurements were then analysed to determine whether or not asking price was affected by the visual presence of the line or pylon and if so, whether the orientation of either line or pylon had a significant impact on the results. Each house type was examined, with the exception of specific house types with an insufficient number of cases to produce a meaningful result (Table 5-25 to 5-29).

Detached Houses: The results suggested that the asking price of a 4 x bed detached house having a view of the line, a ¼ view of a pylon or a total view of one pylon which included part of another, could reduce asking price by up to 4% (Table 5-25). However, a ½ pylon, ¾ pylon, 1 pylon or 2 or more pylon view, increased asking price by as much as 8% compared to a similar house with no view of either line or pylon. The orientation of the pylon was taken into consideration and revealed that houses with a side view of a pylon were on average, more expensive than similar units with a more direct view. A similar result was observed with regard to the value of a 3 x bed detached house suggesting that the position of the HVOTL can have a significant impact on the asking price of detached houses in this location.

Table 5-26 shows that the value of a 3 x bed detached house could be reduced by between 2% and 6% due to the visible presence of a pylon, with the exception of units having a ½ pylon view. However, whilst providing an indication of the general trend, there were insufficient cases in each category to draw a conclusive result.

Semi-Detached Houses: Regarding semi-detached houses, the results indicated that all 3 x bed semi-detached houses in this data set were negatively affected by the visual impact of either line or pylon. (Table 5-27) The reduction in asking price was between 6% and 13%. By comparison, the asking price of a 2 x bed semi-detached house (Table 5-28) seemed relatively unaffected with the exception of a ½ pylon view, certainly not showing fluctuations of this magnitude. The orientation of the pylon was considered for both 2 and 3 x bed semi-detached houses but as Tables 5-27 and 5-28 show, there was no evidence to suggest that the position of the HVOTL had any significant impact on the degree of diminution suffered.

Terraced Houses: The asking price of a terraced house (Table 5-29) with a pronounced view of a pylon was found to be 11% lower than a similar unit having a 'line' or a '¼ pylon' only view. The orientation of the pylon did not appear to have any impact on the degree of value diminution suffered. However, due to the small number of cases within each category this could not be considered sufficient evidence of a trend.

Table 5-25: Front View - Impact of a Pylon Visible From the Front of 4 x Bedroom Detached Houses

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	17	199199.5			
Line only	10	192017.7	Side	191148.6	8
			Facing	195494.2	2
¼ pylon	5	198723.2	Side	218069.5	2
			Side Front	185825.6	3
½ pylon	9	210651.0	Side	210088.2	2
			Side Front	210932.4	6
			Facing	193943.2	4
¾ pylon	8	217376.5	Side	233464.2	4

			Side front	208368.7	2
			Facing	194208.9	2
1 pylon	4	200844.5	Side	203403.4	3
			Facing	193167.5	1
1 pylon + part of another	3	190442.4	Facing	190442.4	3
2 pylons or more	4	201517.4	Side Front	205561.2	1
			Facing	200169.5	3

Table 5-26: Front View - Visual Impact of a Pylon on the Value of a 3 x Bedroom Detached Houses in St Peter

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	8	173365.7	-	-	-
Line only	11	173958.4	Side	176725.4	8
			Facing	166579.5	3
¼ pylon	5	172206.4	Side	180622.3	3
			Side Front	146778.0	1
			Facing	172306.9	1
½ pylon	5	196419.5	Side	196419.5	3
			facing	164519.4	2
¾ pylon	5	162820.4	Side	148672.4	1
			Side front	171238.2	1
			Facing	164730.5	3
1 pylon	1	167500	Side	167500.0	1
1 pylon + part of another	1	169532.6	Facing	169532.6	1
2 pylons or more	1	169693.2	Facing	169532.6	1

Table 5-27: Front View - Visual Impact of a Line and Pylon From the Front of a 3 x Bed Semi-Detached Houses

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	10	152862.3	-	-	-
Line only	5	132584.2	Side	137052	3
			Facing	125882.6	2
¼ pylon	2	135837	Side	151275.8	1
			Facing	120398.2	1
½ pylon	8	131608.3	Side	124546.2	6
			Facing	152794.7	2
¾ pylon	2	125293.1	Side	125293.1	2
1 pylon	3	135932.4	Side front	135718.5	2
			Facing	136360.2	1
1 pylon + part of another	1	117577.3	Side	117577.3	1
2 pylons or more	4	142947.4	Side Front	142947.4	1
			Facing	143588	2

Table 5-28: Front View - Visual Impact of a Line and Pylon on the Value of a 2 x Bed Semi-Detached Houses

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	7	117459.7	-	-	-
Line only	1	121077.4	Side	121077.4	1
¼ pylon	4	116799.3	Side	115844	3
			Facing	119665.1	1
½ pylon	4	103390.8	Side	103367	3
			facing	103462.3	1
¾ pylon	7	112806.9	Side	112381.6	6
			Facing	115358.8	1
1 pylon	2	116344.3	Side	121944.5	1
			Facing	110744	1
2 pylons or more	2	110617.6	Side	99950	1
			Facing	121285.2	1

Table 5-29: Front View - Visual Impact of a Line and Pylon From the Front of a Terraced Houses
(1 bed terraced houses were excluded due to insufficient numbers)

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	10	109723.9			
Line only	2	115072.3	Side	115072.3	2
¼ pylon	6	115391.9	Side	116549.2	4
			Facing	113077.4	2
½ pylon	7	109972.7	Side	10876.3	5
			Side Front	109567.8	1
			Facing	116420.1	1
¾ pylon	4	107573.9	Side Front	106887.7	3
			Facing	109629.5	1
1 pylon	5	103532.1	Side	95120.71	1
			Side Front	96849.82	1
			Facing	108563.4	3
2 pylons or more	2	104850.8	Side Front	112308.7	1
			Facing	97392.93	1

Rear View: Considering the impact of a rear view of either line or pylon on different house types indicated that, detached houses (Table 5-30 and 5-31) suffered less from the visual impact than semi-detached houses. Overall, a 4 x bed detached house (Table 5-30) only suffered a loss in value if it had a partial view of one pylon. Values were observed to rise after this point despite a more prominent view of one or more pylons.

A pronounced rear view of two or more pylons was found to reduce the asking price of a 3 x bed detached house (Table 5-31), by only 4%, compared to similar units having no view. The orientation of the pylon was again observed to have little significant impact on asking price.
By comparison, the asking price of a 3 x bed semi-detached house was more affected. Table 5-32 shows that the mean value of a house having no rear view of either line or pylon was 18% higher

than the same unit with a rear view of two or more pylons. There was a slight indication that the orientation of the pylon may influence the degree of diminution suffered, but this association was very weak.

Tables 5-33 and 5-34 suggested that both 2 x bed semi detached and terraced houses having a rear view of two or more pylons, suffered from a reduction in value compared to houses with no view of a pylon (6% and 20% respectively). However, orientation did not appear to influence the degree of diminution suffered.

Table 5-30: Rear View - Impact of a Rear View of a Line and Pylon on a 4 Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon	40	207224.2			
Line only	5	205939.6	Side	22437.6	2
			Side Front	181500	1
			Facing	193943.2	2
¼ pylon	9	194728.2	Side	187508.5	2
			Side Front	200641.5	5
			Facing	187164.9	2
½ pylon	6	197326.3	Side	213872.6	2
			Side Front	183037.7	2
			Facing	195068.6	2
¾ pylon	3	188036.6	Facing	188036.6	3
1 pylon	1	208357.3	Side Front	208357.3	1
1 pylon + part of another	2	209420.3	Side	242404.0	1
			Side Front	176436.5	1
2 pylons or more	1	205499.5	Facing	205499.5	1

Table 5-31: Rear View - Impact of a Rear View of a Line and Pylon on a 3 Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	18	174650.8			
Line only	9	175048.2	Side	178084	6
			Facing	168961.6	3
¼ pylon	2	181149.3	Side	168582.8	1
			Facing	180000.0	1
½ pylon	4	160763.9	Side	164713.8	2
			Facing	156814.0	2
¾ pylon	2	171238.2	Side rear	171238.2	1
			Facing	172386.9	1
1 pylon	-	-	-	-	-
1 pylon + part of another	-	-	-	-	-
2 pylons or more	3	167411.8	Side	177458.9	1
			Side Rear	162388.2	2

Table 5-32: Rear View - Impact of a Rear View of a Line and Pylon on a 3 Bed Semi-Detached House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	16	144372.5			
Line only	2	136592.8	Side	136592.8	2
¼ pylon	9	138499.6	Side	139946.4	7
			Facing	133435.5	2
½ pylon	2	148163.8	Side	151013.1	1
			Facing	145314.5	1
1 pylon	2	131319.7	Facing	131319.7	2
1 pylon + part of another	4	118806.8	Side front	119216.6	3
			Facing	117577.3	1

Table 5-33: Rear View - Impact of a Rear View of a Line and Pylon on a 2 Bed Semi-Detached House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	9	113498.5			
Line only	5	112186.6	Side	110436.4	3
			Facing	119187.2	1
½ pylon	3	117978.5	Side	121944.5	1
			Facing	115995.5	2
¾ pylon	2	119810.9	Side	121077.4	1
			Facing	118544.3	1
1 pylon	4	116727.6	Side	110297	1
			Side front	124172.7	1
			Facing	116220.3	2
1 pylon + part of another	1	106210.2	Facing	106210.2	1
2 pylons or more	3	106176.9	Side	106176.9	3

Table 5-34: Rear View - Impact of a Rear View of a Line and Pylon on a Terraced House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No pylon/line	15	110818.2			
Line only	2	119877.1	Side	119877.1	2
¼ pylon	8	105384.3	Side	107724.9	5
			Side Front	105456.4	1
			Facing	100236.6	2
½ pylon	2	104793.8	Side	101377.9	1
			Side Front	108209.7	1
¾ pylon	2	104793.8	Side	101377.9	1
			Side Front	108209.7	1
1 pylon	5	113266.2	Side	115273.4	2
			Front	111928.1	3
1 pylon + part of another	2	95985.27	Facing	95985.27	2

5.4.4 House Type and Plot Size Relative to Proximity to HVOTL

Two final tests were conducted to determine whether there was any evidence to suggest that proximity to a HVOTL influences the type of house built or the plot size.

5.4.4.1 House Type: The type of house built on the estate was examined in relation to physical proximity to both line and pylon. Using sales data in this analysis suggested that there was no difference between the type of house built close to either line or pylon and that built further away. The majority of terraced houses and flats were built within 350m of both pylon (Table 5-35) and line (Table 5-36) and over 50% of detached houses in the data set were built within 200m of a pylon.

Table 5-35: House Type Relative to Distance From a Pylon

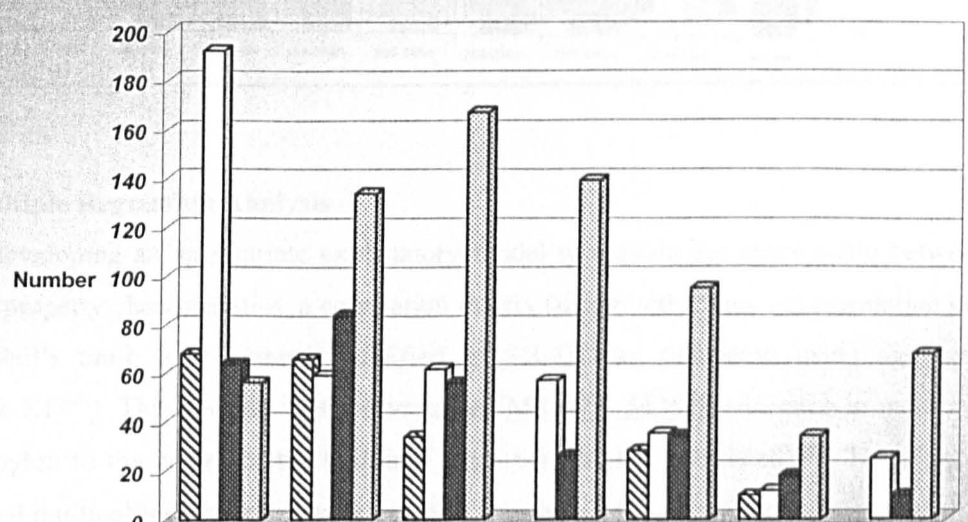
Distance to Pylon	House Type				Total
	Flat	Terraced	Semi	Detached	
550m				1	1
450-499m			5	4	9
400-449m	1		4	4	9
350-399m			2	8	10
300-349m	1	5	2	6	14
250-299m	3	6	7	14	30
200-249m	2	6	5	13	26
150-199m	2	8	9	24	43
100-149m	1	6	11	20	38
50-99m	1	8	16	6	31
0-49m		3	8	2	13
Total	11	42	69	102	224

Table 5-36: House Type Relative to Distance From a Line

Distance to Line	House Type				Total
	Flat	Terraced	Semi	Detached	
550m				1	1
500-549m			4	3	7
450-499m	1		4	5	10
400-449m			2	8	10
350-399m				5	5
300-349m	2	9	6	12	29
250-299m	3	6	5	13	27
200-249m		7	7	19	35
150-199m			3	7	10
100-149m		6	8	9	23
50-99m	1	4	11	14	30
0-49m	2	10	19	6	37
Total	11	42	69	102	224

However, these data only reflected the type of house sold within the case study location and not the actual residential units built on the estate. A third table (Figure 5-15) was generated using data obtained from plot maps. The location was zoned into 50m increments measured from the centre of the HVOTL. House types within each 50m band were counted and analysed using frequency analysis. This indicated that the majority of terraced homes built on the estate was sited within 50m of the HVOTL and that flats tended to be sited within 100m of the HVOTL. Detached houses in general, were spread over a range of 50-200m range whereas, the majority of semi-detached houses were built within 150m of the HVOTL. This suggested that if developers have any concerns about the impact on value from proximate HVOTLs, they are limited to the first 50m from the HVOTL.

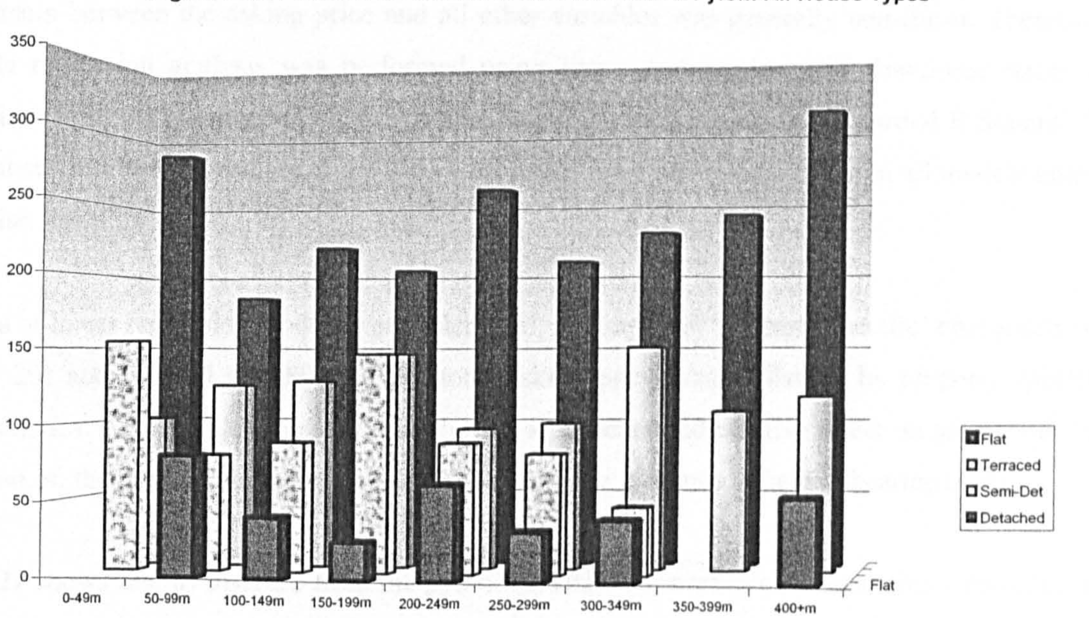
Figure 5-15: House Type in Relation to Distance from the HVOTL



	0-49	50-99	100-149	150-199	200-249	250-299	300-349
Flat	68	66	34		28	10	
Terrace	192	59	62	57	35	12	25
Semi-Detached	64	84	56	26	34	18	10
Detached	56	134	167	139	95	34	68

5.4.4.2 Plot Size: The relationship between plot size and proximity to pylon was considered to establish whether, or not, developers afford HVOTL proximate homeowners a larger plot size. Figure 5-16 suggests that detached and terraced houses sited within 50m of a pylon have larger plots than houses further away. Flats were also observed to have a larger floor area those sited elsewhere on the estate. This provided evidence to support the hypothesis that developers compensate HVOTL-proximate houses with a larger plot size as earlier research by Kinnard (1967[18] and Clarke *et al.*, 1972[19] indicated (see also Chapter Two: 2.2).

Figure 5-16: Plot Size in Relation to Distance from a Pylon: All House Types



5.4.5. Multiple Regression Analysis

Prior to developing an appropriate explanatory model to explain the relationship between asking price and property characteristics, a correlation matrix (using both Pearson's correlation coefficient and Kendall's tau-b as previously justified in 5.3.4) was calculated using aggregated data (Appendix XI[xxxii]). This showed that the variables M.LINE, M.PYL (distance in metres from the line and pylon to the centre of the building) were very highly correlated[xxxiii]. Therefore to avoid problems of multicollinearity, they were not used together in the same regression model.

In all models, one dummy variable from each dummy set was excluded for computational purposes, as justified earlier (see 5.3.4 above). In all models, the variables constructed to represent a detached house (DETACHED) sited at least 400m away from a pylon (DISTPYL9) and having no view of either pylon or line (VISPYL0, REARPYL0, FORSC, RORSC) were excluded from the equation and therefore the unstandardised coefficients (B)[xxxiv] in all models (unless expressly stated) indicates the difference in value compared to a detached house at 400m and having no view of the HVOTL.

No stratification of data took place at this stage (e.g. divided into house type) to avoid the problems of spurious results caused by an insufficient number of cases. The distribution patterns of the data

[xxxii] Appendix XI shows the correlation matrix for aggregated data. As in the correlation matrix calculated for Blackwood, the variables DISPYL0-9 and DISLINE have been excluded.

[xxxiii] For an explanation of multicollinearity see footnote xviii above.

[xxxiv] See section 5.3.4 and footnote xx above for an explanation of unstandardised coefficients (B)

had been checked earlier using scatter plots and showed, as in the Blackwood data, that the relationship between the asking price and all other variables was generally non-linear. Therefore, multiple regression analysis was performed using linear and log-linear[xxxv] functional forms to determine which form produced the best model according to the calculated Adjusted R Square[xxxvi]. Only those variables significant at the 95% confidence limit have been shown in all models unless otherwise stated.

A series of linear regression models were calculated, starting with 'property specific' characteristics (Model 20) and showed that 89% of the total asking price was explained by property specific characteristics. All variables were found to have a significant and positive effect on price, with the exception of, the presence of a garden (GARDEN) and the presence of central heating (CH).

Model 21 shows that as distance from the pylon METRPYL) increases (houses within this data set were sited between 18m - 552m from a pylon) value increased by £26.77 per metre. The same regression model was re-calculated substituting distance to the pylon with distance to the line (METRLINE). This model is not shown but indicated that a line had a slightly more negative impact on value (t=3.219, sig. =.001) Adj.R^2 .894.

The visual impact of the HVOTL was found to have no significant impact on value at the 95% confidence level. However, certain visual aspects were found to be significant at the 90% confidence level (Models 22, 23, and 24). This confidence level was therefore adopted for the rest of the analysis except where stepwise regression was used (Models 25, 26).

Models 22 and 23 show that a rear view of one pylon (REARPYL4) and a partial view of a pylon from the front of the house (VISPYL3 and VISPYL2) have a significant impact on asking price at the 90% confidence level. Although, as these models show, having a view of a pylon does not by itself, signify a reduction in value. Including the orientation of the pylon in Model 23 indicated that the position of the pylon was the key factor determining whether the visual presence of the HVOTL had a negative impact on asking price and indicated that a facing view of a pylon from either the front or rear of the house, reduced value significantly at the 90% confidence level.

The physical distance to the HVOTL (METRPYL, METRLNE) was shown to be significant in all models, although it was not clear whether this impact was linear. Recoding this variable into a new set of variables to represent distance from the HVOTL in 50m bands enabled Model 24 to show

[xxxv] See 5.3.4 for an explanation

[xxxvi] *ibid.,*

whether, or not, value increased as distance from the pylon increased (in other-words, there was a positive correlation). As the model indicates, whilst the impact on value diminishes with distance, the relationship is not linear.

Model 20: Adj.R2 .889	Coefficients	Standardised Coefficients	T	Sig.
	B	Beta		
(Constant)	61802.659		6.283	.000
FLAT	-26396.468	-.130	-3.714	.000
TERRACE	-26949.129	-.239	-6.356	.000
SEMI	-24627.384	-.258	-7.234	.000
N.BEDRM	21511.261	.457	11.178	.000
PLOTSIZE	32.428	.070	2.229	.027
PARKING	8218.410	.106	3.975	.000
NO.BATH	13483.755	.158	3.351	.001
Model 21 Adj. R2 .893				
(Constant)	59228.751		6.111	.000
FLAT	-27662.448	-.136	-3.958	.000
TERRACED	-26914.873	-.239	-6.467	.000
SEMI	-24796.621	-.260	-7.420	.000
N.BEDRM	21786.198	.463	11.520	.000
PLOTSIZE	29.479	.064	2.060	.041
PARKING	6908.083	.089	3.329	.001
NO.BATH	11824.337	.138	2.965	.003
METRPYL	26.767	.070	3.013	.003
Model 22 Adj. R2 .893				
(Constant)	50564.176		4.724	.000
FLAT	-27124.247	-.133	-3.811	.000
TERRACE	-25610.878	-.227	-5.875	.000
SEMI	-24030.119	-.252	-6.962	.000
N.BEDRM	22685.281	.482	11.507	.000
PARKING	7215.304	.093	3.400	.001
NO.BATH	11319.032	.132	2.776	.006
PLOTSIZE	30.898	.067	2.024	.044
METRPYL	40.507	.106	3.260	.001
REARPYL4	8742.728	.048	1.754	.081
VISPYL3	6422.051	.047	1.776	.077
Model 23 Adj.R2 .897				
(Constant)	57816.278		5.164	.000
FLAT	-27762.508	-.136	-3.906	.000
TERRACE	-28422.801	-.252	-6.378	.000
SEMI	-26251.695	-.275	-7.506	.000
N.BEDRM	22316.274	.475	11.024	.000
PLOTSIZE	36.625	.079	2.409	.017
PARKING	6683.708	.086	3.174	.002
GARDEN	8469.242	.048	1.748	.082
NO.BATH	11385.093	.133	2.794	.006
METRPYL	29.560	.077	2.280	.024
REARPYL4	14287.361	.079	2.476	.014
VISPYL2	6022.113	.052	1.680	.095
VISPYL3	7683.141	.056	1.929	.055
RORF	-6930.110	-.065	-1.722	.087
FORF	-7212.246	-.069	-1.853	.065
Model 24 Adj.R2 .893				
(Constant)	75310.376		6.353	.000
FLAT	-28358.663	-.139	-3.866	.000
TERRACE	-29259.291	-.259	-6.354	.000
SEMI	-27549.191	-.289	-7.523	.000

N.BEDRM	22187.053	.472	10.634	.000
PARKING	7056.321	.091	3.253	.001
GARDEN	8507.682	.048	1.668	.097
NO.BATH	12130.117	.142	2.917	.004
PLOTSIZE	38.409	.083	2.452	.015
VISPYL3	7405.393	.054	1.800	.074
REARPYL4	11650.405	.064	1.840	.067
FORF	-7884.542	-.075	-1.913	.057
DISTPYL1	-16384.337	-.087	-2.370	.019
DISTPYL2	-10617.541	-.083	-1.848	.066
DISTPYL3	-11402.043	-.097	-2.261	.025
DISTPYL4	-11110.936	-.099	-2.413	.017
DISTPYL5	-13268.015	-.097	-2.732	.007
DISTPYL6	-9059.702	-.070	-1.982	.049

Dependent Variable: VALNOW – Significant at the 90% confidence level.

Finally, three stepwise regression analyses were undertaken, first with all variables available for the data from St Peter's case study (Model 25). Stepwise regression removed all variables that were not significant at the tolerance level of 0.05% and produced the following equation:

Value = f (N.BEDRM, NO.BATH, PLOTSIZE, PARKING, SEMI, TERRACE (house type), *METRPYL, RORS, REARPYL4, e)*

Value = £57460.53 + £22455.22 x number of bedrooms, + £13526.84 x number of bathrooms + £35.69 x plot size + £6720.81 x parking + -£25404 x semi detached house + -£27809.24 x terraced house + - £31973.74 x flat + £32.95 per metre away from the pylon + £6074.83 x side view of HVOTL + £9722.23 rear view of 1 pylon + error.

Model 25 **Adj. R2 .879** **Stepwise**	Unstandardised Coefficients B	Standardised Coefficients Beta	t	Sig.
(Constant)	57460.530		7.683	.000
N.BEDRM	22455.219	.478	12.504	.000
NO.BATH	13526.836	.158	5.575	.000
PLOTSIZE	35.689	.077	2.521	.012
PARKING	6720.817	.087	3.321	.001
SEMI	-25403.996	-.266	-7.759	.000
TERRACE	-27809.240	-.247	-6.848	.000
FLAT	-31973.742	-.157	-5.155	.000
METRPYL	32.954	.086	3.649	.000
RORS	6074.826	.059	2.631	.009
REARPYL4	9722.229	.053	2.324	.021

Dependent Variable: VALNOW

Model 26 **Adj. R2 .883** **Stepwise**				
(Constant)	84615.360		10.883	.000
N.BEDRM	24942.543	.530	13.362	.000
PLOTSIZE	40.375	.088	2.730	.007

SEMI	-31022.955	-.325	-9.005	.000
TERRACE	-34127.086	-.303	-7.863	.000
FLAT	-33202.421	-.163	-5.041	.000
PARKING	6174.891	.079	2.879	.004
RORSF	-15641.233	-.099	-4.092	.000
RORF	-8401.493	-.078	-3.177	.002
FORF	-6918.888	-.066	-2.743	.007
REARPYL4	10705.538	.059	2.353	.020
RORS	6593.259	.064	2.676	.008

Dependent Variable: VALNOW

The second model only included variables available for all three valuation data sets to enable a between study comparison to be undertaken. Model 26 produced the following equation:

Value = f (N.BEDRM, PLOTSIZE, SEMI, TERRACE, FLAT, PARKING, RORSF, RORF, FORF, REARPYL4, RORS, e)

where,

Value = £84615.36 + £24942.54 x number of bedrooms, + £40,38 x plot size + -£310222.96 x semi detached house + £-34127.09 x terraced house + £-33202.42 x flat + £6174.89 x parking + £-15641.23 x a side facing view from the rear + £-8401.49 x a facing view from the rear + £-6918.89 x a facing view from the front +£10705.53 x a rear view of 1pylon + £6593.26 x a side view from the rear + error.

The same analysis was undertaken using a severely encumbered house as the benchmark for the model but this did not significantly alter the result.

The final analysis was undertaken to determine whether or not, a causal relationship existed between plot size and proximity to the HVOTL as indicated by the frequency analysis undertaken earlier. A model was developed using plot size (PLOTSIZE) as the dependent variable. However no significant relationship was observed.

5.4.6 Summary of St Peter Data

The results from the analysis of asking price data gathered for the St Peter case study indicated that, the presence of a line and pylon have a significant and negative impact on the asking price of residential units. The presence of a pylon can reduce the price of all house types, particularly if sited within 100m, by between 1% and 20%. Semi-detached houses sited within 100m of a pylon were found to be house type most negatively affected; suffering a 20% reduction in asking price compared to a similar house sited more than 250m away.

By contrast, the impact of a line on asking price was found to be more pronounced for houses situated within the first 100m. The results indicated that the degree of diminution suffered could be between 13% and 19%. Value diminution however, did not follow a linear pattern and in some cases asking price appeared to increase as the distance from the HVOTL decreased.

Previous research had suggested (Bond and Hopkins, 2000[1]) that there was little impact on value beyond a distance of 200m from either line or pylon. However, the results presented here indicated that values may be negatively affected beyond this point since asking price continued to rise at distances beyond 200m from both line and pylon.

Distance to the HVOTL was found to be significant in all regression models. Asking price was shown to increase as distance from the HVOTL increased, although this relationship was not linear. The visual impact of either line or pylon was found to be significant at the 90% confidence level, with a rear view of 1 pylon (REARPYL4) and a partial view of a pylon from the front of the house (VISPYL3 and VISPYL2) increasing the asking price. The orientation of the pylon was shown to be the key factor determining whether the visual presence of the HVOTL had a negative impact on asking price, with a facing view having a more negative impact on price than a less direct view. Frequency analysis revealed that 3 x bed semi-detached and detached houses were most negatively affected by the visual presence of a HVOTL.

Comparison Between Local, Regional and National House Price: The results were compared with a) average house prices nationally and b) the average house price for that location (see 5.3.4.4), using data provided by the National Average House Price Index and the Land Registry.[xxxvii] This showed that house values in Worcester were below the national average (-1% for semi-detached, -12% for detached, -10% for a terraced house and -45% for a flat). The mean value of all house types in St Peter suggested that house prices were lower than both the national average and Worcester in general (3% for semi-detached houses and 15% for detached). This may suggest that the presence of a HVOTL can reduce the value of all residential units in the immediate neighbourhood.

The results indicated that the impact on the asking price of a 4 x bed detached house was likely to be 2% within 49m of a pylon. Asking price for this house type rose to above the national average at a distance of 350m. The impact was found to be much greater on the asking price of a 3 x bed detached house. The asking price of this house type was found to be 13% lower than comparable houses in Worcester at a distance of 50-100m from the pylon. Values were still found to be 3% lower than regional house prices, at a distance of more than 400m from the HVOTL. By

[xxxvii] National average house prices and regional average house prices are provided by the Halifax Building Society. This data can be found on their website: www.hbosplc.com/economic/historical_data.xls and the Land Registry on www.upmystreet.com.

comparison, the value of a 3 x bed semi-detached house remained above the regional and national average, irrespective of physical proximity.

Hypothesis Testing

The hypotheses to be tested by the valuation research (see 5.3.4.4) were:

Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential units than physical proximity.

Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line.

Hypothesis 3.The results of the regression analysis indicated that physical proximity had a greater negative impact on value than the visual impact. Analysis of variance (ANOVA) confirmed this at the 0.01 confidence level. Therefore Hypothesis 3 was rejected.

	F. Value	Significance	Accept or Reject
Hypothesis 3	Distance HVOTL = 4.27 Visual HVOTL = 2.06	.000 .041	Reject

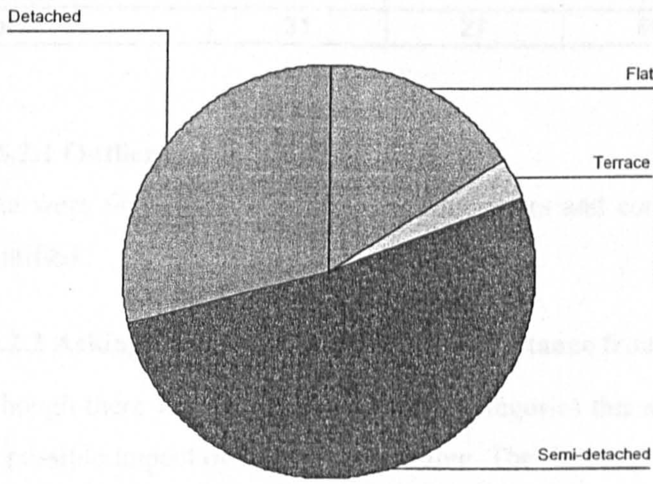
Hypothesis 4. Frequency analysis indicated that the presence of a pylon had a greater negative impact on value than a line, but a more robust test was needed to determine whether this hypothesis was true or false. This was undertaken using ANOVA, which indicated that neither variable representing a view of the line and pylon from the front of the house were significant. However, the variables representing a view of the pylon and line from the rear of the house were both highly significant (rear pylon: f value = 3.196, sig. = .005; rear line: f value = 7.834 sig. = .006). The results showed that, the impact of a pylon on asking price was slightly more significant (although the t value was much lower). As the difference between the impact of the line and pylon was marginal when the data was analysed using ANOVA, other statistical tests undertaken earlier in the analysis (for instance frequency analysis) were considered and provided support for a decision to accept Hypothesis 4 as true in this instance.

	F. Value	Significance	Accept or Reject
Hypothesis 4	Rear Pylon = 3.196 Rear Line = 7.834	.005 .006	Accept

5.5 THE ANALYSIS OF WALMLEY ASKING PRICE DATA

The values attributed to each residential unit used in this analysis are 'asking price', not transaction price (see 5.4 above and Chapter Four: 4.8 for a further explanation). These data includes all residential units advertised 'for sale' in the local property papers[xxxviii] over a period of two years[xxxix] and resulted in details of 152 mid price, mixed style, residential units. 38 units had no view of either line or pylon and 25 units had a line only view leaving 89 houses having some view of one or more pylons. Figure 5-17 shows that the majority of units in the data set were semi-detached.

Figure 5-17: House Type



	Frequency	Percent
Flat	24	15.8
Terraced	5	3.3
Semi-detached	79	52.0
Detached	44	28.9
Total	152	100.0

5.5.1 Variables Used In The Analyses

This data were based on details provided by Estate Agents and included additional 'property specific' variables that were unavailable for Blackwood's data. Therefore, in addition to the variables shown in Table 5-1 above (5.1.2.1), the following variables (Table 5-37) were included in the analysis.

Table 5-37: Additional Property Specific Variables

Variable Name	Variable Type	Explanation of Values
N.BATH	*Measurement*	Number of Bath / shower rooms including en-suite.
N.TOIL	*Measurement*	Number of toilets
GARDEN	*Dummy*	Presence of a rear garden
CH	*Dummy*	Central heating

[xxxviii] The Sutton Coldfield Observer and The Worcester Times (Thursday edition).

[xxxix] Unlike property transaction prices from the Blackwood location, it was not possible to collect historic data over a number of years. Therefore these data were collected during a two year period.

5.5.2 Analysis

The analysis following the same procedure used above to analyse data from Blackwood and St Peter (see 5.2.2, 5.3 and 5.4). As there were only 152 cases, data were aggregated and a variable created (VALNOW) to represent the relative value of each case as of the first quarter of 2003[xl]. Data were then subdivided into different house types for further analysis (Table 5-38).

Table 5-38: Breakdown of House Type

House Type	Number of Bedrooms					Total
	1 Bed	2 Bed	3 Bed	4 Bed	5 Bed	
Flat	20	4				24
Terraced	1	1	3			5
Semi-detached	10	21	48			79
Detached		1	15	24	4	44
Total	31	27	66	61	4	152

5.5.2.1 Outliers

Data were first checked for any entering errors and corrected where necessary. No outliers were identified.

5.5.2.2 Asking Price Relative to Physical Distance from a HVOTL

Although there were few cases in many categories this analysis would provide some indication of the possible impact of a HVOTL on value. The first test was a comparison of the mean value of all house types in relation to physical distance from the pylon (Table 5-39). This revealed that the asking price for detached houses, semi-detached houses and flats was lower than similar units sited further away on the estate. The relationship is not linear as Figures 5-18 and 5-19 show, but does indicate that units within 100m of a pylon can suffer up to an 18% reduction in asking price (4 x bed detached house = 18%; 3 x bed detached house = 14%; 1 x bed semi-detached = 15%) compared to similar units sited 400m away. The negative impact on the asking price of a flat within 50m of a pylon was found to be greater, reducing value by up to 42% compared to a similar unit sited 200m away from a pylon.

Proximity to the line was found to have less impact on asking price than proximity to a pylon. This difference was in the region of 8 to 10%. Asking prices generally increased as distance from the HVOTL increased until reaching a threshold of 200-250m (Figures 5-20 and 5-21). Prices then either leveled out, or fell. Interestingly, a more obvious feature of data obtained from this location was the fact that 35 units were sited within 49m of the line, compared to only 7 within 49m of a

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[xl] VALNOW was calculated using the relevant inflation multiple obtained from the Halifax House Price Index.

pylon. This perhaps, indicated that developers considered the line had less impact than a pylon on the value of residential units (Table 5-39 and 5-40).

Table 5-39: Impact of a Pylon on the Mean Value of Different House Types

House Type	>49m	50-99m	100-149m	150-199m	200-249	250-299	300-349	350-399	<400
4 bed-det		207230.6	244973.8	277851.8	255416.3	225503.1	274892.1	238940.8	250474.6
No. Cases	-	3	4	4	3	2	2	3	3
Std D		24446.07	51601.11	106281.5	33677.3	19437.5	59465.7	15760.57	44916.69
3 bed-det	186787.4	207705.6	188040.8	131419.7	184942.7	201530.1	209222.7	181585.1	215428.2
No. Cases	1	1	3	1	1	4	1	1	2
Std D			2405.6			28125.84			4076.54
3 bed-semi	158241.9	147498.1	152353.3	157779.9	171501.1	154681.6	151420.3	159823.8	142560.9
No. Cases	2	13	5	8	3	6	4	5	2
Std. D	1001.476	20200.94	19821.75	14394.17	4895.07	11793.44	5431.526	3482.06	7897.11
2 bed-semi	135626.8	131834.3	135198.3	125278.0	131558.2		112872.2	116420.1	
No. Cases	1	7	4	3	4	-	1	1	-
Std. D	-	7656.78	23230.7	14642.14	9073.406		-	-	
1 bed-semi		91061.26	91602.26	107010.6					
No. Cases	-	3	5	2	-	-	-	-	-
Std. D		1035.83	1750.44	4586.8					
Terraced	178090.4	139786.2	120819.6	153292					
No. Cases	1	1	2	1	-	-	-	-	-
Std. D	-	-	31417.36	-					
Flat	60320.59	79339.03	76899.95	103653.8	88115.48				
No. Cases	2	3	11	2	6	-	-	-	-
Std. D	524.08	13608.28	15624.6	30117.32	26166.77				
Total No. of each house type	7	31	34	21	17	12	8	10	7

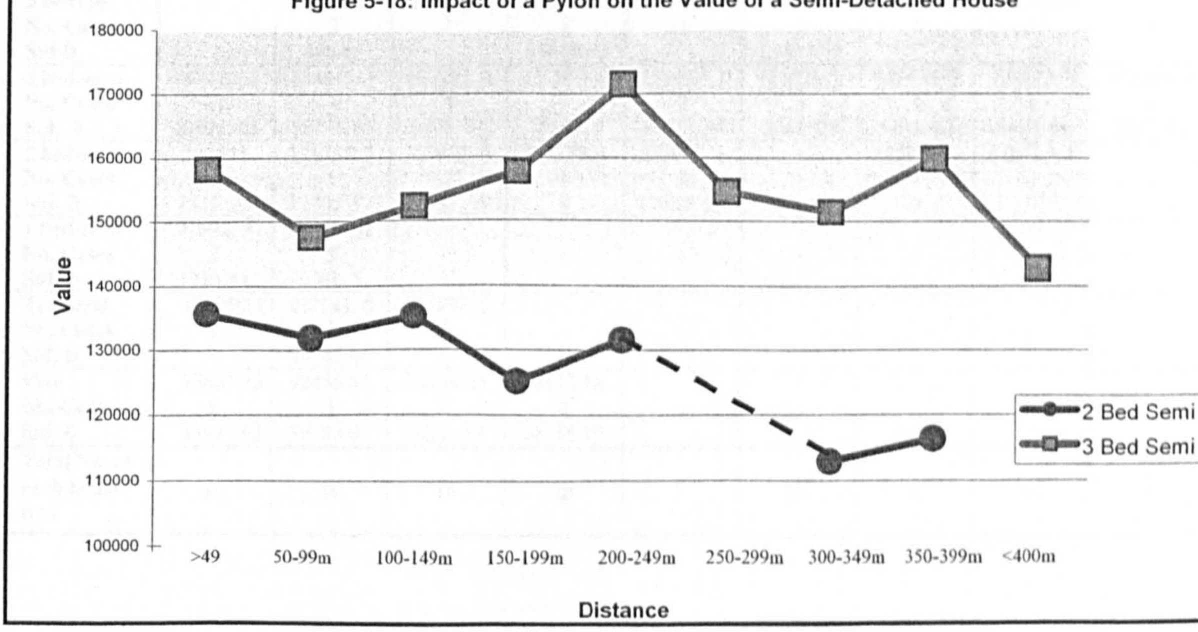


Figure 5-18: Impact of a Pylon on the Value of a Semi-Detached House

Figure 5-19: Impact of a Pylon on the Value of a Detached House

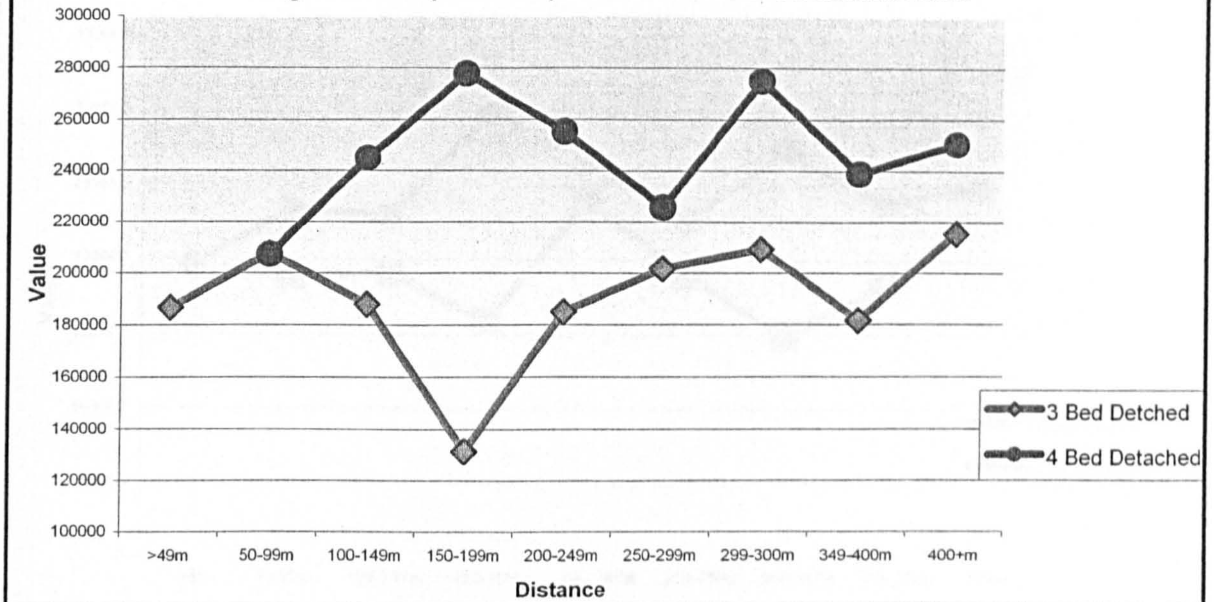
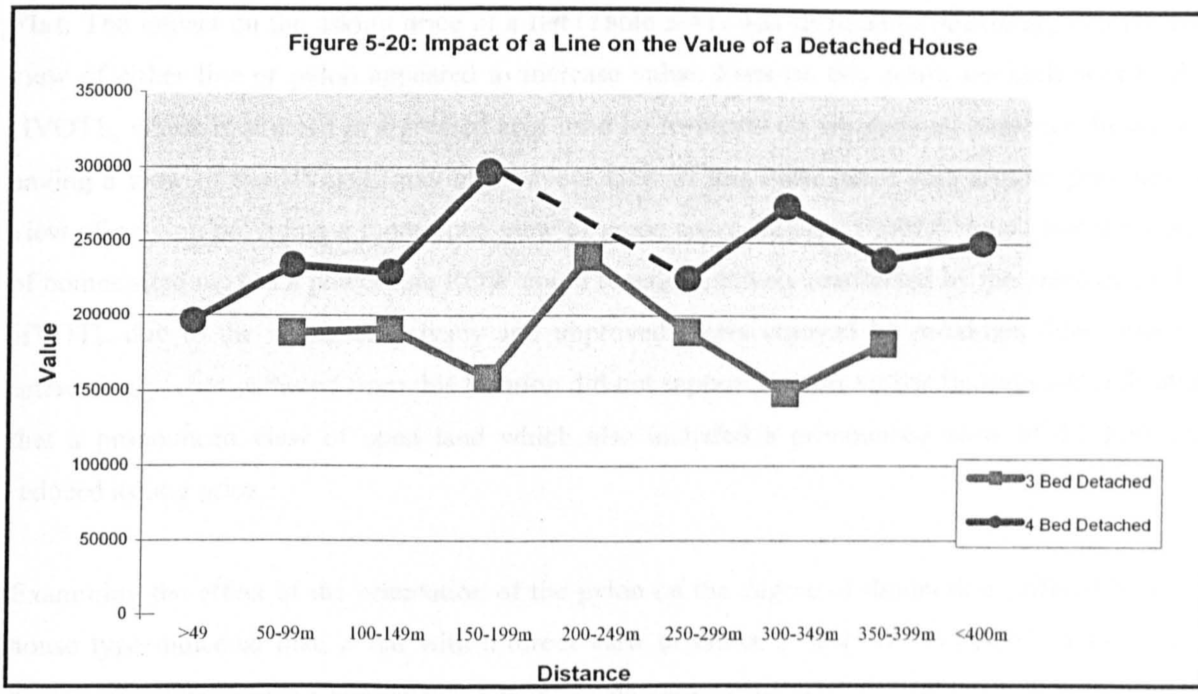
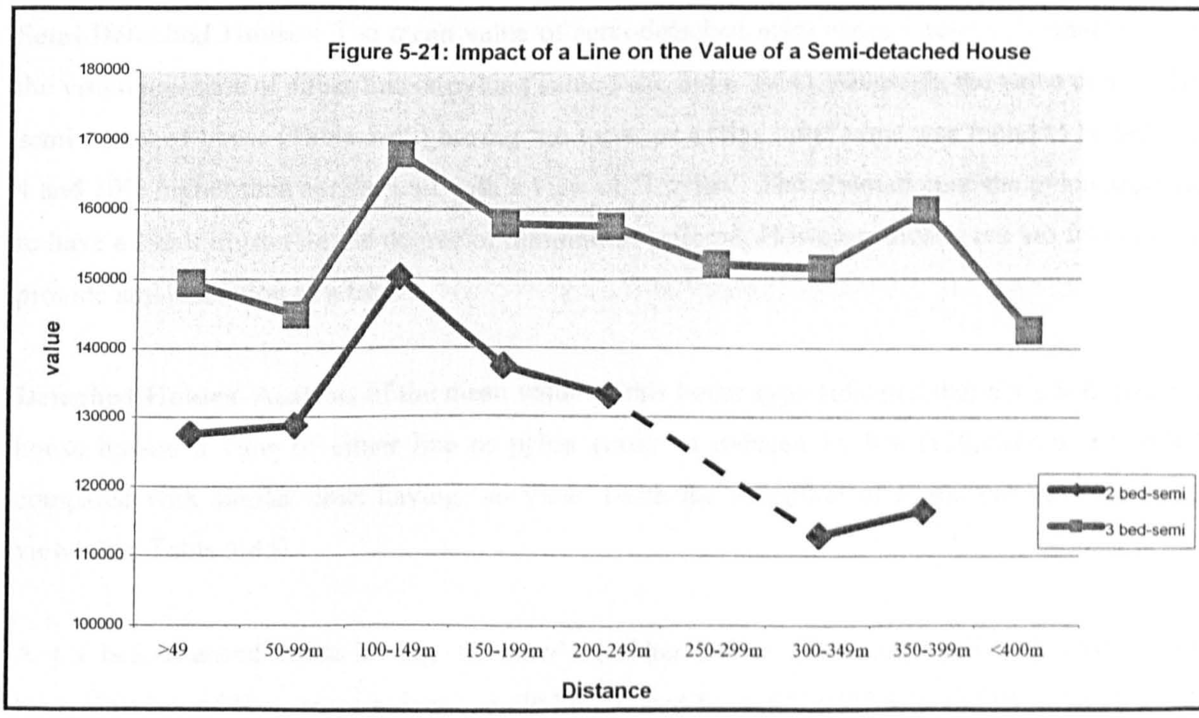


Table 5-40: Impact of a Line on the Mean Value of Different House Types

House Type	>49m	50-99	100-149	150-199	200-249	250-299	300-349	350-399	<400
4 bed-det	196542.5	234174.1	229310.2	297431.4		225503.1	274892.1	238984.8	250474.6
No. Cases	1	6	3	4	-	2	2	3	3
Std D		45632.38	21692.86	96819.7		19437.52	59465.7	15760.57	44916.69
3 bed-det		186665.0	190792.3	158181.2	239760.8	188786.5	148106.8	181585.1	
No. Cases	-	2	1	2	1	3	1	1	-
Std D		466.65		37846.48		14567.19			
3 bed-semi	149475. 5	144845. 1	167971. 4	157903. 3	157437. 2	151926. 0	151420. 3	159823. 8	142560. 9
No. Cases	11	7	6	7	3	3	4	5	2
Std. D	20495. 83	15792. 95	8705. 31	15542. 9	16122. 94	8061. 25	5431. 52	3482. 06	7897. 11
2 bed-semi	127571	128758. 3	150295. 6	137338. 1	133013. 1		112872. 2	116420. 1	
No. Cases	8	5	2	1	3	-	1	1	-
Std. D	7335. 85	12463. 97	26587. 99	0	10525. 93		0	0	
1 bed-semi	91692. 9	97441. 02							
No. Cases	5	5	-	-	-	-	-	-	-
Std. D	1750.44	9061. 5							
Terraced	178090.4	127141. 8	153292. 5						
No. Cases	1	3	1	-	-	-	-	-	-
Std. D	-	24767.64	-						
Flat	78631.63	92458.67	71134.13	88115.48					
No. Cases	9	3	6	6	-	-	-	-	-
Std. D	13935.63	30783.66	16226.94	26166.77					
Total No. of each house type	**35**	**31**	**19**	**20**	**7**	**8**	**8**	**10**	**5**





5.5.2.3 Asking Price Relative to the Visual Impact from the Presence of a HVOTL

The visual impact of both line and pylon was measured using the established process of data gathering (see 5.1.2.1 and figure 5-1). Views from the rear of the unit were estimated where required. The measurements were then analysed to determine whether or not the visual presence or the orientation of either line or pylon had a measurable impact on asking price. Each house type was examined in isolation, with the exception of house types with very small case numbers.

Flat: The impact on the asking price of a flat (Table 5-41) was difficult to determine, as a limited view of either line or pylon appeared to increase value. Flats on this estate are built next to the HVOTL, which is situated in a grassed area used by residents for recreational purposes. Residents having a view of the HVOTL may also have a view of this open space with a more pronounced view of a pylon providing a more open view of green space. Rosiers (2002)[13] found that the value of homes sited next to a power line ROW could remain relatively unaffected by the presence of the HVOTL due to the increased privacy and improved views enjoyed by proximate homeowners. Interestingly, data gathered from this location did not support Rosiers earlier findings and indicated that a pronounced view of open land which also included a pronounced view of the HVOTL reduced asking price.

Examining the effect of the orientation of the pylon on the degree of diminution suffered by each house type indicated that, a flat with a direct view of either a 'line' or '½ pylon' could have a higher asking price than a similar unit having a side view of the HVOTL. However, there were too few cases to determine whether this indicated a trend associated with this house type.

Semi-Detached Houses: The mean value of semi-detached units appears relatively unaffected by the visual presence of either line or pylon (Table 5-42, 5-43, 5-44). Although, the value of a 1 x bed semi-detached house (Table 5-42) having 'no view' or a 'line only' view was found to be between 4 and 10% higher than similar unit with a view of '1 pylon'. The orientation of the pylon appeared to have a small impact on the degree of diminution suffered. However, there were too few cases to provide any indication of a trend.

Detached Houses: Analysis of the mean value of this house type indicated that a 3 x bed detached house having a view of either line or pylon could be reduced by 9% (£20,4648 to £18,6787) compared with similar units having 'no view' (with the exception of a unit having a '¾ pylon view'. See Table 5-45)

A 4 x bed detached house having 'no view' of either line or pylon compared with similar units having a view of '2 or more pylons', could be reduced from £24,6707.8 to £18,9947.9 (23%). By contrast, a '½ pylon' view was found to increase value by 7% (2 cases) (see Table 5-46).
There was no obvious pattern to the degree of diminution suffered by detached units in relation to the position of the line or pylon.

Rear View: Looking at the impact of a line or pylon visible from the rear of a house on the mean value of each house type indicated that the asking price of a flat having a rear view of a line or pylon was reduced by between 12% and 31%. The orientation of the line affected the degree of diminution suffered, with units having a more direct view suffering from greater value diminution (Table 5-47). Orientation was also observed to have a negative impact on the asking price of a 1 x bed semi detached house, particularly if the unit had a more direct view of either line or pylon (Table 5-48). By contrast, the asking price of all 2 x bed semi-detached houses with any view of either line or pylon was found to be reduced by at least 6% compared to similar houses having 'no view' (Table 5-49).

The available data suggested that the asking price of a 3 x bed semi-detached house may be affected by either line or pylon, although any negative impact was limited to units having a line only view or partial view of a pylon. Units with a more pronounced view of a pylon were unaffected. There were however, too few examples to provide any reliable evidence of a trend (Table 5-50).

The impact on a 3 x bed detached unit was difficult to determine due once again to the small number of cases. Table 5-51 suggests that having a 'line only' or a '½ pylon' view has a negative impact on this house type. By contrast, a more pronounced view of a pylon was found to increase value. The orientation of either line or pylon was shown to affect the degree of value diminution suffered. This suggested that a more direct view of the pylon caused greater diminution.

The asking price of a 4 x bed detached house (Table 5-52) with 'no view' of either line or pylon was found to be 12% and 28% higher than a similar unit with either a slight or a more pronounced view of a pylon. Having a more direct view of a pylon also increased the negative impact on value. For example; a house with a screened view of 1 pylon was on the market at £255,115 compared to £211,676 for the same house type with a direct view.

Table 5-41: Front View - Impact of a Line and Pylon Visible from the Front of a Flat

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	6	74123.59			
Line only	7	83575.4	Side	81515.27	6
			Facing	93876.08	1
¼ pylon	1	82979.51	Side	82979.51	1
½ pylon	5	61709.26	Side	54530.6	4
			Facing	81819.4	1
1 pylon	2	73141.15	Side	73141.15	2

Table 5-42: Front View - Impact of Line and Pylon Visible from the Front of a 1 x Bed Semi-Detached House

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	5	93916.45			
Line only	1	110254.1	Side	110254.1	1
½ pylon	2	92091.9	Side	920950.0	1
			Side front	91233.8	1
1 pylon	2	90975.0	Side Front	90975.0	2

Table 5-43: Front View - Impact of a Pylon Visible from the Front of a 2 x Bed Semi-Detached House

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	5	125666.3			
Line only	1	120531.4	Side	120531.4	1
¼ pylon	4	125874.9	Side	119248	2
			Facing	132501.8	2
½ pylon	3	129501.3	Side	134416.6	2
			Facing	125112.8	1
1 pylon	5	137858.9	Side	125112.8	2
			Side Front	169096.1	1
			Facing	134986.6	2
2 pylon	3	133486.4	Side	133486.4	3

Table 5-44: Front View - Impact of a Pylon Visible from the front of a 3 x Bedroom Semi-Detached House

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	12	156026.5			
Line only	12	156878.0	Side	161967.2	3
			Side Front	165733.1	5
			Facing	141982	4
¼ pylon	5	155962	Side	158715.1	4
			Facing	144950	1
½ pylon	4	163243.7	Side	158505.3	3
			Side Front	177458.9	1
¾ pylon	7	141832.6	Screen	168582.8	1
			Side	135614.3	1
			Facing	137726.2	5
1 pylon	3	140260.8	Side	157533.7	1
			Side front	131692.1	1
			Facing	131556.6	1
2 pylon	5	157611.9	Side	164102	4
			Side Front	131651.9	1

Table 5-45: Front View - Impact of a Pylon Visible from the Front of a 3 x Bedroom Detached House

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	6	204648.1			
Line only	3	187576.7	Screened	184942.9	1
			Side Front	186995	1
			Facing	190792.3	1
¼ pylon	3	177105.2	Screened	199947.9	2
			Facing	131419.7	1
¾ pylon	1	207705.6	Side	207705.6	1
1 pylon	1	186335.1	Facing	186335.1	1
1+ pylon	1	186787.4	Side	186787.4	1

Table 5-46: Front View - Impact of a Pylon Visible from the Front of a 4 x Bedroom Detached House

Visual impact FRONT	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	10	246707.8			
Line only	5	237125.6	Screened	238126.9	2
			Side	236458.1	3
¼ pylon	3	245415.2	Side	248499	2
			Side front	239249.5	1
½ pylon	2	262598.3	Side front	262598.3	2
1 pylon	2	204109.6	Side	196542.5	1
			Side front	211676.7	1
1+ pylon	1	236096.7	Side front	236096.7	1
2+ pylon	2	189947.9	Facing	189947.9	2

Table 5-47: Rear View - Impact of a line and Pylon Visible from the Rear of a Flat

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	12	79740.5			
Line only	1	62627.7	Side	62627.7	1
1 pylon	5	70605.6	Side	71153.8	2
			Facing	70240.21	3
1+ pylon	2	55729.89	Facing	55729.89	2

Table 5-48: Rear View - Impact of Line and Pylon Visible from the Rear of a 1 x Bed Semi-Detached House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	5	93916.45			
Line only	1	110254.1	Side	110254.1	1
¼ pylon	4	91345.84	Side	92091.9	2
			Facing	90599.79	2

Table 5-49: Rear View - Impact of Line and Pylon Visible from the Rear of a 2 x Bed Semi-Detached House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	13	133633.1			
Line only	2	115309.5	Screened	108986.0	1
			Side	121432.9	1
¼ pylon	1	119670.8	Side	119670.8	1
¾ pylon	1	129509.3	Side	129509.3	1
1 pylon	1	132501.8	Side	132501.8	1
1+ pylon	1	131495	Facing	131495	1
2+ pylon	2	117291.5	Side front	117291.5	1
			Facing	131495	1

Table 5-50: Rear View - Impact of Line and Pylon Visible from the Rear of a 3 x Bed Semi-Detached House

Visual impact REAR	No., cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	32	155442.7			
Line only	10	148374.1	Screened	178954.4	2
			Side	141892.5	8
½ pylon	2	132444.4	Side	132444.4	2
1 pylon	2	160312.8	Side	185011.2	1
			Facing	135611.2	1
2 pylon	2	172942	Facing	172942.0	2

Table 5-51: Rear View - Impact of a Line and Pylon Visible from the Rear of a 3 x bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	12	198070.8			
Line only	1	131419.7	Side	131419.7	1
½ pylon	1	186787.4	Screened	186787.4	1
2+ pylon	1	207705.6	Screened	207705.6	1

Table 5-52: Rear View - Impact of a Line and Pylon Visible from the Rear of a 4 x Bed Detached House

Visual impact REAR	No., Cases	Mean Value £	Position of Pylon/line	Mean Value £	No., cases
No line/ no pylon	13	262799.5			
¼ pylon	4	234809.3	Screened	234809.3	4
¾ pylon	1	196542.5	Facing	196542.5	1
1 pylon	2	233396.1	Screened	255115.5	1
			Facing	211676.7	1
1+ pylon	1	310000.1	Side	310000	1
2+ pylon	1	189947	Side Front	189947	1

5.5.3 House Type and Plot Size Relative to Proximity to HVOTL

Two final tests were conducted to determine whether there was any evidence to suggest that proximity to a HVOTL influences either the type of residential unit built or plot size.

5.5.3.1 House Type: Analysing sales data (Table 5-53 and 5-54) indicated that developers did not differential between the type of unit built near the HVOTL and that, built further away.

This data, however only reflected the type of unit sold within the case study location and not the actual unit built. A third table was produced (Figure 5-22), using data obtained from plot maps and counting house type within each 50m band from the HVOTL[xli]. This showed that detached and semi-detached houses were generally built over 400m away from the HVOTL. By contrast, the majority of terraced houses were sited within 100m of the HVOTL. Three apartment blocks sited within the ranged of 100-150m from the HVOTL were identified as social housing which supported the theory that developers site low cost housing nearest the HVOTL (see Chapter Two: 2.7.2; Chapter Three 3.4.3; Chapter Four: 4.4.5; and 4.9.1.4).

5.5.3.2 Plot Size: The relationship between plot size and proximity to the pylon was considered, to determine whether any evidence existed to support the theory that developers compensated HVOTL proximate home owners by giving them a larger plot size (Figure 5-23).

The results confirmed that terraced and semi detached homes within 50m of the pylon had, on average, larger plot sizes than similar units sited further away from the line. By comparison, detached homes closest to the HVOTL was found to have a smaller than average plot size. Interestingly Figure 5:23 also shows that the area of a flat increased with distance from the HVOTL.

Table 5-53: House Types in Relation to Distance From a Pylon

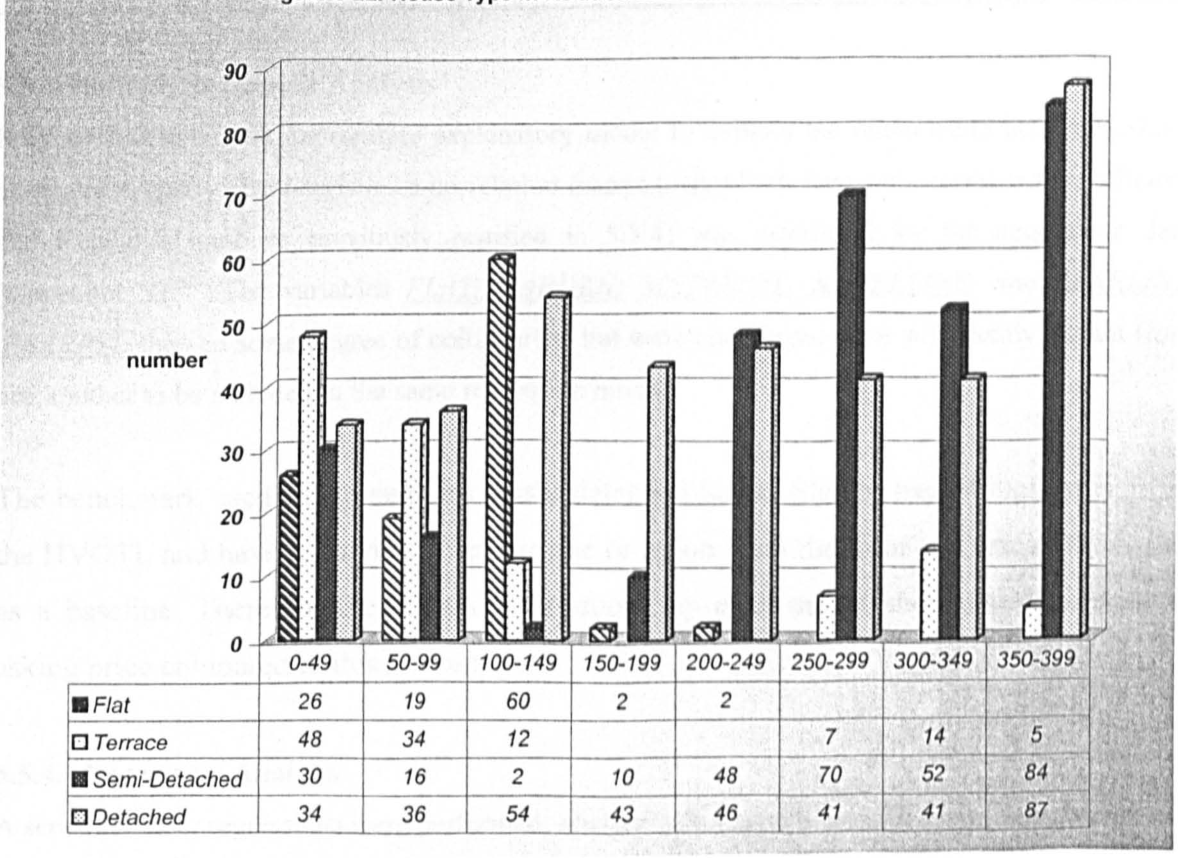
Distance Pylon	Flat	Terraced	Semi-detached	Detached	Total
500+m			2		2
450-499m				2	2
400-449m				3	3
330-399m			6	4	10
300-349m			5	3	8
250-299m			6	8	14
200-249m	6	1	7	4	18
150-199m	2		13	6	21
100-149m	11	2	14	9	36
50-99m	3	1	23	4	31
0-49m	2	1	3	1	7
Total	24	5	79	44	152

[xli] As undertaken in the previous two case studies.

Table 5-54: House Type in Relation to Distance From a Line

Distance Line	Flat	Terraced	Semi-detached	Detached	Total
500=+m			2		2
450-499m				2	2
400-449m				3	3
330-399m			6	4	10
300-349m			5	3	8
250-299m			3	6	9
200-249m	6	1	6	2	15
150-199m			8	6	14
100-149m	6		8	4	18
50-99m	3	3	17	11	34
0-49m	9	1	24	3	37
Total	24	5	79	44	152

Figure 5-22: House Type in Relation to Distance from the HVOTL



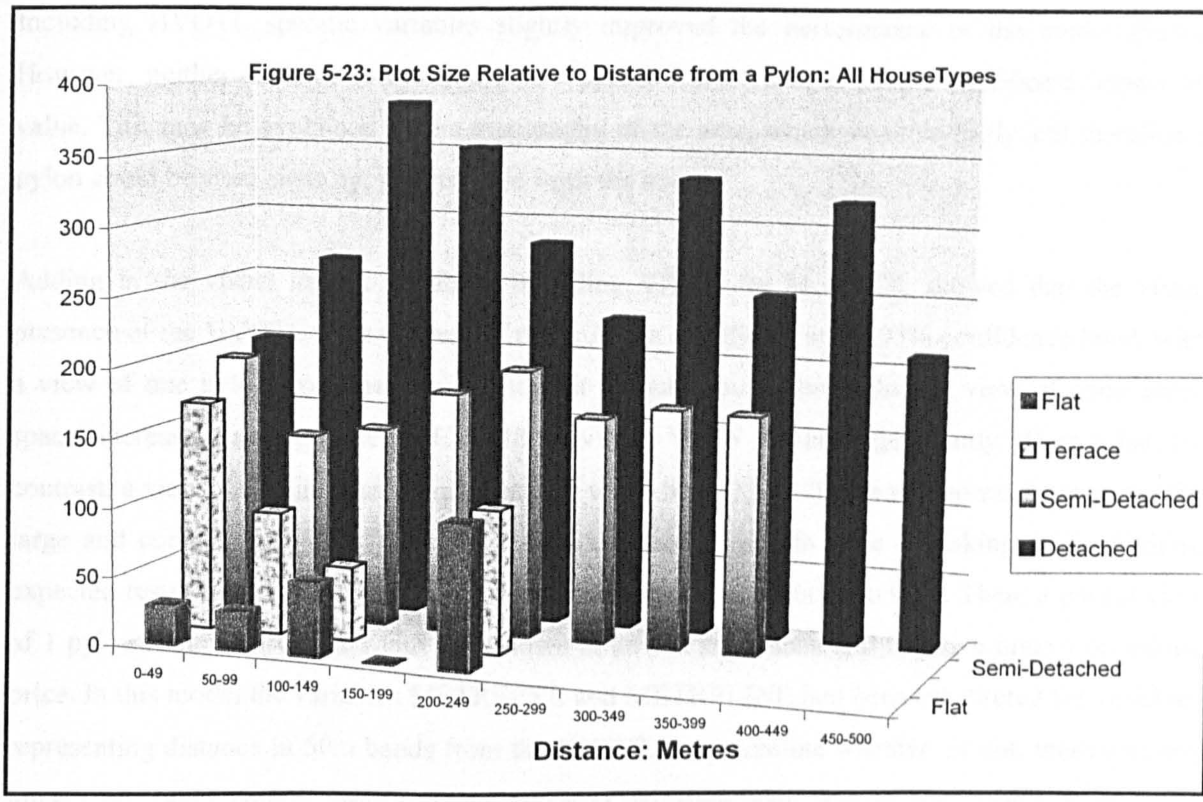


Figure 5-23: Plot Size Relative to Distance from a Pylon: All HouseTypes

5.5.4 Multiple Regression Analysis

Prior to developing an appropriate explanatory model to explain the relationship between asking price and property characteristics a correlation matrix (using both Pearson's correlation coefficient and Kendall's tau-b as previously justified in 5.3.4) was calculated for the aggregated data (Appendix XII[xlii]).The variables FLAT, GARDEN; METREPYL, METRELINE; and REARLINE ,REARPYL showed some degree of collinearity, but were considered to be sufficiently distant from one another to be included in the same regression model.

The benchmark used in the analysis was a detached house sited at least 400m away from the HVOTL and having no view of either line or pylon from the front and rear of the house as a baseline. Therefore the equations produced by each model show the difference in asking price compared to this house type.

5.5.4.1 Regression Analysis

A series of linear regressions were performed, starting with property specific characteristics (Model 27) that explained 92% of the total house price. Only house type, number of toilets and plotsize were found to have a significant impact on asking price.

[xlii] Appendix XII shows the correlation matrix for aggregated data. As in the correlation matrix calculated for data gathered from Blackwood and St Peter, the variables DISPYL0-9 and DISLINE have been excluded.

Including HVOTL specific variables slightly improved the performance of the model (93%). However, neither distance to the line or the pylon, were found to have a significant impact on value. This may be explained by the topography of the area, which was very hilly and therefore a pylon could be sited close by, yet invisible from the house.

Adding in the visual impact variables, including VIEW, for Model 28, showed that the visual presence of the HVOTL from the rear of the unit was significant at the 95% confidence level, with a view of one pylon from the rear of the unit (which would also include a view of open green space) increasing asking price by £24,448. Having a VIEW did not significantly affect value. By contrast, a view of the line was found to reduce value by £17,564. There was no explanation for the large and contrasting impact these two variables were shown to have on asking price. A more expected result was achieved when the confidence level was reduced to 90%. Then, a partial view of 1 pylon from the front of a unit was shown to have a significant and negative impact on asking price. In this model the variables METREPYL and METRELINE had been substituted for variables representing distance in 50m bands from the HVOTL, to determine whether, or not, there was any impact on value within specific zones however no significant impact was found at the 90% confidence level.

Model 27 **Adj. R2 .922**	Unstandardised Coefficients	Standardised Coefficients	t	Sig.
	B	Beta		
(Constant)	60462.853		5.015	.000
FLAT	-35397.674	-.197	-3.861	.000
SEMI	-19268.141	-.147	-3.470	.001
BUNGALOW	19452.353	.047	1.839	.068
BEDROOM	22504.536	.362	7.585	.000
N.TOIL	16903.899	.176	4.115	.000
PLOTSIZE	217.420	.420	11.144	.000
		Model 28 **Adj. R2 .930**		
(Constant)	54018.404		4.180	.000
FLAT	-35758.300	-.199	-3.820	.000
SEMI	-16289.890	-.124	-2.810	.006
BEDROOM	23225.149	.374	7.499	.000
N.TOIL	17067.289	.178	4.070	.000
PLOTSIZE	204.720	.396	9.775	.000
VISPYL1	-10698.651	-.050	-1.960	.052
VISPYL3	-12907.091	-.044	-1.680	.095
REAPLY4	24447.706	.104	3.409	.001
REARLINE	-17563.524	-.128	-3.307	.001
		Model 29 **Adj. R2 .923**		
(Constant)	52764.643		3.577	.001
FLAT	-30501.877	-.170	-3.157	.002
SEMI	-13135.817	-.100	-2.214	.029
BEDROOM	22779.141	.367	6.890	.000
N.TOIL	15934.141	.166	3.257	.001
PLOTSIZE	207.109	.400	8.395	.000
VISPYL5	30899.153	.054	1.837	.069
REAPLY4	22374.809	.095	2.536	.013
REARLINE	-23641.321	-.172	-2.624	.010

Two stepwise regression analyses were undertaken which, as previously defined in 5.2.1 removed all variables that were not significant at the tolerance level of 0.05. All variables available for the Walmley case study were entered into the regression model (Model 30) and showed that having a facing view of the HVOTL or any view of the line from the rear of the unit, reduced asking price. The following equation was produced:

Value = f (PLOTSIZE, N.BEDRM, N.TOIL, FORF, BUNGALOW, REARLINE, DISTPYL6, VISPYL5, e)

Value = 23314.25 + 227.24 x plot size, + 25041.31 x number of bathrooms, + 21787.88 x number of toilets, + -15559.96 front facing view of the HVOTL + 205021.4 x house type, + -7429.89 x rear view of the line + 11482.86 x sited in the 250m to 300m zone, + 28452.24 x a front view of more than 1 pylon

Using only those variables available for all three case studies reduced the number of significant variables (Model 31). This was also found to lower the performance of the model slightly from 93% to 92%. A stepwise tool was used for the analysis and showed that, whilst a view of more than 1 pylon from the front of the unit (which would also include a view of open green space) increased asking price by £36428, having a direct (facing) view of the HVOTL from the front of the unit would reduce value by £17821. The model produced this equation to enable a between case comparison of the results:

Value = f (PLOTSIZE, N.BEDRM, SEMI, FLAT, F.OR, VISPYL5, e)

where,

Value = £74418.485 + 246.595 x plot size + £23221.834 x number of bedrooms + £-27700.514 x semi detached house + £-33599.510 x flat + £-17821.183 front facing view of the HVOTL + £36428.112 x a front view of more than 1 pylon + error.

Model 30 **Adj. R2 .927**	Unstandardised Coefficients	Standardised Coefficients	t	Sig.
	B	Beta		
(Constant)	23314.245		5.242	.000
PLOTSIZE	227.235	.439	12.257	.000
BEDROOM	25041.308	.403	11.483	.000
N.TOIL	21787.879	.227	7.597	.000
FORF	-15559.964	-.088	-3.818	.000
BUNGALOW	25021.937	.061	2.663	.009
REARLINE	-7429.891	-.054	-2.404	.018
DISPYL6	11482.861	.051	2.122	.036
VISPYL5	28452.242	.049	2.067	.041
Model 31 **Adj.R2 .917**				
(Constant)	74418.485		8.846	.000

PLOTSIZE	246.595	.477	13.145	.000
BEDROOM	23221.834	.374	8.706	.000
SEMI	-27700.514	-.211	-6.401	.000
FLAT	-33599.510	-.187	-4.672	.000
FORF	-17821.183	-.101	-4.181	.000
VISPYL5	36428.112	.063	2.501	.013

Dependent Variable: VALNOW

Model 32 **Adj R^2.728**	Unstandardized Coefficients	Standardized Coefficients	t	Sig.
	B	Beta		
TERRACE	-97.543	-.137	-2.583	.011
BEDROOM	39.295	.327	3.285	.001
PARKING	41.632	.210	2.952	.004
VISPYL5	273.735	.246	4.624	.000
REARPYL2	-145.704	-.205	-3.468	.001
REARPYL5	165.460	.209	3.339	.001
RORSF	157.921	.222	3.402	.001
DISTPYL4	66.407	.181	1.933	.051

Dependent Variable: PLOTSIZE

One final regression model was calculated to determine whether there was a causal relationship between distance from the pylon and the plot size of a unit. The results showed that only units sited within ranges of 150 and 199m from a pylon had a larger plot than similar units sited elsewhere on the estate.

5.5.5 Summary of the Walmley Data

Despite the small number of cases within each category analysis of these data indicated that the visual presence of the HVOTL had a more significant impact on asking price than physical distance from either line or pylon. The visual presence of a pylon was found to reduce the value of a detached house by as much as 23% and up to 10% for a semi-detached house having a view of one pylon. A rear view of a pylon had an even more negative impact reducing asking price by up to 31%, depending on the orientation of the pylon (more direct view had a more pronounced negative impact on value). Regression analysis showed the visible presence of a line at the rear of a unit had a significant and negative impact on asking price and in addition, the orientation of the HVOTL was a significant factor in the degree of diminution suffered by all units. The house type most negatively affected was a flat, with asking price reduced by up to 31% if the flat had a rear view of a pylon.

House Type: Looking at the type of house built on the estate in relation to proximity to the HVOTL, revealed that low cost housing (flats and terraced houses) were frequently sited within 150m of the line. Whereas, semi-detached houses, in general, were sited at distances greater than 200m from the HVOTL. Detached houses were fairly evenly spread over the estate.

Comparison Between Local Regional and National House Prices: A comparison was undertaken between the mean value[xliii] (asking price) for different house types and a) the average house price nationally and b) the average house price for that region as indicated by the Land Registry (see 5.3.4). This indicated that the asking price for all house types in Walmley were much higher than either national or regional house prices, with the exception of a flat. Local agents indicated that units within this location are in high demand (Paul Carr Estate Agents; Greens Estate Agents), due to desirability of the locality, in addition to the close proximity to schools, shops, leisure facilities, transport networks and countryside.

Hypothesis Testing

The hypotheses to be tested by the valuation research (see 5.3.4.4) were:

Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential property than physical proximity.

Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line.

Hypothesis 3 The results of the regression analysis indicated that the visual presence of a line at the rear of a house had a slightly more negative impact on value than the physical proximity of the HVOTL. Further tests using ANOVA produced a somewhat different result which showed that there was only a slight difference between impact on asking price from the physical distance to the HVOTL and the visual presence of the either line or pylon. Based on the f. score obtained from ANOVA, Hypothesis 3 was rejected.

	F. Value	Significance	Accept or Reject
Hypothesis 3	Distance HVOTL = 2.122 Visual Pylon = 2.067	.036 .041	Reject

Hypothesis 4 Regression analyses only showed a significant relationship between a reduction in asking price and the visual presence of a line at the rear of a house. By contrast, a pylon at the rear of the house was observed to increase asking price. The reason for this is unknown. Further tests using ANOVA did not identify a significant relationship between value and the visual presence of either a line or a pylon. However, the F. scores indicated that the impact of a pylon on asking price was slightly more significant. Therefore Hypothesis 4 was accepted.

	F. Value	Significance	Accept or Reject
Hypothesis 4	Pylon = .233 Line = .002	.792 .998	Accept

[xliii] National and Regional house price data was provided by the Halifax Building Society which can be found on their website: www.hbosplc.com/economic/historical_data.xls and the Land Registry on www:upmystreet.com

In this case study the most important factor with regard to the degree of influence the HVOTL had on asking price was the orientation of the HVOTL from the front of the unit. This factor was not tested by the hypotheses.

5.6 CONCLUSION OF THE CHAPTER

The primary function of gathering and analysing data, referred to as valuation data (transaction price and asking price) was to achieve research Objective 6 (to establish the impact of the presence of a HVOTL on house prices in the UK), Objective 3 (to determine whether there is a measurable correlation between the physical distance of HVOTLs and value and visual encumbrance and value), and test Hypotheses 3[xliv] and 4[xlv] stated in Chapter One: 1.5. The results would provide the data necessary to a) establish the degree to which attitudes can be relied upon to provide an accurate determination of the value of residential units in close proximity to HVOTLs and b) establish a set of criteria for measuring the likely impact on the value of residential, thus achieving research Objectives 4 and 5.

Blackwood data provided the benchmark for the research as the results from these analyses are based on transaction price, not asking price (see 5.3). Where necessary, the transaction price or asking price, were adjusted using inflation index multiples to enable data to be aggregated[xlvi]. The mean values of each house type were then compared with data from the Scottish House Price Index (available with kind permission from the University of Paisley, Scotland) and the National House Price Index for England (available from The Halifax and Nationwide Building Society, see 5.3.4.4; 5.4.6; 5.5.5; also footnote xliii) indicating that, in addition to some regional variations, house prices in Scotland were much lower than the national average (Table 5-55).

Table 5- 55: Mean Value of all House Types

Data Source	Flat	Terraced	Semi-detached	Detached
National House Price Index	**137983.8**	**107332.4**	**128852.4**	**225149**
Blackwood Data - transaction price	57654.8	61898	70338.9	92550.5
St Peters Data - asking price	90415.4	110023.7	125049.4	191147.4
Walmley Data – asking price	80856.6	142561.7	140065.2	254930.4

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xliv The visual impact of HVOTLs has a greater negative impact on the value of residential units than physical proximity.

xlv The visual presence of a pylon has a greater negative impact on value than the line.

xlvi Aggregating data deal with issues such as, insufficient numbers of cases in various categories and fluctuations within the market caused by negative public perception due to periodic media attention focussing on the link between living near HVOTLs and cancer.

Therefore, to avoid spurious results, comparisons between data sets were made using the results of regression analysis and the mean value of different types of residential units, expressed as a percentage.

5.6.1 Stepwise Regression

A stepwise regression analysis was undertaken using only variables available in all three case studies[xlvii] and produced the following equations:

All negative 'HVOTL specific' variables in the equations have been highlighted in red.

***Blackwood** Value = £66130.583 + -£13598.53 x semi detached house, + £37.578 x plot size + £4918.630 x number of bedrooms, + -£16456.046- x terraced, + -£18550.391 x flat, + -£10786.731 sited within 50-99m band + -£8194.154 x sited within 150-199m band + -£8669.95 x sited within 100-149m band + -£13842.864 x rear view of ¾ pylon, + -£3395.196 x sited within 200-249m band + £3249.723 x parking + error.*

***St Peter** Value = £84615.36 + £24942.54 x number of bedrooms, + £40,38 x plot size + -£310222.96 x semi detached house + -£34127.09 x terraced house + -£33202.42 x flat + £6174.89 x parking + -£15641.23 x a side facing view from the rear + -£8401.49 x a facing view from the rear + -£6918.89 x a facing view from the front + £10705.53 x a rear view of 1 + £6593.26 x a side view from the rear + error.*

***Walmley** Value = £74418.485 + £246.595 x plot size + £23221.834 x number of bedrooms + -£27700.514 x semi detached house + -£33599.510 x flat + -£17821.183 front facing view of the HVOTL + £36428.112 x a front view of more than 1 pylon + error.*

The equations showed that in all locations there was a significant relationship between HVOTL features and house values. The impact was not always negative and revealed that whilst distance to the HVOTL was the key factor in value diminution for the Blackwood case study, in St Peter and Walmley, the visual impact had a more significant impact on asking price.

5.6.2 Mean Value Relative to Physical and Visual Proximity to the HVOTL

The results indicated that in each case study location the value of a 4 x bed detached house with no view of either line or pylon could be as much as 14% higher than a similar house situated 350m away from the pylon but having a view of pylon. Diminution for this house type, sited within 50m of a pylon, ranged between 0% (Walmley) 1% (Blackwood) and 20% (St Peter). Units within 50m of the HVOTL in Blackwood and Walmley had larger plots. This factor may have offset the negative impact of the HVOTL (see Chapter Seven: Table 7-11).

A 3 x bed semi-detached house situated within 50m of a pylon in both Blackwood and St Peter, was shown to be between 9% and 20% lower in value than similar houses situated more than 400m further away. By contrast, units close to a pylon in Walmley were found to be, on occasion, 4%

[xlvii] These were house type, number of bedrooms, parking, plot size, topography, view, distance to pylon, distance to line, visual impact of line and pylon from the front and rear of the unit.

higher than the same house type sited 300m away. However, the reduction in asking price from proximity to a line in this location ranged from 2% to 16%.

The visual impact of the HVOTL affected the value of most house types included in the analysed. Whilst, the impact was not linear, a pattern emerged which indicated that a slight view of a pylon reduced the value of all house types compared to similar units having 'no view'. However, transaction price and asking price were often observed to rise beyond this point even though the visual encumbrance increased.

It was concluded from the Blackwood data that units having a rear view of a pylon were likely to be reduced by, on average, 7.1%. Units having a front view of a pylon could suffer a reduction in value of twice that figure at 14%. Establishing the visual impact on the selling price of units in this location was difficult, as value diminution was not linear.

In St Peter, having a rear view of a HVOTL had a more negative impact on the asking price of semi-detached and terraced houses than a view from the front of the unit. However, the opposite was observed for a detached house, which could suffer from a reduction in asking price of up to 6% compared to only 4% for a rear view (compared to a similar house having no view of either pylon, or line).

The most negative impact observed was for the asking price of 3 x bed semi-detached units which could be reduced by 9.5% for a view of the HVOTL from the front of the house and twice that, at 18%, for a view from the rear. The value of terraced houses with a view of a HVOTL from the front of the house could be up to 11% lower than comparable units elsewhere on the estate. By contrast, having a rear view was observed to have a more negative impact on value (up to 20%). There were too few examples to determine the visual impact on the value of flats; only six units had some view of either a line or a pylon.

A rear view of the HVOTL was found to have less impact on the value of a detached house (on average 4%) compared to semi-detached and terraced houses, which suffered from a reduction in value of between 6 to 18% for a semi detached house and 20% for a terraced house.

In Walmley, having a rear view of either pylon or line was found to reduce value by, on average, 19% compared to a front view, which reduced the asking price of some, although not all units, by between 4% and 23%. The effects on value from the visual aspects of the HVOTL were difficult to determine, as they were not linear. However, focusing on the most common house type (3 x bed semi-detached and 4 x bed detached) indicated that in all locations the mean value of units having a front view of either line or pylon remained lower than similar units with a rear view (3 x bed semi-detached houses see Figures 5-24 to 5-26; 4 x bed detached houses see Figures 5-27 to 5-29).

Orientation: The orientation of the HVOTL was found to have some impact on the degree of diminution suffered with a more pronounced view of a pylon (from either the front or rear of the property) often having a greater negative impact on value. Any impact was however, not observed to be linear. In addition, this phenomenon was more frequently observed with data obtained from the two 'asking price' case study locations which may indicate that agents adjust the asking price to reflect what they consider to be a negative impact on value due to the visual presence of a pylon.

Figure 5-24: Visual Impact of a Line and Pylon:-3 x Bed Semi-Detached House in Blackwood

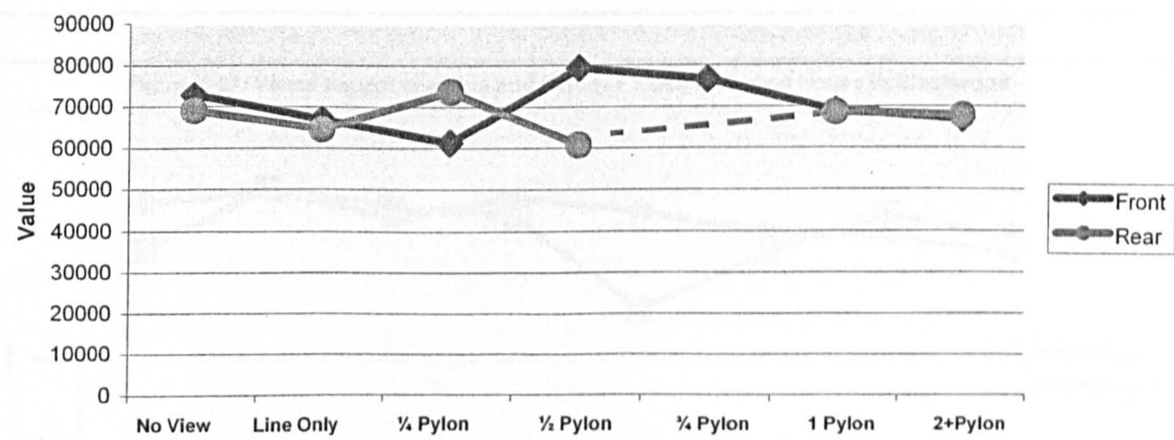
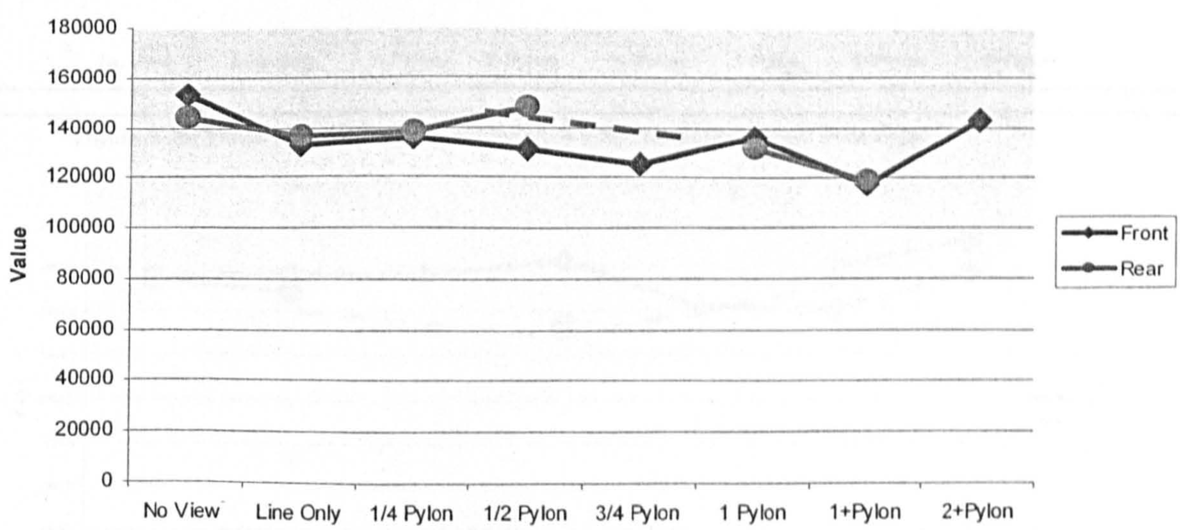


Figure 5-25: Visual Impact of a Line and Pylon- 3 bed Semi-detached House in St Peter



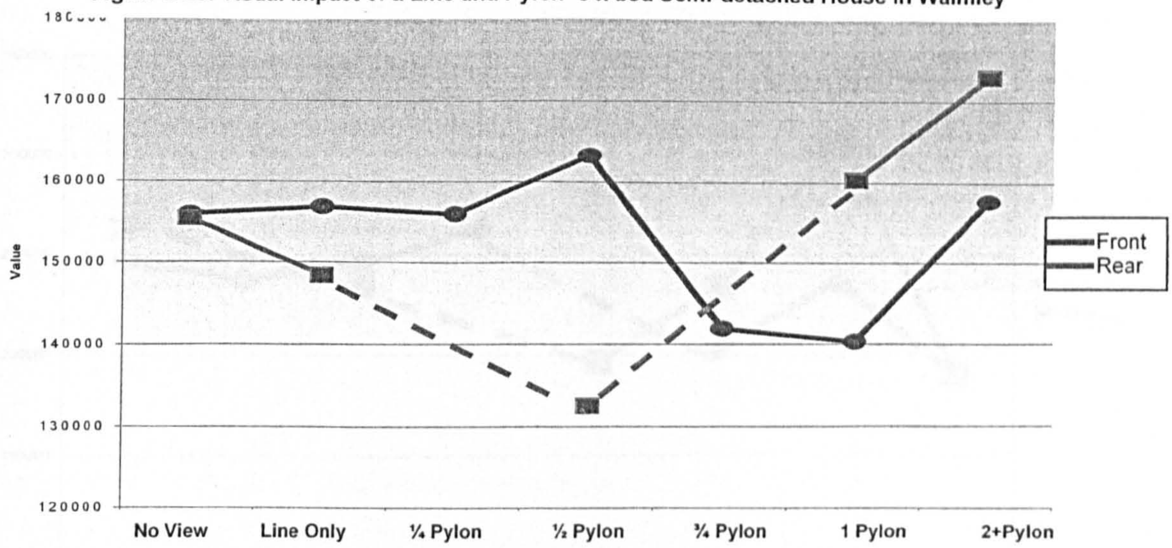


Figure 5-26: Visual Impact of a Line and Pylon- 3 x bed Semi-detached House in Walmley

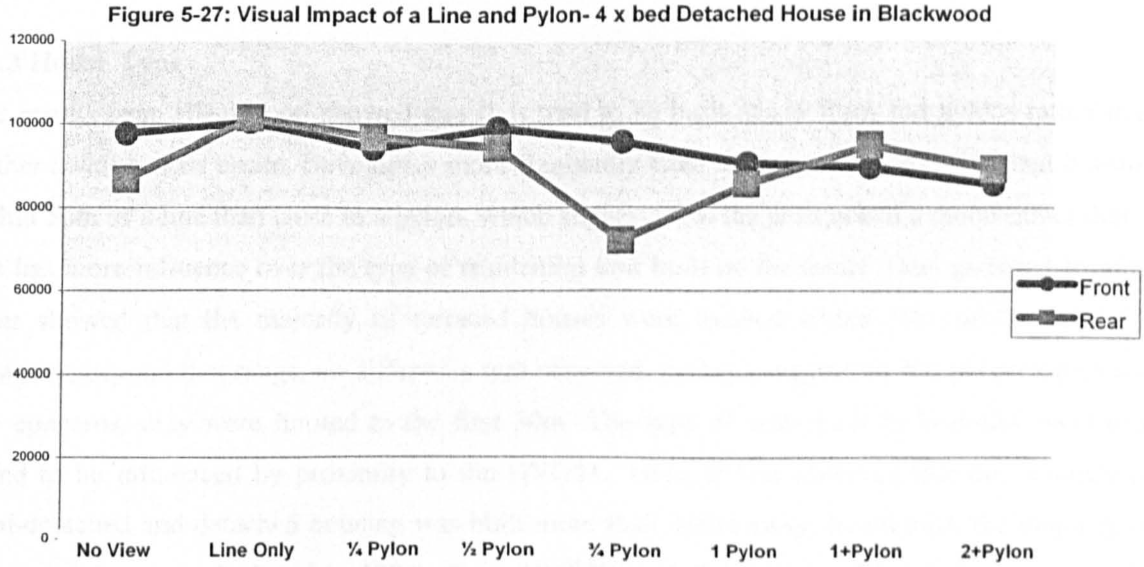


Figure 5-27: Visual Impact of a Line and Pylon- 4 x bed Detached House in Blackwood

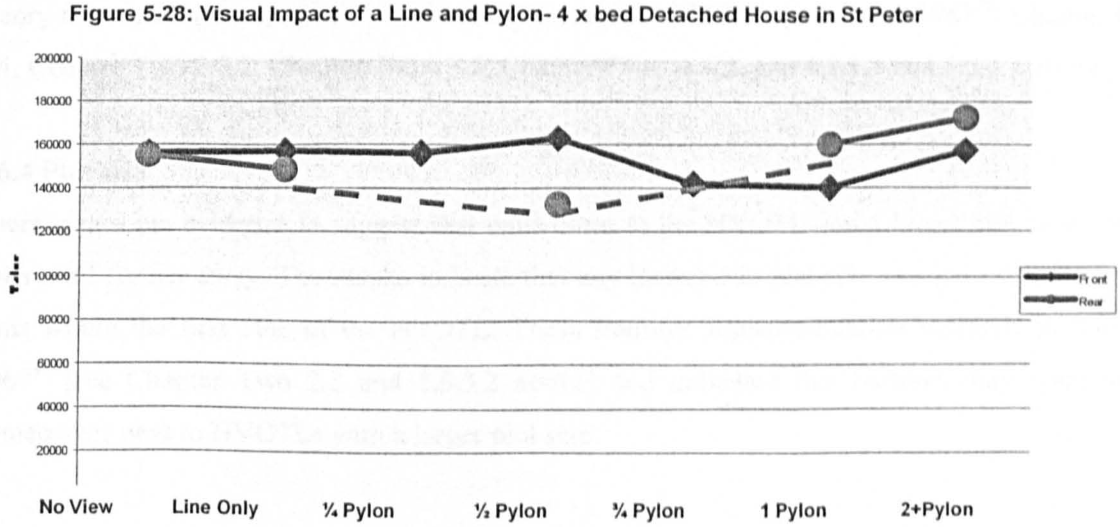
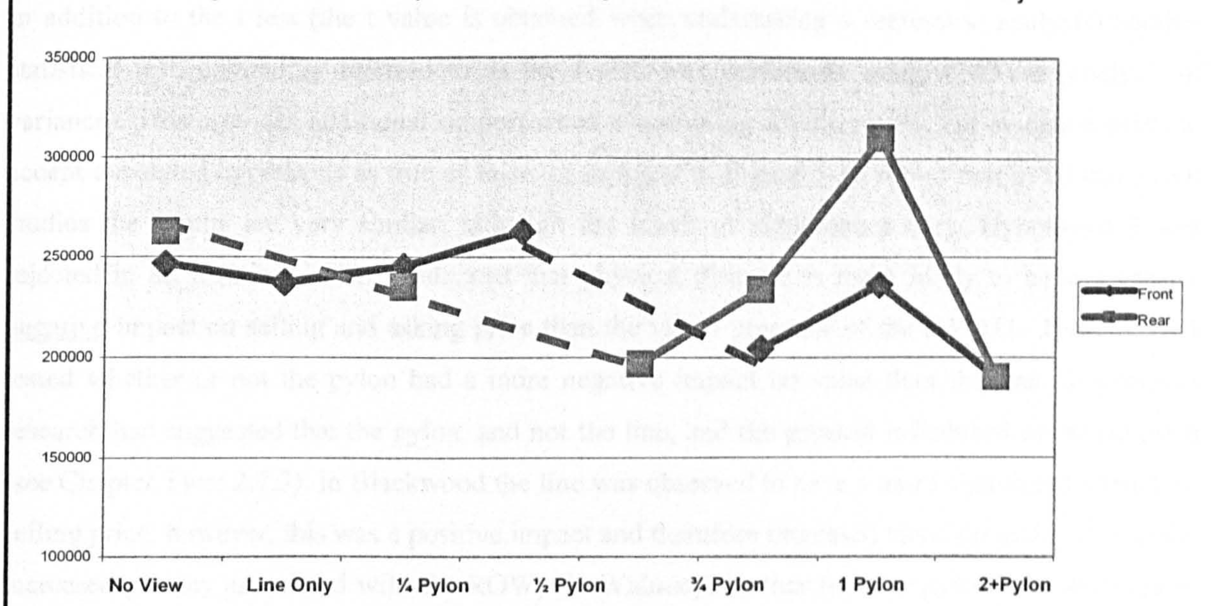


Figure 5-28: Visual Impact of a Line and Pylon- 4 x bed Detached House in St Peter

Figure 5-29: Visual Impact of line and Pylon- 4 x Bed Detached House in Walmey



5.6.3 House Type

The results from Blackwood showed that flats tend to be built nearer lines and pylons rather than further away on this estate. Developers more frequently sited semi detached and detached housing within 50m of a line than close to a pylon, which suggests that the presence of a pylon rather than a line has more influence over the type of residential unit built on the estate. Data gathered from St Peter showed that the majority of terraced houses were located within 50m of the HVOTL. However, beyond that range, no difference was observed, perhaps suggesting that if developers had any concerns, they were limited to the first 50m. The type of units built in Walmley were also found to be influenced by proximity to the HVOTL. Here, it was observed that the majority of semi-detached and detached housing was built more than 400m away. In contrast, the majority of terraced units were sited within 100m of the HVOTL and flats within 150m. This supported the theory that developers sited low cost housing nearest the HVOTL (see Reese 1967[20]; Chapter One: 1.4; Chapter Two 2.7.2; Chapter Three 3.5; Chapter Four: 4.4.5; and 4.9.1.4 and 5.5.3.1 above).

5.6.4 Plot size

There was some evidence to suggest that units close to the HVOTL had a larger plot than similar units sited further away. The results indicate that any increase in plot size was generally limited to units within the first 50m of the HVOTL. These findings supported earlier research by Kinnard 1967[18] (see Chapter Two 2.2 and 5.5.3.2 above) and indicated that builders may compensate homeowner next to HVOTLs with a larger plot size.

5.6.5 Hypothesis Testing

In addition to the t test (the t value is obtained when undertaking a regression analysis) another statistical test, commonly referred to as the f test, was performed using ANOVA (analysis of variance). This provides additional support when determining whether sufficient evidence exists to accept the stated hypothesis as true or false, or to reject it. Figure 5-30 shows that in all three case studies the results are very similar, although the levels of significance vary. Hypothesis 3 was rejected in all locations, which indicated that physical distance is more likely to have a greater negative impact on selling and asking price than the visual presence of the HVOTL. Hypothesis 4 tested whether or not the pylon had a more negative impact on value than the line, as previous research had suggested that the pylon, and not the line, had the greatest influenced on house price (see Chapter Two: 2.7.3). In Blackwood the line was observed to have a more significant impact on selling price, however, this was a positive impact and therefore increased value (arguably due to the increased privacy associated with the ROW). In Walmley, neither line nor pylon was observed to have a significant impact on house price, although there were slight differences between the scores which showed that that the pylon was likely to have a slightly more negative impact on house price than the line. Therefore, in all cases Hypothesis 4 was accepted as true.

Figure 5-30: Testing Hypotheses 3 and 4

Blackwood	*F. Value*	*Significance*	**Accept or Reject**
Hypothesis 3	Distance HVOTL = 9.54 Visual HVOTL = 2.77	.000 .011	Reject
Hypothesis 4	Front Pylon = -1.42 Rear Line = 2.03	.030 .000	Accept *(The line had a positive impact on value)*
St Peter	*F. Value*	*Significance*	**Accept or Reject**
Hypothesis 3	Distance HVOTL = 4.27 Visual HVOTL = 2.06	.000 .041	Reject
Hypothesis 4	Rear Pylon = 3.196 Rear Line = 7.834	.005 .006	Accept
Walmley	*F. Value*	*Significance*	**Accept or Reject**
Hypothesis 3	Distance HVOTL = 2.122 Visual Pylon = 2.067	.036 .041	Reject
Hypothesis 4	Pylon = .233 Line = .002	.792 .998	Accept

5.6.5 Summary

Finally, whilst the presence of an HVOTL clearly has a negative impact on the value of residential units, finding a pattern of value diminution has proved difficult which may in part, be due to the small number of cases for St Peter and Walmley case studies. There was however, sufficient information to make a number of generalised predictions about the likely impact of a HVOTL on the value of different house types. This will be discussed further, in Chapter Seven (A Drawing Together of the Empirical Research & Final Conclusion and Further Research) where the results from the three valuation case studies are compared with one another and contrasted with the results from the perceptual research to be presented in Chapter Six. A table of likely value diminution is then created based on the analyses of the valuation and perceptual data.

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Relevant Web Sites

Halifax House Price Index:	www.hbosplc.com/economic/historical_data.xls
Land Registry postcode values	www.upmystreet.com

Chapter Six

Perceptual Research Analysis

6.0 INTRODUCTION TO THE CHAPTER

This chapter explains the analyses of perceptual, attitude and opinion data gathered from property professionals, house buyers, electricity utility employees and other relevant sources, towards the impact of a HVOTL on the value, marketability and desirability of residential units.

The aim of the perceptual research is fourfold.

1. To establish the opinions and perceptions of surveyors[i] and agents[ii] (collectively referred to as **'Valuers'**) towards the impact of a HVOTL on the transaction price of residential units and thus achieve, Research Objective Two[iii]. This will enable a comparative analysis to be undertaken with the results from the transaction data analysis and establish the degree to which attitudes can be relied upon to provide an accurate determination of the value[iv] of homes in close proximity to HVOTLs (Objective Four)[i].

2. To determine the key factors influencing the value and marketability of residential units in close proximity to HVOTLs and examine how these factors affect the behaviour of market participants (Objective One)[i].

3. To determine occupiers' attitudes (classified as **'Buyers'**)towards buying or renting homes near HVOTLs.

4. To further inform the results with additional information generated through telephone or face to face interviews. The results of the perceptual study will then be triangulated with the results from the 'asking price' data obtained through live experiments in two case study locations (Chapter Five: 5.4 and 5.5), and the benchmark created from transaction data obtained from a case study location in Blackwood (Chapter Five: 5.3), to determine whether or not opinions of value impacts reflect reality (Triangulated results are presented in Chapter Seven).

In addition, two hypotheses were tested by the perceptual research:

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[i] Group 1' are all members of the Royal Institution of Chartered Surveyors (RICS).

[ii] Participants in 'Group 2' are members of the National Association of Estate Agents (NAEA

[iii] See Chapter One 1.5.0 and Chapter Four 4.1.2

[iv] Valuing Property: It is important to note that whilst the terms value or valued are used for both groups of respondents, the value placed on a residential unit by an agent is only an opinion of the likely selling price achievable at a given time and will be influenced by, amongst other factors; current market conditions, professional experience and personal perception, knowledge of the local market and instructions from the vendor. See Chapter Four: 4.4.5

Hypothesis 1. Chartered surveyors would perceive a greater negative impact on the value of residential property than estate agents.

Hypothesis 2. Surveyors and agents who had no experience of valuing HVOTL proximate property would perceive a greater degree of value diminution than those familiar with the valuation of this type of property.

6.1 BACKGROUND

Previous research (examined in Chapter Three: 3.4) established that attitude surveys and interviews were the most appropriate tools for gathering perceptual data and thus provided a foundation for this part of the research (see Chapter Four: 4.4).

Data were obtained through the use of postal surveys[v] and a number of face-to-face (semi structured) and telephone (structured) interviews[vi]. This was to enable themes to emerge and results to be analysed using tests of association where appropriate.

6.1.1 Postal Survey: Questionnaire Design

Both questionnaires ('Valuers' and 'Buyers') were designed using, as appropriate, Likert scales and a ten-point sliding scale anchored at both ends.[vii] This produced data which, strictly speaking, were ordinal (Wright 1997[1]) although, Likert scales are treated by, *"most social scientists ... as an interval scale"(ibid).* Other information referred to as nominal or categorical data, were collected to enable respondents to be placed into various categories. The collection of these data allowed between participant categories and within participant category analysis to be conducted enabling comparisons to be made with the results from the transaction data analysis and the asking price data analysis. The results of the research would be 'triangulated', thus improving the validity of the findings and leading to a more robust and indeed useful final conclusion.

The Valuers' questionnaire (see Chapter Four: 4.5.1) was designed to test the opinions of both groups towards:-

a) the impact of HVOTLs and pylons on the value and marketability of residential homes.
b) The impact of the different aspects of a HVOTL on value and marketability.
c) Identifying steps taken by developers to mitigate any perceived value loss, and
d) Identify any differences between the opinions of valuers and agents towards the impact of a HVOTL on value.

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[v] See Appendix III and IV.

[vi] See Appendix XIII

[vii] See Chapter Four 4.4 and, amongst other text, Oppenheim (1992); Bryman (2001); Robson (1993).

The Buyers' questionnaire (see Chapter Four 4.6) was designed to test the opinions of occupiers towards the presence of HVOTLs near residential units. To avoid focusing specifically on HVOTLs, participants were asked to comment on three environmental features that had been the subject of media attention during the last two years due to their association with EMFs.[viii] These were, **Electricity Sub-station; High Voltage Overhead Electric Power Line and Mobile Phone Base Station.** A fourth feature, **Overhead Telephone Line,** which had no association with EMFs, was included to act as a control. In addition, respondents were asked to express their opinions in terms of a 'willingness to pay' to have these features removed.

6.1.2 Undertaking the Postal Survey

Data for the 'Buyers Survey' were collected from residents living in the three valuation case study locations (Blackwood, St Peter and Walmley), where there are residential units sited near and not near a HVOTL, in addition to a control location sited in an area known as Westerwood, Lanarkshire, Scotland, where no HVOTL was sited.

6.1.3 Sample Size and Response Rates

Buyers Survey: 800 questionnaires (Appendix VI) were sent out to randomly selected residents in the four locations. A response rate of at least 25% was anticipated.[ix] Following a 2nd mailing, the total response rate from all locations was 18% (See Figure 6-1 and Chapter Four: 4.4 and 4.6). Responses to the pilot study (6 =near HVOTLs, 9 = not near) were included in the analysis. No further steps were taken to gather data through this medium.[x]

Valuers' Survey: The 'Valuers' questionnaire was posted to 500 members of the RICS (Group1) and 500 members of the NAEA (Group 2). Participants were randomly selected using a stratified random sample from members within both groups and where necessary from Estate Agents holding no professional qualification or affiliation to a recognised professional body.[xi] Following a second mailing a total of 51% from Group 1 and 40% from Group 2 responded (see Figure 6-2).

Of those, 182 were excluded from the analysis for the following reasons. 169 were received from valuers and agents who either did not carry out property valuations or did not complete the questionnaire; two valued agricultural land and 11 were returned unopened. This left 277 useable responses (155 Agents and 122 Valuers) consisting of:

[viii] See Chapter Three: 3.3

[ix] See Chapter Four: 4.5.4

[x] See Chapter Four: 4.6.7

[xi] See Chapter Four: 4.5.3.1 and 4.5.3.2

57 (20.6%) commercial valuers/agents.

162 (58.5%) residential valuers/agents.

58 (20.9%) valuers/agents who regularly dealt with commercial and residential units (referred to as 'mixed property' valuers/agents).

Figure 6-1: Buyers Questionnaire-Sample size and Response Rate

	Study Location	Sample Size	Response 1st Mailing	Response 2nd Mailing	Total % Within Each Category
CONTROL	Pilot Control Study	25	6	-	24%
CONTROL	Westerwood	100	3	2	5%
CASE	Pilot Case Study	25	9	-	36%
CASE	Blackwood	100	23	7	30%
CASE	St Peter	300	39	14	14%
CASE	Walmley	300	47	11	19%
	Total	850	161		19%

Figure 6-2: Valuers Questionnaire-Sample size and Response Rate.

Participants	Sample Size	Response 1st mailing	Response 2nd mailing	Total Response	%
Group 1	500	189	68	257	51%
Group 2	500	97	105	202	40%
Total	1000	286	173	459	46%

6.1.4 Interviews

Additional information was gathered through the use of semi-structured and structured face-to-face and telephone interviews[xii]. The main aim of the interviews was to support the quantitative research and allow other elements to emerge, thus producing a more rounded and robust conclusion. No interviews were taped and key points were written up afterwards.

The interviewees consisted of:

Residents: 30 face-to-face interviews were conducted, each lasting between 5 and 10 minutes. Participants were first asked how long they had lived in their current home and why they had chosen that location. More specific questions followed[xiii] to examine their feelings towards the

[xii] See Chapter Four: 4.7

[xiii] See Appendix XIII

environmental features present in their neighbourhood. This was to introduce HVOTLs into the interview without appearing to focus specifically on this feature.

Valuers and Agents: 16 valuers and agents were contacted by telephone for information about the method of valuation used to determine the impact of a HVOTL if any, on house price.

Residential Property Developers: Four telephone interviews were obtained with residential development companies and focussed on their policy towards buying and developing land crossed by HVOTLs.[xiii]

Electricity Utility Employees: Three face-to-face interviews were undertaken with electricity utility employees. Questions focused on siting electricity equipment, the cost of under-grounding and planning issues[xiii].

Interview responses are analysed in section 6.5.

6.2 MEASUREMENT AND DATA ANALYSIS

All data were entered onto an SPSS spreadsheet for a within participant and between participant analysis of the results. Data were checked for any entering errors and corrected where necessary.

6.2.1 Choice of Statistical Tests

The choice of statistical test was largely dependent upon the nature of the data to be included in the analyses (Figure 6-3).

The perceptual research presented here, is a mixture of nominal[xiv], ordinal[xv] and interval[xvi] data and as such the following statistical tests were undertaken, where appropriate.

Descriptive Statistics

Measures of Central Tendency and Frequency Analysis either count the number of values in each variable, or use the mean, mode or median to analyse data.

[xiv] Nominal variables are also known as categorical variables and comprise categories that cannot be rank ordered. For instance; 'Type of Property Valued?' Bryman (2001).

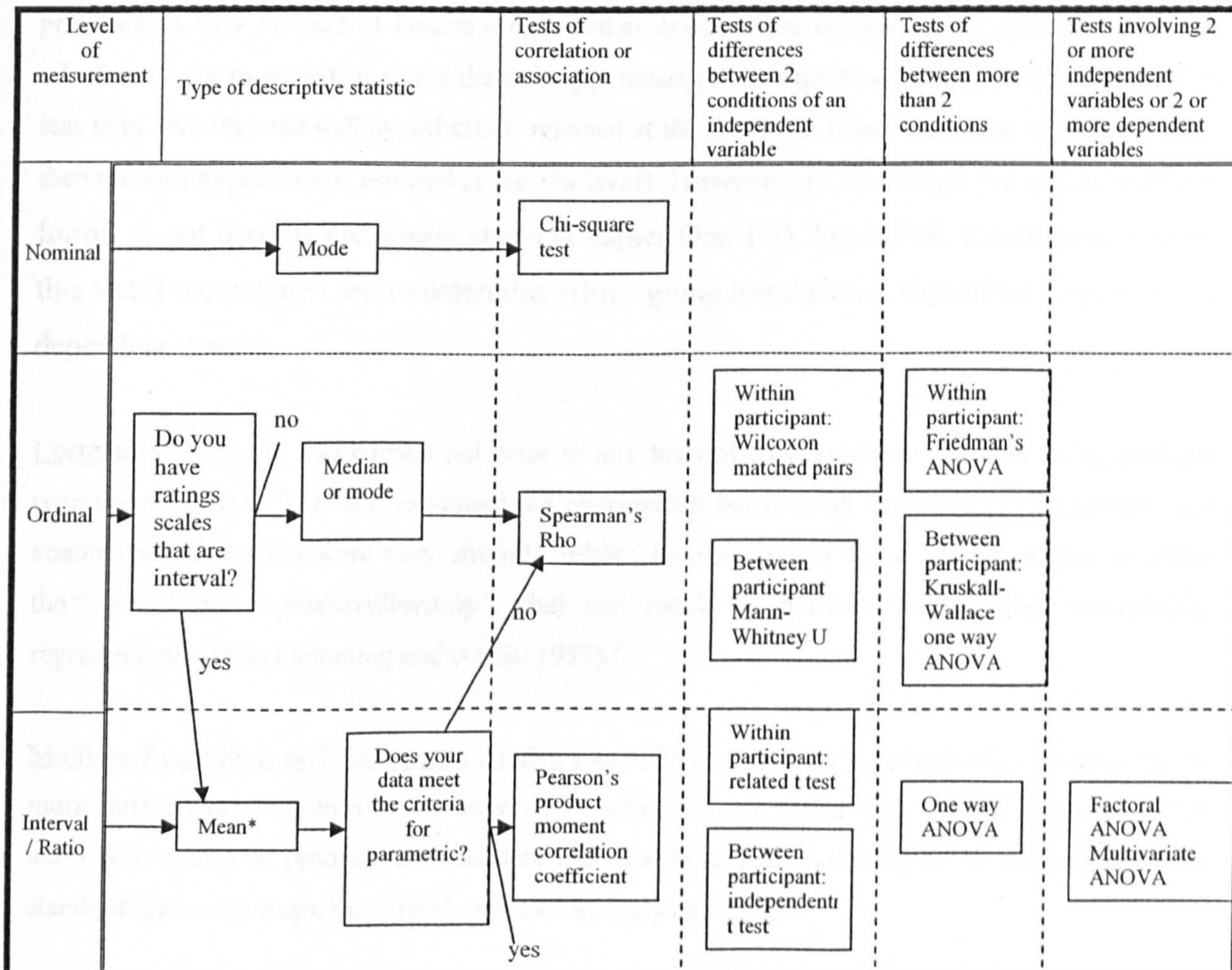
[xv] Ordinal variables have categories which can be rank ordered (as in the case of interval/ratio variables) but distances between categories are not equal across the range (*ibid).*

[xvi] Interval variables are variables where the distance between the categories are equal across the range. For instance; time. Likert scales, whilst strictly ordinal are treated as interval by social scientists, to enable tests of association and causality to be conducted (*ibid*).

Cross tabulation uses frequency analysis to determine whether there is a relationship between two variables.

Confidence Interval (CI) of 95% was calculated for the population mean. Using a 95% (CI) means that on 95% of occasions when the CI is calculated, the mean will fall within the calculated interval.

Figure 6-3: Flow chart indicating how data influences choice of statistical test



*If there are extreme scores (outliers) use the median or mode to avoid spurious results

Based on the work of Dancey and Reidy (1999)[2]

Inferential Statistics: Parametric and Nonparametric Tests

Tests of association or causality are referred to as parametric or non-parametric tests. Non-parametric tests are based on the rankings or frequency of occurrence of the values in the data. "*Parametric tests are more powerful because they use more of the information from your data*" and therefore produce a more reliable result (Dancey and Reidy[2]). However, parametric tests make certain assumptions about the data, in particular, the population sample from which the data were drawn[xvii].

Chi Square Test (Pearson X^2) is a non-parametric test to measure the degree of association between categorical variables by measuring the deviance from the value predicted by the model from the observed value to determine whether to accept or reject the stated hypothesis.
It is based on the null hypothesis assumption which is, that there is no difference between the groups and therefore an equal proportion from each group will choose each category. SPSS provides an easy method of determining whether or not there is such a difference and therefore whether or not to accept or reject the null hypothesis (if the significance (Sig.) value (2-tailed) is less than .005 then the null hypothesis is rejected at the 5% level. If the Sig. value is less than .001, then the null hypothesis is rejected at the 1% level). However, in this thesis the null hypothesis format is not used as previously stated (Chapter One 1.5). Instead the results produced by this test (t scores) are used to determine which group has the most significant impact on the dependent variable.

Correlation Analysis was carried out prior to any tests of association or causality using multiple regression analysis. This test examined the relationship between all variables in the equation and enabled variables that were very strongly related to one another to be identified thus avoiding the "*...problems of multicollinearity*", that can result in spurious results when undertaking regression analysis (Flemming and Nellis, 1997).[3]

Multiple Regression or Econometric Analysis establishes causality by statistically relating one or more independent variables to the dependent variable (see Chapter Five: 5.2.1). Social scientists use Likert scales to produce interval data that enable causal modelling to be undertaken using standard linear and stepwise multiple regression analysis (*ibid*).

6.2.2 Conducting the Analysis

For ease of reading, Section 6.3 presents the analysis of the 'Valuers' Survey'. Section 6.4 presents the analysis of the 'Buyers' Survey'. Additional information from the interviews is presented in Section 6.5 and the perceptual research is concluded in Section 6.6.

[xvii] The criteria for using parametric tests are:

1. The population from which the sample is drawn should be normally distributed.
2. The variances of the population should be normal.
3. The data should be interval or ratio.
4. There should be no extreme scores (Dancey and Reidy[2]).

6.3 ANALYSIS OF THE VALUERS' SURVEY

The data analysed in this section are the responses to the postal survey (Appendix III) undertaken to establish the perceptions of surveyors and agents towards the impact of HVOTLs on residential units.

6.3.1 Perceived impact on Value

The 'Valuers' questionnaire asked the two categories of participant, **'On average, what is the effect** [of a HVOTL] **on market value'?** The response was cross-tabulated to explore the issue of bias in relation to four respondent attributes. These were;

a) profession-whether the participant was a valuer or agent.

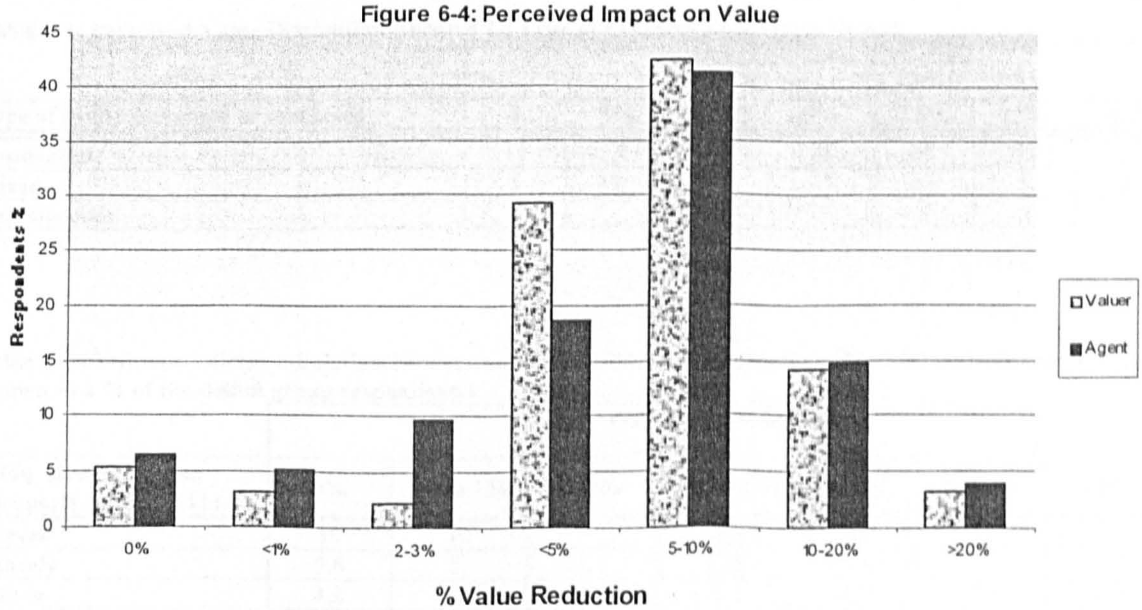
b) length of time spent as a practising valuer/agent.

c) type of property normally valued/marketed by the respondent.

d) how often the respondent had valued property near HVOTLs.

Frequency analysis revealed that the majority of valuers and agents perceive that value is reduced by between 5% and 10%. There were fluctuations between the opinions of both cohorts, with a higher percentage of agents suggesting a reduction in value of 2-3% (response rate = 3% valuers, 10% agents) and a higher percentage of valuers perceiving a 5% reduction in value (response rate 29% valuers, 18% agents) Converting the results into a percentage of the within group respondents revealed that valuers' opinions of diminution tended to cluster around 5% to 15 %, whereas agents' views were slightly more varied (Figure: 6-4).

Figure 6-4: Perceived Impact on Value



Valuers: Number of cases= 92; Mean= -7.5%; Std Dev= 4.48
Agents: Number or cases=155; Mean= -6.9%: Std Dev= 4.5

6.3.2 Factors Influencing Perceptions

Respondents were asked '**What type of property do you normally value?**' to determine whether this influenced opinions towards value diminution. Respondents were subdivided into three groups, depending on whether they regularly dealt with residential units, commercial units, or a mixture of both. No significant differences between the subsets were observed using frequency analysis (Table 6-1), or a Chi square test (Chi^2=13.343, df=12, sig = .345).

Respondents were asked, '**Have you ever valued property near power lines**'? This was to establish whether or not familiarity with valuing[xviii] this type of unit reduced the perceived negative impact on value. The levels of response were as follows;

22.6%=never; 49.8%=rarely; 24.6%=often; 3%=frequently.

The majority of respondents reduced value by 5-10%, irrespective of the number of HVOTL proximate units they had valued in the past. Whereas, the small number of respondents (2.2% = agents), who 'often' marketed units near HVOTLs suggested the greatest value diminution at 20% or above (Tables 6-2 and 6-3).

Overall, the results showed that those who 'never' or 'rarely' valued or marketed this type of unit reduced value by an average of 5.78% (n=158) compared to those within the 'often' or 'frequently' groups who perceived an average reduction of 7.96% (n=11).

Table 6-1: Perceived Value Diminution Relative To Type of Property Frequently Valued

	Percentage Value Reduction						
Type of property valued or marketed	0	1%	2.5%	5%	7.5%	15%	>20%
Residential	11	7	10	28	64	20	5
Mixed	1	1	3	17	24	5	2
Commercial	2		1	3	7	6	

Table 6-2: Valuers - Cross tabulation between value reduction and familiarity with valuing units near HVOTLs (shown as a % of the within group respondents)

	Percentage Reduction						
How often ... valued property near HVOTL	0%	Up to 1%	2-3%	Up to 5%	5-10%	10-20%	>20%
Never	10	10	-	20	50	10	-
Rarely	5.6	3.	3.7	27.8	44.4	11.1	3.7
Often	4.2	-	-	33.3	37.5	20.8	4.2
Frequently	-	-	-	50	50	-	-

xviii See Chapter 4.4.6 for an explanation of the term 'value' in relation to an agent.

Table 6-3: Agents – Cross tabulation between value reduction and familiarity with valuing units near HVOTLs (shown as a % of the within group respondents)

	Percentage Reduction						
How often ... valued property near HVOTL	0%	Up to 1%	2-3%	Up to 5%	5-10%	10-20%	>20%
Never	6.2	5.5	10.3	17.8	41.8	14.4	4.1
Rarely	5.7	2.3	11.5	18.4	42.5	13.9	5.7
Often	6.7	11.1	11.1	15.6	42.2	11.1	2.2
Frequently	14.3%	-	-	14.3	28.6	42.9	-

A Chi square test was undertaken to determine whether these findings were significant. The initial result revealed an insufficient number of cases within each category to ensure a reliable result. Data were therefore aggregated into two subsets; those who 'never' or 'rarely' valued houses near HVOTLs and those who 'often' or 'frequently' valued HVOTL-proximate houses. No significant differences were observed between the groups (Chi^2 = 5.851, df=6, sig,= .440).

6.3.3. Factors Affecting Value and Marketability

The indicator interviews with agents and valuers (Chapter Four: 4.4.1, 4.4.2, 4.4.5) identified a number of variables which they considered to be associated with the presence of power lines near residential units. (Tables 6-4, 6-5) Respondents were asked to identify how often they had encountered each variable in association with this type of unit in their professional experience.

The responses indicated that there were slight differences between the perceptions of the groups, in particular, the responses to **'Removed Buyers'** or **'Increased Sale Time'**, with valuers indicating a greater reduction in the number of potential buyers, whereas agents suggested longer marketing periods.

Re-grouping the respondents into subsets according to the type of property they normally valued / marketed revealed significant differences between groups in response to the questions, **'Increased Sale Time'** (Chi^2 =17.213, df =8, Sig .028) and **'Reduce Mortgage Availability'** (Chi^2 = 15.404. df =8, sig .052) with 'commercial' and 'mixed' groups producing more varied responses than the residential group, possibly indicating that their opinions are based on personal perceptions rather than professional experience.

Table 6-4: Valuers' Responses

	Increased Value	Reduced Value	Removed Buyers	Increased Sale Time	Reduce Mortgage Availability	Not Marketable
Never	96.8	5.1	2.1	4.2	18.0	52.7
Rarely	3.2	6.1	6.3	11.6	31.5	29.7
Sometimes	-	40.8	34.4	36.8	37.1	12.2
Often	-	33.7	45.8	36.8	9.0	1.4
Always	-	-	11.5	10.5	4.5	4.1

Table 6-5: Agents' Responses

	Increased Value	Reduced Value	Removed Buyers	Increase Sale Time	Reduce Mortgage Availability	Not Marketable
Never	96.3	33.7	1.8	1.2	15.6	68.2
Rarely	2.5	6.8	4.9	5.5	36.4	17.2
Sometimes	1.2	35.2	35.6	35.0	32.5	7.0
Often	-	30.9	37.4	41.7	13.0	3.2
Always	-	23.5	20.2	16.6	2.6	4.5

6.3.4 Factors affecting Value and Marketing

Respondents were asked to rank each variable between 0 and 10 (0= no impact, 10=very large impact) according to the degree of negative impact it would have on;

a) the value of a house, and
b) the marketing process.

a) The Impact on House Value

Frequency analysis revealed that, the majority of all respondents ranked concerns about 'Health Effects' (Table 6-9), 'Future Value' (Table 6-10) and 'Visual Impact' (Table 6-6) as the most likely cause of value diminution. Respondents believed these factors had a 'moderate' to 'very large' impact on value, whereas 'Safety Issues' (Table 6-8), 'Land Use' (Table 6-11) and 'Bird Nuisance' (Table 6-12) were perceived to have little or no impact. 'Noise' was found to have a moderate to large impact (Table 6-7).

Apart from slight differences between the opinions of valuers and agents towards the impact on value from concern over 'Future Value'[xix] and 'Land Use'[xx], there were no significant differences between the responses from both cohorts. This suggested that, in general, the opinions of the valuer who places a value on unit usually for mortgage purposes are very similar to the opinions of the estate agent who markets the unit.

To test whether there were differences between the opinions of valuers and agents, a Chi squared test was performed for each variable. This showed that there were no significant differences between the opinions of both group with the exception of attitudes toward the impact of 'Birds on Lines'[xxi] where differences between groups were observed (f value = 15.805,df = 7, p= .027). Frequency analysis showed that a larger proportion of valuers than agents, felt that 'Birds on Line' negatively effected value.

[xix] Table 6-14

[xx] Table 6-15

[xxi] Birds sitting on pylons and earth wires of HVOTLs were identified by the indicator interviews with agents and valuers as one aspect associated with living near a HVOTL that was considered to be undesirable by residents and prospective buyers, due to bird droppings on cars, houses and in gardens.

Using the chi^2 test to determine whether there was a difference between residential, commercial or mixed property, valuers/agents. The results revealed significant differences between the subsets in response to **'Negatively Affect Future Value'** (Chi^2 =40.789, df =20, sig =.004) with 28% of commercial valuers/agents indicating that concern over future value had a very large negative effect on value, compared to 31% of mixed and 34% of residential valuers/agents who indicated a less negative impact.

Key to Tables 6-6 to 6-19

	=RICS Valuers		=NAEA Agents		=Main Area of Spread

Table 6-6		Degree of Impact on Value: Visual Presence											
		No Impact										Very Large Impact	
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	4		3	7	6	20	6	10	19	2	14	91
	% of respondents	4.4%		3.3%	7.7%	6.6%	22.0%	6.6%	11.0%	20.9%	2.2%	15.4%	100.0 %
Agent	Count	2	1	9	9	6	45	9	14	22	11	17	145
	% of respondents	1.4%	.7%	6.2%	6.2%	4.1%	31.0%	6.2%	9.7%	15.2%	7.6%	11.7%	100.0 %
Total	Count	6	1	12	16	12	65	15	24	41	13	31	236
	% within question	2.5%	.4%	5.1%	6.8%	5.1%	27.5%	6.4%	10.2%	17.3%	5.5%	13.1%	100.0 %

Table 6-7		Degree of Impact on Value: Noise											
		No Impact										Very Large Impact	
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	4	2	9	8	6	25	3	7	13	2	9	88
	% of respondents	4.5%	2.3%	10.2%	9.1%	6.8%	28.4%	3.4%	8.0%	14.8%	2.3%	10.2%	100.0 %
Agent	Count	5	7	14	10	9	40	9	13	21	8	13	149
	% of respondents	3.4%	4.7%	9.4%	6.7%	6.0%	26.8%	6.0%	8.7%	14.1%	5.4%	8.7%	100.0 %
Total	Count	9	9	23	18	15	65	12	20	34	10	22	237
	% within question	3.8%	3.8%	9.7%	7.6%	6.3%	27.4%	5.1%	8.4%	14.3%	4.2%	9.3%	100.0 %

Table 6-8		Degree of Impact on Value: Concern Over Safety Issues											
		No Impact										Very Large Impact	
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	15	7	15	7	7	18	1	7	4	1	5	87
	% of respondents	17.2%	8.0%	17.2%	8.0%	8.0%	20.7%	1.1%	8.0%	4.6%	1.1%	5.7%	100.0 %
Agent	Count	22	15	16	12	13	26	11	11	9	4	4	143
	% of respondents	15.4%	10.5%	11.2%	8.4%	9.1%	18.2%	7.7%	7.7%	6.3%	2.8%	2.8%	100.0 %
Total	Count	37	22	31	19	20	44	12	18	13	5	9	230
	% within question	16.1%	9.6%	13.5%	8.3%	8.7%	19.1%	5.2%	7.8%	5.7%	2.2%	3.9%	100.0 %

Table 6-9		Degree of Impact on Value: Concern Over Publicised Health Risks											
		No impact								Very Large Impact			
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	2	1	3	2	3	23	5	9	19	1	20	88
	% of respondents	2.3%	1.1%	3.4%	2.3%	3.4%	26.1%	5.7%	10.2%	21.6%	1.1%	22.7%	100.0 %
Agent	Count	3	3	6	6	2	44	9	12	26	18	21	150
	% of respondents	2.0%	2.0%	4.0%	4.0%	1.3%	29.3%	6.0%	8.0%	17.3%	12.0%	14.0%	100.0 %
Total	Count	5	4	9	8	5	67	14	21	45	19	41	238
	% within question	2.1%	1.7%	3.8%	3.4%	2.1%	28.2%	5.9%	8.8%	18.9%	8.0%	17.2%	100.0 %

Table 6-10		Degree of Impact on Value: Concern Over Future Value											
		No impact								Very Large Impact			
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	1	2	3	5	5	29	4	7	17	2	10	85
	% of respondents	1.2%	2.4%	3.5%	5.9%	5.9%	34.1%	4.7%	8.2%	20.0%	2.4%	11.8%	100.0 %
Agent	Count	4	4	5	6	7	37	6	21	27	12	13	142
	% of respondents	2.8%	2.8%	3.5%	4.2%	4.9%	26.1%	4.2%	14.8%	19.0%	8.5%	9.2%	100.0 %
Total	Count	5	6	8	11	12	66	10	28	44	14	23	227
	% within question	2.2%	2.6%	3.5%	4.8%	5.3%	29.1%	4.4%	12.3%	19.4%	6.2%	10.1%	100.0 %

Table 6-11		Degree of Impact on Value: Concern Over Land Use											
		No Impact								Very Large Impact			
		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	16	10	20	10	3	13	4	3	1	1	2	83
	% of respondents	19.3%	12.0%	24.1%	12.0%	3.6%	15.7%	4.8%	3.6%	1.2%	1.2%	2.4%	100.0 %
Agent	Count	43	13	20	19	10	23	2		4		1	135
	% of respondents	31.9%	9.6%	14.8%	14.1%	7.4%	17.0%	1.5%		3.0%		.7%	100.0 %
Total	Count	59	23	40	29	13	36	6	3	5	1	3	218
	% within question	27.1%	10.6%	18.3%	13.3%	6.0%	16.5%	2.8%	1.4%	2.3%	.5%	1.4%	100.0 %

Table 6-12		Degree of Impact on Value: Concern Over Birds on Lines								
		Impact					Very Large Impact			Total
		0	1	2	3	4	5	6	9	
Valuer	Count	43	14	10	5		6		5	83
	% of respondents	51.8%	16.9%	12.0%	6.0%		7.2%		6.0%	100.0%
Agent	Count	85	22	14	8	2	2	1		134
	% of respondents	63.4%	16.4%	10.4%	6.0%	1.5%	1.5%	.7%		100.0%
Total	Count	28	36	24	13	2	8	1	5	217
	% within question	59.0%	16.6%	11.1%	6.0%	.9%	3.7%	.5%	2.3%	100.0%

Causality Tests: Using the mode was an adequate test to indicate initial trends but it was not able to determine causality. Stepwise regression analysis was used to establish whether a causal link existed between the test variables and value diminution. Model 6-1 shows that concern over 'future value' had the most significant impact on value, followed by 'health concerns,' and 'noise' (buzzing from lines). All variables were significant at the 95% confidence level.

Model 6-1: Predictors of Negative Value Impacts using Stepwise Regression Analysis

	Unstandardized Coefficients	Standardized Coefficients	T	Sig.
	B	Beta		
(Constant)	1.996		8.325	.000
Future Value	9.566E-02	.197	2.335	.021
Health Concerns	9.616E-02	.205	2.482	.014
Noise from Line	6.733E-02	.151	2.068	.040

Dependent Variable= Percentage value reduction

b) The Impact on Marketing

The same tests were carried out to determine the impact on marketing. Factors found to affect marketing were also 'Health Concerns', followed by 'Visual Impact' and then the 'Future Value' (Tables 6-13 to 6-19). There were no significant differences observed between the opinions of both groups.

A Chi squared test was conducted for each variable to determine whether or not to accept or reject the stated hypothesis[xxii]. Some differences were observed between the groups towards the variables 'Health Concerns' ($Chi^2 = 41.985$, df = 20, sig = .003) and 'Future Value' ($Chi^2 = 33.918$, df = 20, sig = .027). However, although the results showed a significant difference at the 95% confidence level, there were insufficient cases to produce a reliable Chi^2 result or to accept the hypothesis with confidence. The stated hypothesis was accepted for all other variables.

Respondents were divided into subsets according to the type of property they valued or marketed. Significant differences were observed between the 'commercial' and 'mixed' subgroups towards the variable 'Health Concerns'. The commercial group indicated that this variable had less impact on marketability.

		Degree of Impact on Marketing: Visual Presence											
		No Impact								Very Large Impact			
Table 6-13		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	6	6	3	5	20	5	8	1	13	3	8	78
	% of respondents	7.7%	7.7%	3.8%	6.4%	25.6%	6.4%	10.3%	1.3%	16.7%	3.8%	10.3%	100.0 %
Agent	Count	0	8	7	4	46	12	15	0	24	6	16	138
	% of respondents	-	5.8%	5.1%	2.9%	33.3%	8.7%	10.9%	-	17.4%	4.3%	11.6%	100.0 %
Total	Count	6	14	10	9	66	17	23	1	37	9	24	216
	% within question	2.8%	6.5%	4.6%	4.2%	30.6%	7.9%	10.6%	.5%	17.1%	4.2%	11.1%	100.0 %

xxii Hypothesis 1: Chartered Surveyors would perceive a greater negative impact on the value of residential property than estate agents

		Degree of Impact on Marketing: Noise											
		No Impact										Very Large Impact	
Table 6-14		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	8	2	9	5	5	10	3	10	9	2	9	72
	% of respondents	11.1%	2.8%	12.5%	6.9%	6.9%	13.9%	4.2%	13.9%	12.5%	2.8%	12.5%	100.0 %
Agent	Count	7	6	9	9	5	32	13	14	18	5	13	131
	% of respondents	5.3%	4.6%	6.9%	6.9%	3.8%	24.4%	9.9%	10.7%	13.7%	3.8%	9.9%	100.0 %
Total	Count	15	8	18	14	10	42	16	24	27	7	22	203
	% within question	7.4%	3.9%	8.9%	6.9%	4.9%	20.7%	7.9%	11.8%	13.3%	3.4%	10.8%	100.0 %

		Degree of Impact on Marketing: Concern over Safety Issues											
		No Impact										Very Large Impact	
Table 6-15		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	16	9	9	5	4	13	1	5	5	1	5	73
	% of respondents	21.9%	12.3%	12.3%	6.8%	5.5%	17.8%	1.4%	6.8%	6.8%	1.4%	6.8%	100.0 %
Agent	Count	23	11	13	11	11	25	9	7	13	2	5	130
	% of respondents	17.7%	8.5%	10.0%	8.5%	8.5%	19.2%	6.9%	5.4%	10.0%	1.5%	3.8%	100.0 %
Total	Count	39	20	22	16	15	38	10	12	18	3	10	203
	% within question	19.2%	9.9%	10.8%	7.9%	7.4%	18.7%	4.9%	5.9%	8.9%	1.5%	4.9%	100.0 %

		Degree of Impact on Marketing: Concern over Publicised Health Risk											
		No Impact										Very Large Impact	
Table 6-16		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	5	3	5	4	2	18	6	7	12	1	13	76
	% of respondents	6.6%	3.9%	6.6%	5.3%	2.6%	23.7%	7.9%	9.2%	15.8%	1.3%	17.1%	100.0 %
Agent	Count	1	1	3	4	5	38	12	12	24	11	20	131
	% of respondents	.8%	.8%	2.3%	3.1%	3.8%	29.0%	9.2%	9.2%	18.3%	8.4%	15.3%	100.0 %
Total	Count	6	4	8	8	7	56	18	19	36	12	33	207
	% within question	2.9%	1.9%	3.9%	3.9%	3.4%	27.1%	8.7%	9.2%	17.4%	5.8%	15.9%	100.0 %

		Degree of Impact on Marketing: Concern over Future Value											
		No Impact										Very Large Impact	
Table 6-17		0	1	2	3	4		6	7	8	9	10	Total
Valuer	Count	6	3	5	5	4	19	5	6	7	2	7	69
	% of respondents	8.7%	4.3%	7.2%	7.2%	5.8%	27.5%	7.2%	8.7%	10.1%	2.9%	10.1%	100.0 %
Agent	Count	2	3	4	5	7	35	8	19	25	6	15	129
	% of respondents	1.6%	2.3%	3.1%	3.9%	5.4%	27.1%	6.2%	14.7%	19.4%	4.7%	11.6%	100.0 %
Total	Count	8	6	9	10	11	54	13	25	32	8	22	198
	% within question	4.0%	3.0%	4.5%	5.1%	5.6%	27.3%	6.6%	12.6%	16.2%	4.0%	11.1%	100.0 %

		Degree of Impact on Marketing: Concern over Land Use											
		No Impact										Very Large Impact	
Table 6-18		0	1	2	3	4	5	6	7	8	9	10	Total
Valuer	Count	23	7	12	10	3	5	2	2	2	1	1	68
	% of respondents	33.8%	10.3%	17.6%	14.7%	4.4%	7.4%	2.9%	2.9%	2.9%	1.5%	1.5%	100.0 %
Agent	Count	42	13	16	12	10	25		1	2		2	123
	% of respondents	34.1%	10.6%	13.0%	9.8%	8.1%	20.3%		.8%	1.6%		1.6%	100.0 %
Total	Count	65	20	28	22	13	30	2	3	4	1	3	191
	% within question	34.0%	10.5%	14.7%	11.5%	6.8%	15.7%	1.0%	1.6%	2.1%	.5%	1.6%	100.0 %

Table 6-19		Degree of Impact on Marketing: Concern over Bird Mess									
		No Impact							Very Large Impact		
		0	1	2	3	4	5	6	8	9	Total
Valuer	Count	40	10	8	3		7		1	1	70
	% of respondents	57.1%	14.3%	11.4%	4.3%		10.0%		1.4%	1.4%	100.0%
Agent	Count	78	17	12	5	3	10	1			126
	% of respondents	61.9%	13.5%	9.5%	4.0%	2.4%	7.9%	.8%			100.0%
Total	Count	118	27	20	8	3	17	1	1	1	196
	% within question	60.2%	13.8%	10.2%	4.1%	1.5%	8.7%	.5%	.5%	.5%	100.0%

A stepwise regression analysis using marketing time as the dependent variable only found a significant relationship between an increase in the amount of time a unit would be on the market before being sold and concerns over 'Future Value' (Model 6-2).

Model 6-2: Stepwise Regressions (Dependent Variable= Increase in Marketing Time)

Adj. R^2.421	Unstandardised Coefficients	Standardised Coefficients	T	Sig.
	B	Beta		
(Constant)	2.447		11.344	.000
Future Value	.195	.420	5.973	.000

6.3.5 Changes in Land Use

Preliminary investigations produced a number of indicators that suggested that there had been a change in the way this type of land was developed over the last decade. These changes were possibly caused by either a shift in the attitudes of builders and developers towards developing residential schemes near HVOTLs (see Chapter Two: 2.7.2) or due to planning conditions imposed on developers as a result of the revisions to PPG3 (see Chapter One: 1.1.4).

The main indicators were: the introduction of power line corridors[xxiii], larger plots[xxiv] and buffer zones[xxv]. In addition, other more subtle changes were noted by estate agents and valuers (see Chapter One: 1.1.3), such as a tendency to place low cost and social housing near the pylon, under-grounding[xxvi] and re-routing HVOTLs, or rejecting land for residential developments[xxvii]. A list of variables was constructed and included in the questionnaire for testing. Responses were first analysed to determine whether there were any significant differences between participants in

[xxiii] For instance, St Peter and Blackwood compared to Walmley.

[xxiv] See Chapter Five: 5.3.3.2; 5.4.4.2 and 5.5.3.2.

[xxv] For instance, Walmley.

[xxvi] See Appendix XIII, Interviews 31, 51, 52 and 53.

[xxvii] *ibid.*

relation to a) the type of property valued/marketed or b) whether they were an agent or valuer. No significant differences were observed therefore, responses to this section were aggregated for an analysis of the mean.

The results showed that most frequently observed actions taken by developers, were to place 'Low Cost Housing' or 'Social Housing' nearest the HVOTL and to introduce a 'Buffer Zone'. In addition, the majority of respondents believed that developers either 'Never' or only 'Occasionally' rejected land totally for development, although 16% felt that land was more likely to be rejected for residential use. The majority of respondents indicated that other variables were mainly encountered 'Sometimes' or 'Occasionally' (Table 6-20).

Table 6-20: Changes in Land Use

	Lower Price	Larger Plot	Buffer Zone	Low Cost Housing	Social Housing	Power Line Corridor	Reject Land For Housing	Reject Totally
Occasionally	35.5	41.4	25.1	27.1	24.9	25.9	40.5	36.3
Sometimes	22.6	23.7	37.2	25.2	27.3	32.7	21.0	11.4
Often	16.6	6.0	17.5	33.0	30.6	25.5	5.2	3.0
Always	1.4	.5	4.0	3.7	2.9	3.6	-	-
Never	24.0	28.4	16.1	11.0	14.4	12.3	33.3	49.3

6.4 RESIDENTIAL SURVEY

This section of Chapter Six analyses data gathered from two groups of residential occupiers, those living respectively 'near' and 'not near' a HVOTL[xxviii]

Public perception is one factor that has an impact on the desirability and value of a house[xxix]. Previous attitude studies established that public perception is generally negative towards HVOTLs[xxx] although the degree of negativity expressed by occupiers is often dependent upon whether they live close to, or have a view of a HVOTL. In addition, previous literature has raised some concern about the reliability of using public attitude surveys as a measure of likely market behaviour (Kinnard and Dickey, 1995[4]). The current research, whilst exploring residents' attitudes towards living near HVOTLs in the UK, attempted to address this issue by asking respondents to express their negativity in financial terms.[xxxi]

[xxviii] 'Near' is defined here as a residential unit within 200m of a HVOTL or with a prominent view. See Chapter Four: 4.6

[xxix] See Chapter Three 3.1

[xxx] Furby *et al.*, (1988); Delaney and Timmons[31]; Mitteness and Mooney[28]; Gallimore and Jayne[18]; Dent and Sims[25]; Chapter Three: 3.4

[xxxi] See 6.4.5 below; Chapter Four: 4.6.2 and Appendix IV)

6.4.1 Respondents

A total of 161 occupiers responded to the questionnaire. Of those, 11 were categorised as 'Not Near' a HVOTL and 150 'Near'.

6.4.2 Establishing Differences Between Cohorts

All variables were analysed using a Chi-squared test (X^2) to determine whether there were significant differences between the responses from the two cohorts[xxxii]. Both cohorts gave similar responses to all questions with one exception **Q3, 'Do you live near (within 100m) any of the following/line/pylon?'** As expected, the test values[xxxiii]. indicated that there was a significant difference between the case and control group to this question. (Chi-Squared value for living near a **line** was Chi^2 = 11.980, df = 1, p = .001 and for living near a **pylon** was Chi^2 = 12.60, df = 1, p = .000)

As respondents living in the control group were not able to see a HVOTL from their house, a similar result was anticipated for **Q4 'Are any of them** (line or pylon) **visible from your house?'** There was, however, no evidence to suggest a significant difference between case and control respondents, although there was concern regarding the accuracy of the Chi-Squared test for this question, due to an insufficient number of respondents within the control category[xxxiv].

Despite the small number of respondents within the 'Not Near' group, respondents were categorised as either 'Near' (the case group) or 'Not Near' (the control group) for further analyses to render the findings more objective. The results are shown as a percentage of responses from within each group.

6.4.3 Determining The Level of Concern Towards HVOTLs

To avoid focussing specifically on HVOTLs, residents were asked to express their level of concern towards four environmental features; a mobile phone base station, overhead telephone line, electricity sub station and HVOTL situated in a residential location. This would also place opinions towards HVOTLs in context with other environmental features.

With the exception of the overhead telephone line, all variables had been associated with EMFs and, therefore, possible health risks. Overhead telephone lines were included as a control to

[xxxii] Those living 'near' (The case group) and those 'not near' (control group) a HVOTL

[xxxiii] The test values are the t scores produced by the Chi square test.

[xxxiv] Results are only considered to be accurate if every expected value is above 5 for this question and some values, particularly in the control category, were below this.

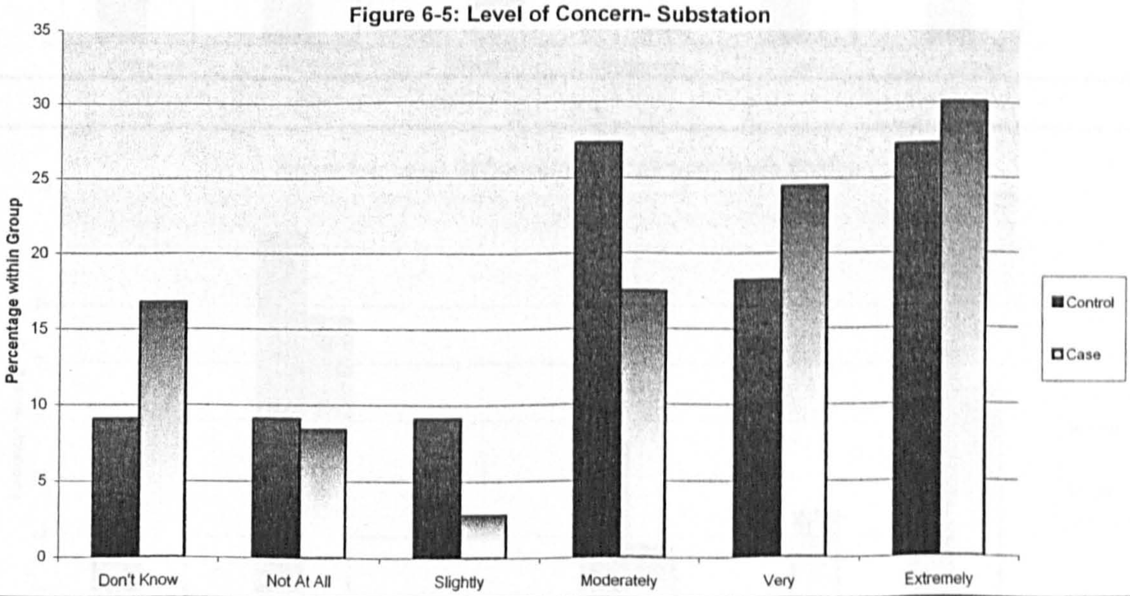
determine whether respondents were a) negative towards environmental features in general or only specific types and b) whether respondents were giving considered answers to the questions.

Question 1 (see Appendix IV) was designed to establish general levels of concern towards HVOTLs in relation to the other environmental features listed above. The results showed that a high percentage of respondents from both cohorts were 'Extremely Concerned' about the presence of a substation ('Near' [Case]= 30.1% and 'Not Near [Control]= 27.3%; Figure 6-5) and 'Very Concerned' about an overhead telephone line ('Near'= 36.4% and 'Not Near' 44.9%; Figure 6-7).

This was an unexpected finding, as telephone lines had never been associated with EMFs and health risks or the subject of media attention. This perhaps indicated that either the public were generally negative towards all the variables or had mistakenly associated the telephone line with the electricity line, possibly due to the fact that the telephone line had been described as 'overhead'.[xxxv]

HVOTLs produced a mixed response (Figure 6-6), with the majority of respondents living near HVOTLs stating that they were either 'Extremely Concerned' or 'Didn't Know' how they felt. Examining the difference between the cohorts revealed that people living near HVOTLs were slightly more concerned about their presence than people living further away (only 30% of the 'Near' cohort were 'Extremely Concerned', compared to 27% of respondents living 'Not Near') Of perhaps greater interest was the fact that the 'Near' group expressed a much higher degree of 'uncertainty' about the level of concern they felt towards HVOTLs than those living further away ('Near' = 30.8%; 'Not near' =18.2%)

Figure 6-5: Level of Concern- Substation



[xxxv] A similar level of concern toward telephone lines had also been noted in opinion surveys conducted by a Mori (Market and Opinion Research International) on behalf of the National Grid Transco to determine attitudes towards HVOTLs (John Swanson EMF Scientific Advisor for National Grid Transco).

Figure 6-6: Level Of Concern-HVOTL

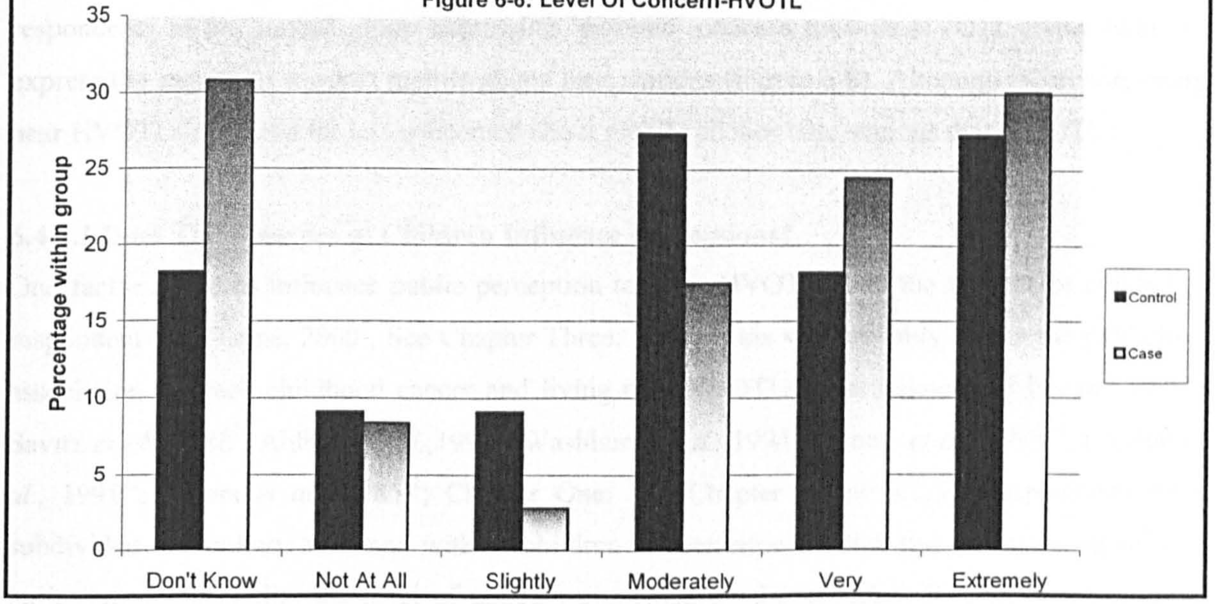


Figure 6-7: Level Of Concern-Telephone Line

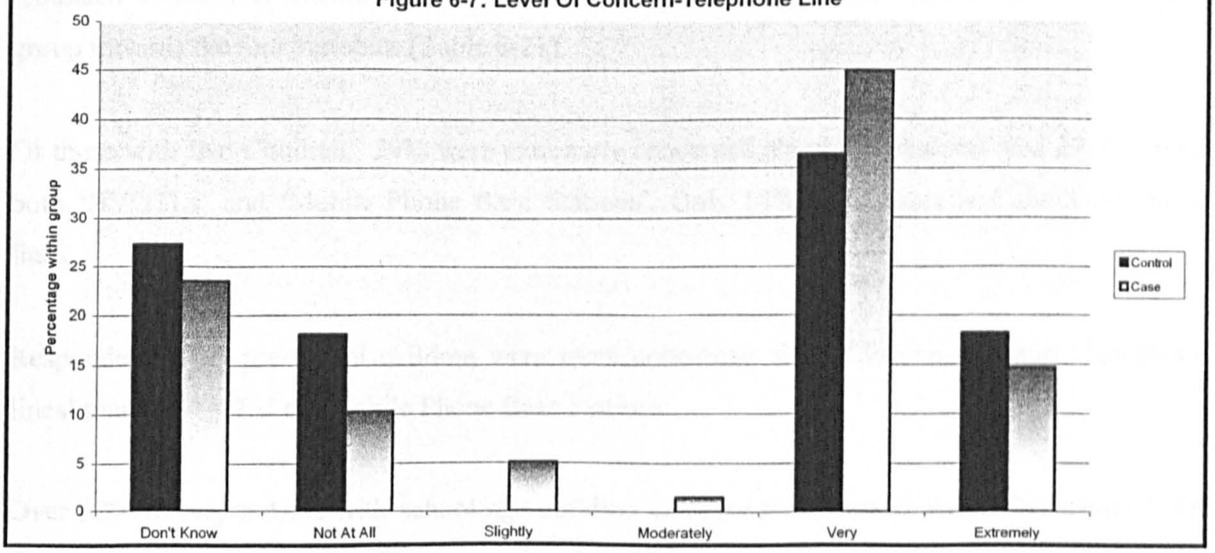
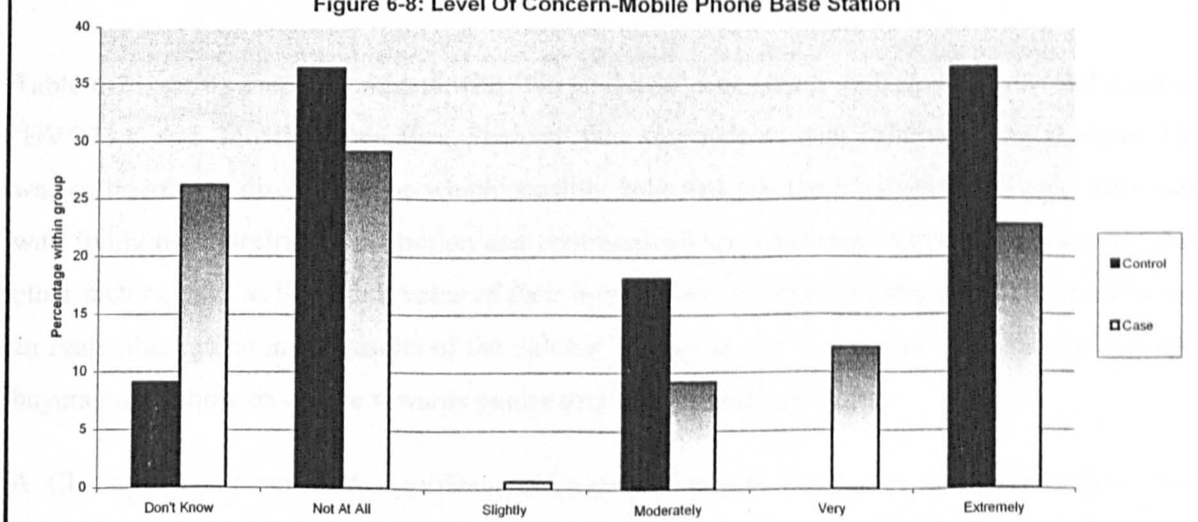


Figure 6-8: Level Of Concern-Mobile Phone Base Station



Comparing these results with the responses towards mobile phone base stations revealed that respondents in the control group expressing 'extreme' concern towards HVOTLs were likely to express the same bias towards mobile phone base stations (Figure 6-8). Although the cohort living near HVOTLs appeared far less concerned about mobile phones base stations than HVOTLs.

6.4.3.1 Does The Presence of Children Influence Perceptions?

One factor found to influence public perception towards HVOTLs was the number of children a respondent had (Jayne, 2000[5], See Chapter Three: 3.5.1). This was arguably due to the publicised association between childhood cancer and living near HVOTLs (Wertheimer and Leeper, 1979[6]; Savitz *et al.*, 1988[7]; Ahlbom *et al.*,1993[8]; Washburn *et al.*, 1994[9]; Tynes *et al.*, 1997[10]; London *et al.*, 1991[11]; Myers *et al.*, 1985[12]; Chapter One: 1.0; Chapter Three: 3.3.3). Respondents were subdivided into cohorts with and without children to determine whether this factor, as Jayne[5] had indicated, could predict the level of concern expressed by the occupier. Responses were cross-tabulated to establish whether or not this factor influenced the level of concern exhibited by each group towards the four variables (Table 6-21).

Of those with 'No Children,' 29% were extremely concerned about 'Substations' and 29.5% about both 'HVOTLs' and 'Mobile Phone Base Stations'. Only 14% were concerned about telephone lines.

Respondents with pre-school children were more concerned about 'Substations' and 'Telephone lines' than 'HVOTLs' or 'Mobile Phone Base Stations'.

Over 32% of respondents with school age children were most concerned about 'Substations'. Of those with children in the 5 – 12 year age bracket, 24% were equally concerned with both 'Mobile Phone Base Stations' and 'HVOTLs'.

Table 6-21 shows that respondents with 'No Children' were more concerned about 'Substations', 'HVOTLs' and 'Mobile Phone Base Stations' than respondents with children living at home. This was an interesting discovery, one which possibly indicated that the reported health risks associated with living near electrical distribution and communications equipment concerned buyers less than other factors, such as the future value of their home. Concern about the impact on future value was an issue highlighted in the results of the valuers' survey as one of the main reasons why potential buyers might show resistance towards purchasing a home near HVOTLs.

A Chi square test revealed significant differences between the opinions of respondents with children and those without children at the 90% confidence level towards 'HVOTLs' (Chi^2=10.819, df=5, sig=.055) and at the 95% confidence level towards 'Phone Line' (Chi2 = 18.156, df=5, sig=.003).

Table 6-21: Respondents Answering 'Extremely Concerned' - Cross-Tabulation to Determine Whether 'Number of Children' has an Impact on the Degree of Concern Expressed by Respondents

	Number of Children			
Extremely Concerned	**No Children**	**Pre-school Children**	**Children 5-11yrs**	**Children 12-18yrs**
Substation Count	27	4	7	6
% within 'number of children' category	29.0%	26.7%	35.0%	31.6%
HVOTL Count	28	2	5	2
% within 'number of children' category	29.5%	13.3%	23.8%	10.5%
Telephone Count	12	4	3	3
% within 'number of children' category	13.8%	26.7%	15.0%	16.7%
Mobile Phone Count	28	2	5	2
% within 'number of children' category	29.5%	13.3%	23.8%	10.5%

6.4.4 Reason For Residents' Concern

To explore the reason for the levels of concern expressed by residents, four variables were constructed to represent the most frequently cited 'drawbacks' associated with living near HVOTLs (See Appendix IV: Question 2)[xxxvi]. These were **Visual Impact** (Figure 6-9, 6-10); **Noise** (Figure 6-11); **Danger from Falling Line/Pylon** (Figure 6-12) **and Health Effects** (Figure 6-13 = HVOTL, Figure 6-14 = Telephone Line, Figure 6-15 = Mobile Phone, Figure 6-16 = Substation).

It was anticipated that, due to the publicised relationship between living near power lines and a number of unproven health risks, in particular, childhood leukaemia, the cohort living near HVOTLs would exhibit more concern about health risks, especially if they also had children. Respondents were asked to rank them on a Likert scale according to their personal levels of concern towards each feature:

1= not concerned ... .5 = very concerned.

The results revealed that the majority of respondents from both control and case study groups were extremely concerned about all four 'drawbacks' associated with a HVOTL (Table 6-22).

[xxxvi] See also Chapter Three generally; more specifically, Delaney and Timmons[31] and Mitteness and Mooney[28]

Respondents living near[xxxvii] a HVOTL were much less concerned about the visual impact from a line (figure 6-9) than a pylon (figure 6-10) Although, in general the 'Near' cohort were less concerned about the visual impact from all features (Substations, HVOTLs, Telephone lines and Mobile Phone Base Stations) than buyers living 'not near'. However, the cohort living 'Near' were found to be more concerned than the control group about the potential health risks from HVOTLs (Figure 6-13), Substations (Figure 6-16) and mobile phone base stations (Figure 6-15). It is possible that recent media attention focused on the potential health risks associated with living near HVOTLs and mobile phone base stations may have affected perceptions[xxxviii].

Table 6-22: Reasons Why Buyers are Concerned:- Majority Scores for the Level of Concern Expressed by Each Group of Buyers:- Case= buyers living near HVOTLs; Control = buyers living 'not near' HVOTLs

Reason for Concern	Type of Respondent	Residential Feature: Substation	HVOTL (line and pylon)	Telephone Line	Mobile Phone Base-Station
Visual Impact	*Case*	Moderately 27.7%	Extremely 47.2%	Not concerned 29.9% Moderately 28.3%	Extremely 35%
	Control	Not concerned 45.5%	Extremely 54.5%	Slightly 45.5%	Extremely 45.5%
Noise	*Case*	Not concerned 40% Very 40%	Extremely 34.1%	Not concerned 35.6%	Not 23.9% Very 23.1%
	Control	Very 26.7%	Extremely 36.4%	Not concerned 60%	Not 50%
Danger (Falling Line/ Pylon/ Electrocution	*Case*	Not concerned 21.8% Extremely 22.6%	Extremely 31.7%	Not concerned 27.8% Slightly 26.3%	Not 27.7%
	Control	Not concerned 36.4%	Extremely 31.7%	Not concerned 36.4%	Not concerned 30% Slightly 30% Extremely 30%
Health Risk	*Case*	Extremely 32.6%	Extremely 49.6%	Not concerned 37.8%	Extremely 54.3%
	Control	Not concerned 36.4%	Extremely 36.4%	Not concerned 36.4%	Extremely 45.5%

There was some concern expressed about the presence of 'Telephone Lines' but this was in relation to the 'Visual Impact' and 'Danger from - line breaking, pylon falling, electrocution'. The response to the variable 'Telephone Line' was particularly important, as this was the variable that tested the

[xxxvii] Although buyers were asked to indicate whether they lived within 100m of a HVOTL, research by Priestley and Evans (1992[32], see Chapter Three: 3.4.6) indicated that buyers often overestimated the proximity of the HVOTL. 'Near' was therefore was taken to mean 'on an estate where a HVOTL was sited and visible from the respondents' home.

[xxxviii] See Chapter Three: 3.4.8.

internal validity of the Buyers' survey and provided the main determinant of the reliability of the results.

6.4.5 Internal Validity

The response to the variable 'Telephone Line' posed in all questions enabled the researcher to make some assumptions about the validity and credibility of the responses to the questions. The results indicated that respondents from both groups had, with the exception of responses to Question One, differentiated between the degree of concern exhibited towards 'Telephone Lines' and other variables; they were less concerned about the presence of a 'Telephone Line'. This showed that they had read the questionnaire and had given some consideration to their responses to some, if not all, of the questions posed.

Figure 6-9: Visual Impact of a HVOTL(Line)

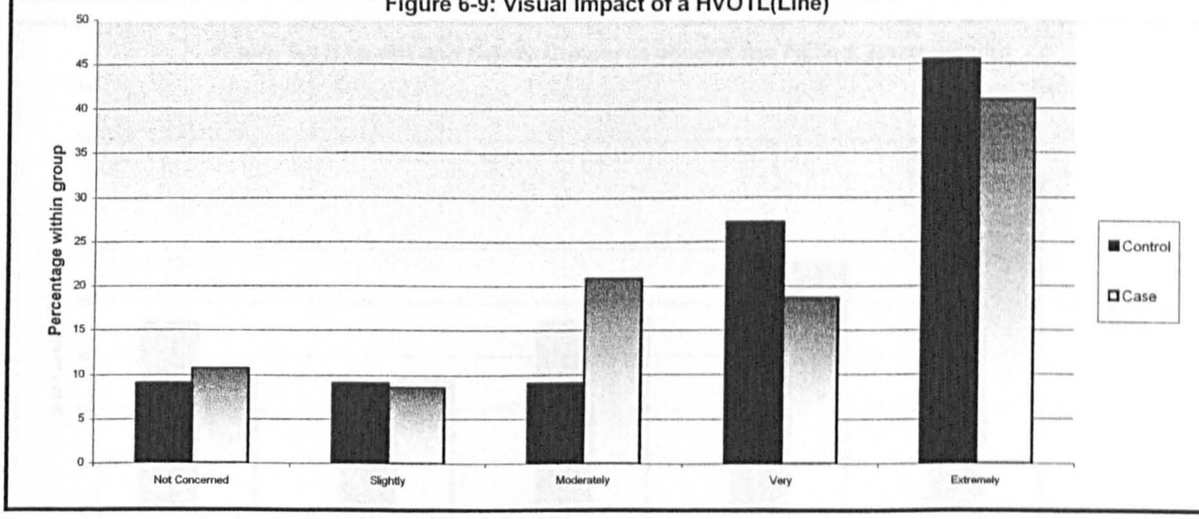
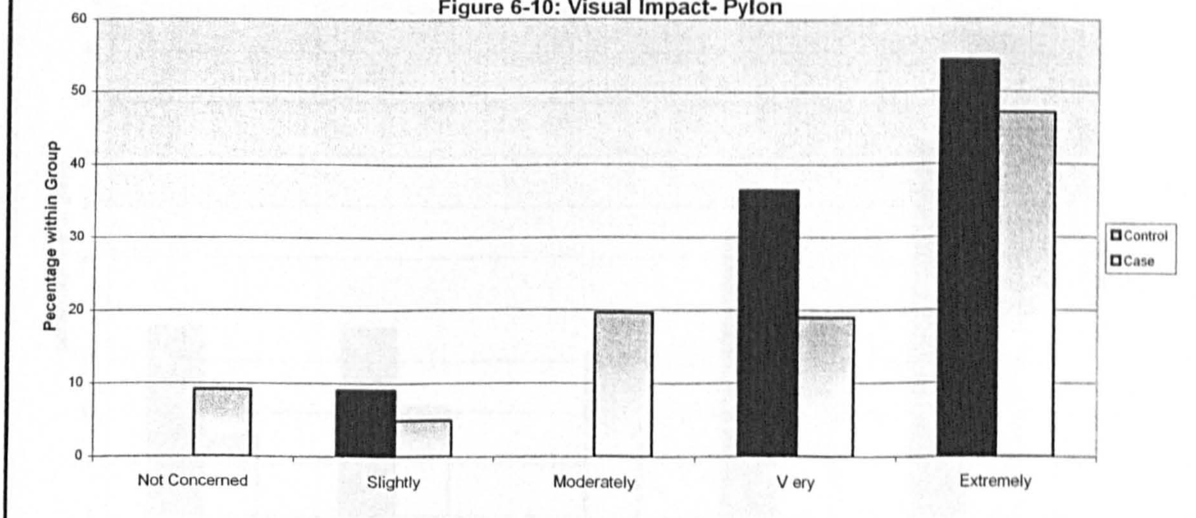


Figure 6-10: Visual Impact- Pylon



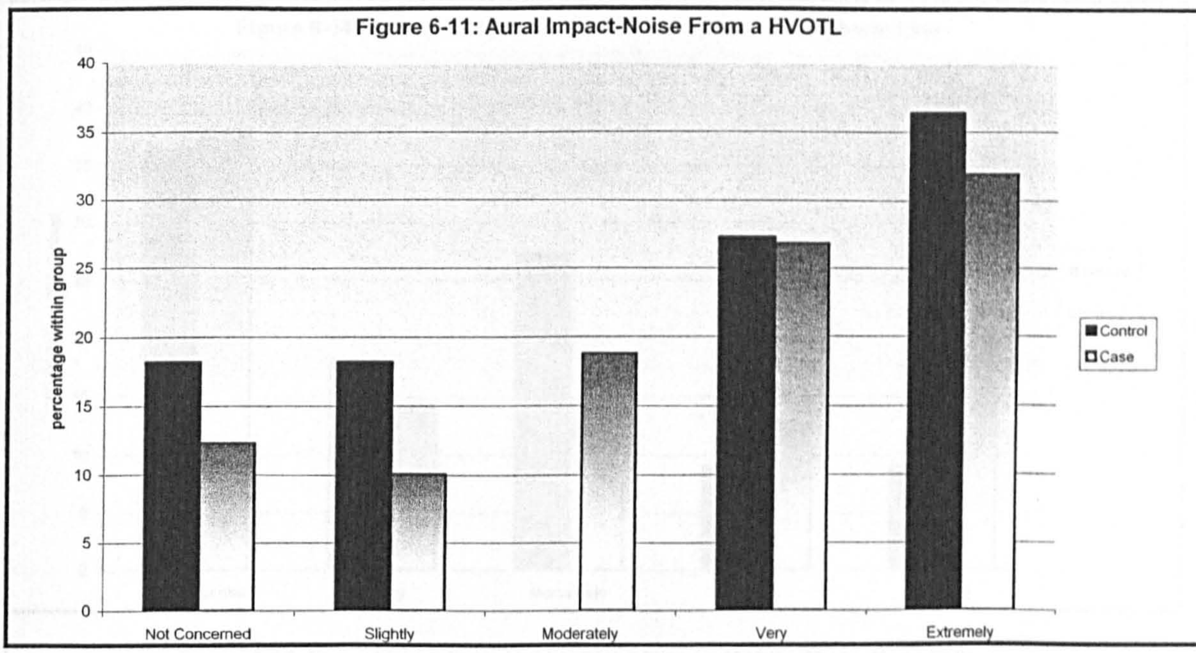


Figure 6-11: Aural Impact-Noise From a HVOTL
percentage within group
0
5
10
15
20
25
30
35
40
Not Concerned
Slightly
Moderately
Very
Extremely
Control
Case

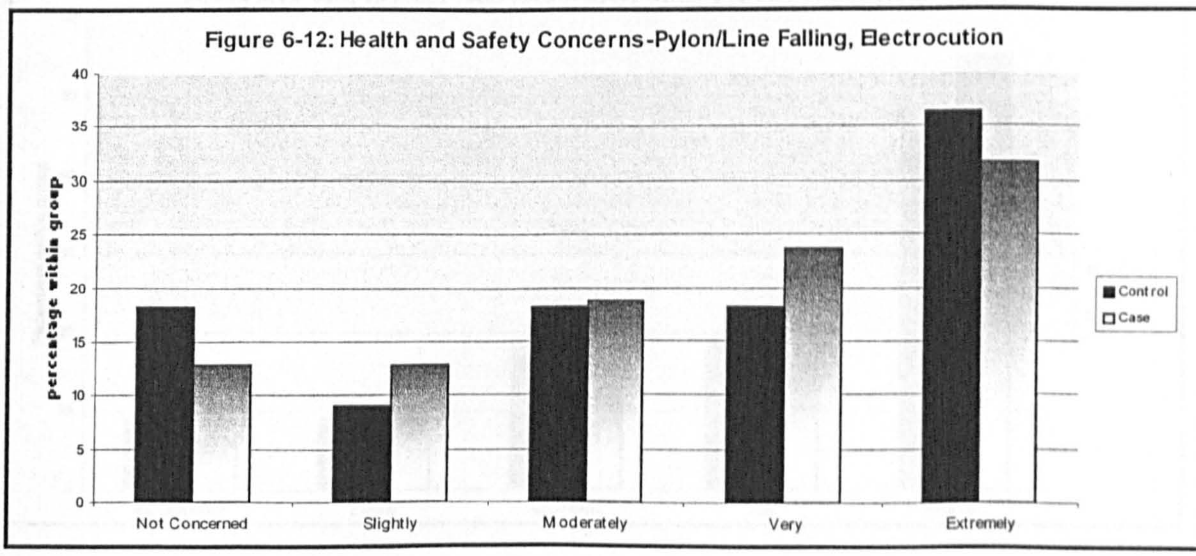


Figure 6-12: Health and Safety Concerns-Pylon/Line Falling, Electrocution
percentage within group
0
5
10
15
20
25
30
35
40
Not Concerned
Slightly
Moderately
Very
Extremely
Control
Case

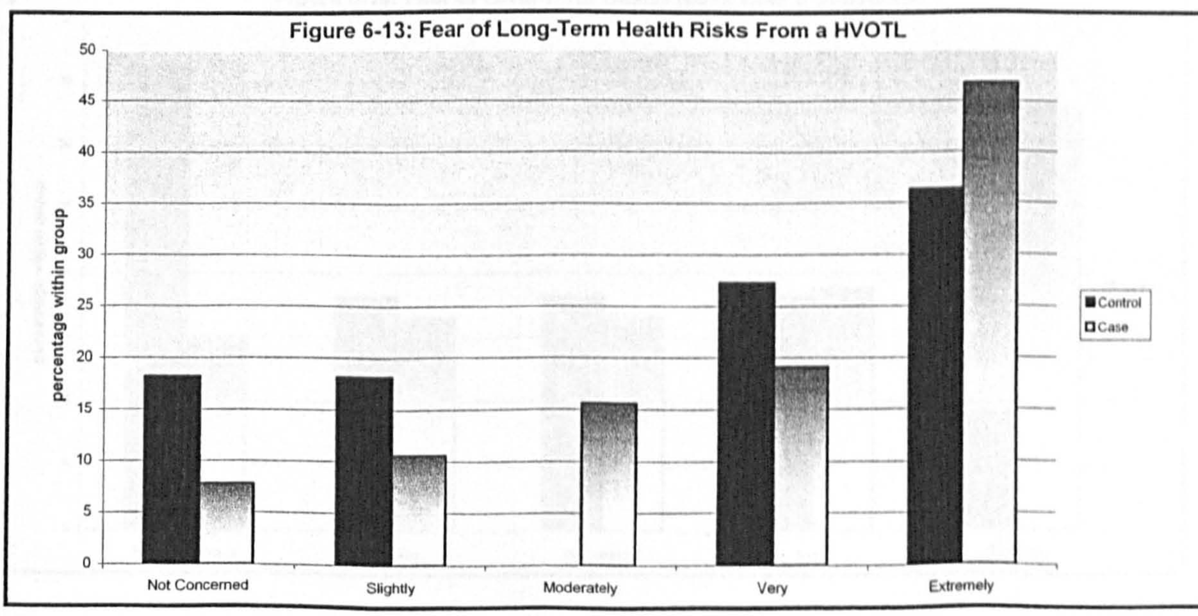


Figure 6-13: Fear of Long-Term Health Risks From a HVOTL
percentage within group
0
5
10
15
20
25
30
35
40
45
50
Not Concerned
Slightly
Moderately
Very
Extremely
Control
Case

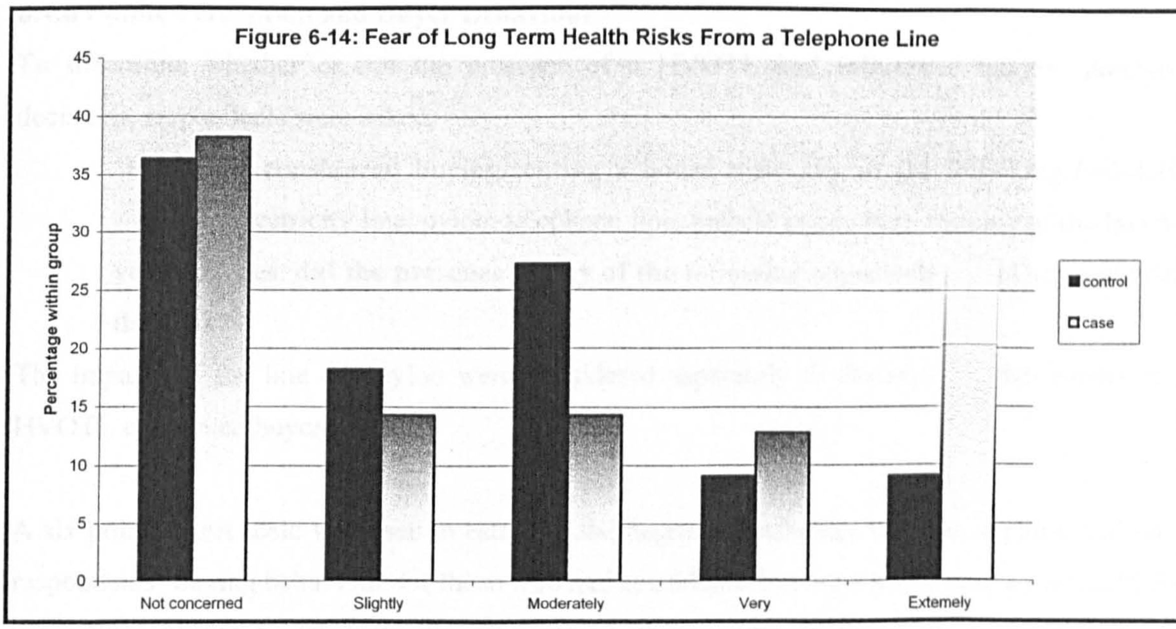


Figure 6-14: Fear of Long Term Health Risks From a Telephone Line
Percentage within group
0
5
10
15
20
25
30
35
40
45
Not concerned
Slightly
Moderately
Very
Extemely
control
case

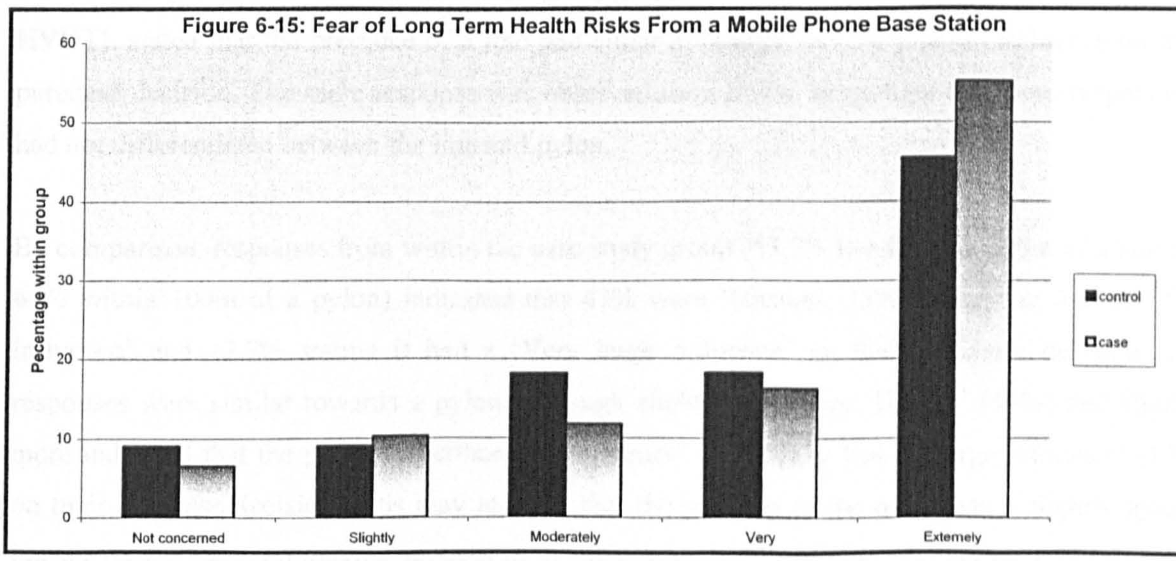


Figure 6-15: Fear of Long Term Health Risks From a Mobile Phone Base Station
Pecentage within group
0
10
20
30
40
50
60
Not concerned
Slightly
Moderately
Very
Extemely
control
case

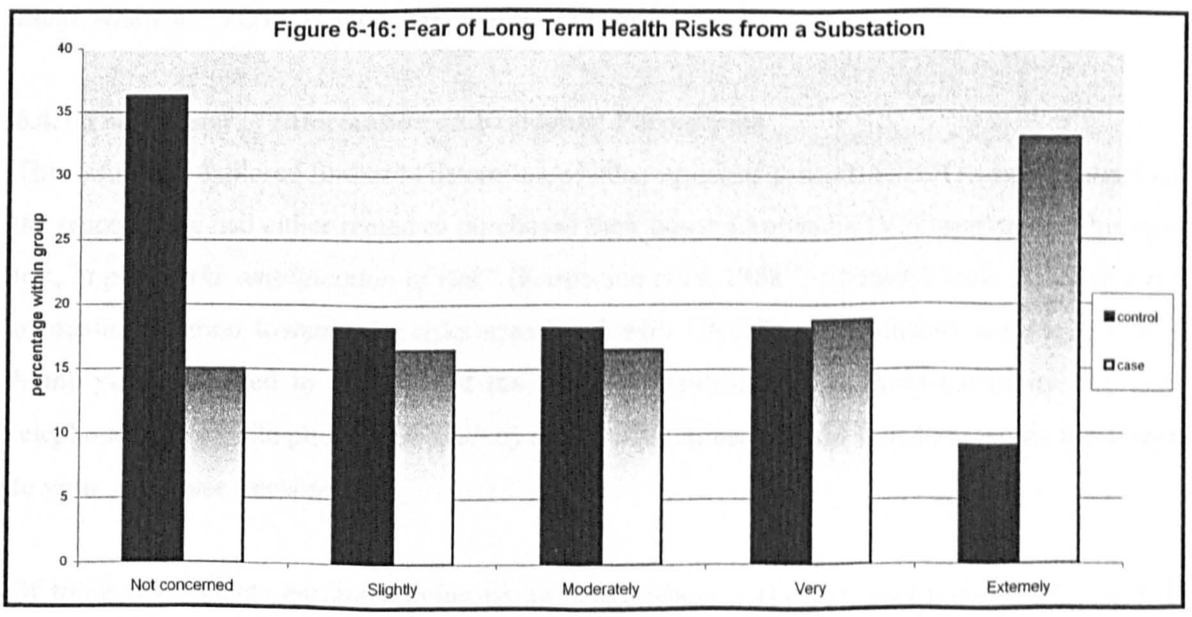


Figure 6-16: Fear of Long Term Health Risks from a Substation
percentage within group
0
5
10
15
20
25
30
35
40
Not concerned
Slightly
Moderately
Very
Extemely
control
case

6.4.6 Public Perception and Buyer Behaviour

To determine whether or not the presence of a HVOTL had influenced buyers' purchasing decisions, respondents were asked,

> **'Have you considered buying/renting a house near any of the following** (substation, overhead electricity line, pylon, telephone line, mobile phone base station) **in the last 5-10 years- If Yes, did the presence of any of the following negatively affect your purchase decision?**

The impacts of the line and pylon were considered separately to determine which aspect of the HVOTL concerned buyers most.

A six point Likert scale was used to establish the degree of influence the line or pylon had on the respondents' buying behaviour. Of those who had considered buying a house near a line (20% from the control group; 52.7% from the case group), those currently living on an estate without a HVOTL stated that the presence of a line had either a 'Large' or 'Very large' influence on their purchase decision. The same response was observed for a pylon, suggesting that these respondents had not differentiated between the line and pylon.

By comparison, responses from within the case study group (53.7% lived within 100m of a line and 66% within 100m of a pylon) indicated that 47% were 'Unsure', 13% stating the line had 'No influence' and 13.7% stating it had a 'Very large influence' on their purchase decision. The responses were similar towards a pylon, although slightly less were 'Unsure' (44%) and slightly more indicated that the pylon had either 'No influence' (14.2%) or had a 'Large influence' (14.2) on their purchase decision. This may indicate that the position of the pylon has a slightly greater impact on the decision-making process of a buyer who is considering purchasing a house on an estate where a HVOTL is sited, although the evidence is weak.

6.4.7 The Impact of Information on Residents' Perceptions

This issue was explored further to determine whether opinions towards HVOTLs had changed since the respondents had either rented or purchased their house (Appendix IV: Question 6). This was to test, in part, *"the amplification of risk"* (Kasperson *et al.*, 1988[13]; Chapter Three: 3.1.2) as a result of media attention towards the risks associated with HVOTLs. Participants were asked **'If the home you now lived in had any of the following** (substation, overhead electricity line, pylon, telephone line, mobile phone base station) **close to the house, would that have made a difference to your purchase decision'?**

Of those respondents currently living on an estate where a HVOTL was present, 47% said they would have 'Not bought' their house if it was sited within 100m of a HVOTL (Table 6-23). 48% would have 'Not bought' if it was sited near a pylon (Table 6-24).

15% of respondents from both cohorts indicated that they would have 'Offered a lower price' if their current home was within 100m of the HVOTL, and 18% of respondents indicated that they would have only 'Offered a lower price' if either pylon or line were visible from their house.

Table 6-23: Impact of Information on Willingness to Purchase a House Near a HVOTL

HVOTL	% of respondents Respondent	
	Control	Case
Not bought house	80.0%	46.9%
Offered lower price	10.0%	14.8%
Offered lower price only if visible	-	18.0%
No difference	10.0%	18.8%

Table 6-24: Impact of Information on Willingness to Purchase a House Near a Pylon

PYLON	% of respondents Respondent	
	Control	Case
Not bought house	80.0%	47.7%
Offered lower price	10.0%	15.2%
Offered lower price only if visible	-	18.2%
No difference	10.0%	18.2%

Perhaps not surprisingly, according to Reese (1967)[14] (see also Chapter Three: 3.4.3), when asked **'How much lower'** they would have offered for their house[xxxix], the majority either did not know (18.4%) or stated they would have offered between 5% -10% less than they paid.

6.4.8 Willingness to Pay to Have the HVOTL Removed

In an attempt to resolve the dichotomy between expressed public opinion and market behaviour,[xl] residents were asked to express any negativity towards the presence of a HVOTL in terms of a willingness to pay to have it removed. Of those who responded, 31.7% said they would pay and 27.8% would pay only if it increased the value of their home[xli].

Finally, to try to attribute a value to the degree of negativity expressed by respondents', Question 9 (Appendix IV) presented a hypothetical situation and asked, **'If removing some of these features from your neighbourhood increased the present value of your house by 10%, would you be**

[xxxix] Appendix IV: Question 7.

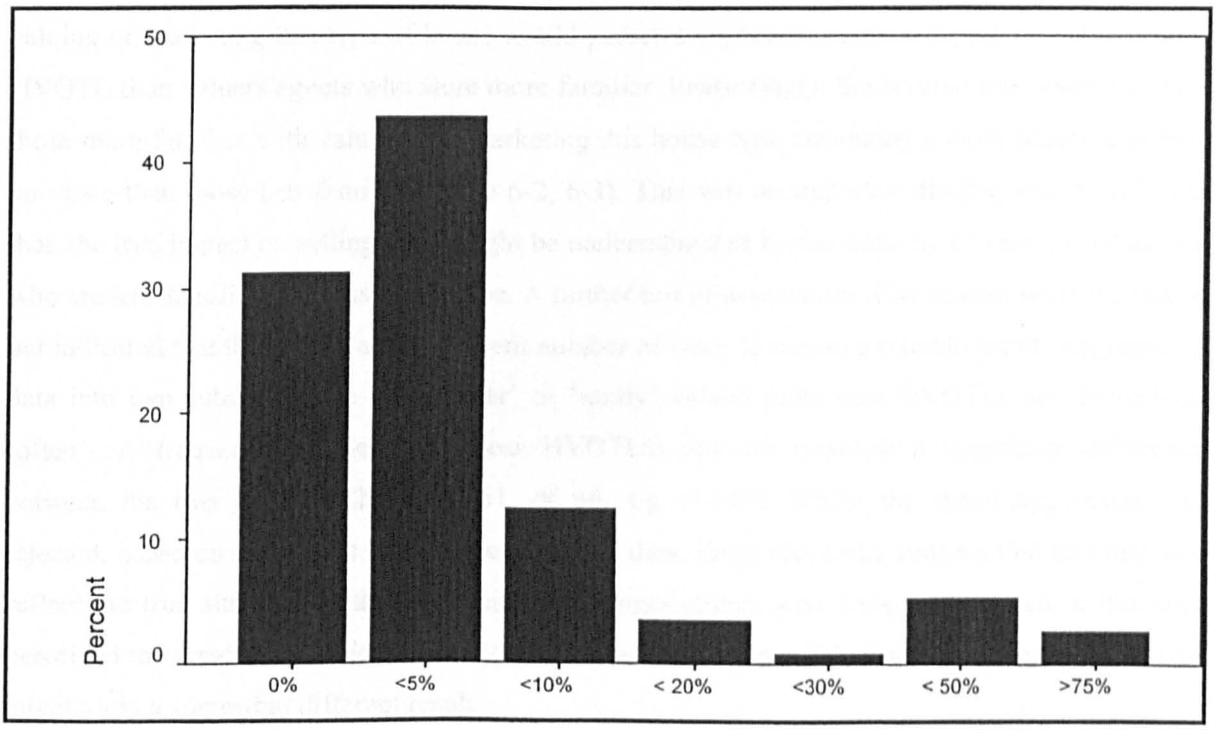
[xl] See Chapter Three: 3.4.4; Kinnard and Dickey[4]

[xli] Appendix IV: Question 8

willing to pay part of that 10% increase towards the cost of their removal? If YES, then how much? (theoretically, you would not pay this sum until you sold your house).'

43 % of the respondents who indicated a willingness to pay were only prepared to pay up to 5% of the increased value of their home to remove both line and pylon. Just over 12% would pay up to a maximum of 10% of that increase in value and 13% indicated a willing to pay up to 15% of the increase in market value. 4% of the respondents would pay 20% of the increase; 1% would pay up to 30% of the increase; 5% would pay up to 50% of the increase; 3% would pay up to 75% (Figure 6-17).

Figure 6-17: 'Willingness to Pay' To Have The HVOTL Removed: Expressed as a percentage of a hypothetical value increase of 10% of the current value of a house.



6.4.8.1 The Presence of Children and the 'Willingness to Pay'

The results from earlier analyses (see Table 6-21, above) undertaken to establish the general level of concern expressed towards HVOTLs had indicated that the cohort without children were likely to be more concerned about the presence of a HVOTL than occupiers with children. A further test of association was undertaken to establish whether or not there was a correlation between the 'willingness to pay' to have the HVOTL removed and the 'number of children living at home'. No significant association between having children and a 'willingness to pay' was found. (Chi^2 = 5.054, df = 4, sig =0.282)

6.4.9 Summary of Surveys

Valuers' Survey

The Valuers' survey revealed no significant difference between the opinions of estate agents, who market residential buildings and professional valuers who value, normally, for mortgage valuation purposes[xlii]. Their responses suggest that value is reduced, on average, by between 5% and 10% (see Figure 6-4 above) and that the main reasons for a reduction in value is concern about future value, potential health risks and noise (see Tables 6-10, 6-9, 6-7; Model 6-1 above). The same factors were found to be significant in relation to an increase in marketing time (see Tables 6-17, 6-16, 6-14; Model 6-2 above). In addition, a reduction in the number of buyers was noted (Tables 6-4, 6-5 above), which correlated with the observed increase in marketing time.

It was hypothesised (Hypothesis 2) that valuers and agents who had little or no experience of valuing or marketing this type of house would perceive a greater negative impact on value from a HVOTL than valuers/agents who were more familiar. Interestingly, the reverse was observed, with those more familiar with valuing and marketing this house type estimating a more negative impact on value than those less familiar (Table 6-2, 6-3). This was an important finding which indicated that, the true impact on selling price might be underestimated by the majority of valuers and agents who are less familiar with this house type. A further test of association (Chi square) was undertaken but indicated that there were an insufficient number of cases to ensure a reliable result. Aggregating data into two subsets (those who 'never' or 'rarely' valued units near HVOTLs and those who 'often' or 'frequently' valued units near HVOTLs) did not establish a significant difference between the two groups (Chi2 = 5.851, df =6, sig, =.440). Whilst the stated hypothesis was rejected, based on the results from aggregating the data, there was some concern that this may not reflect the true situation as the small number of respondents who were experienced in this area perceived the greatest reduction in value. There was therefore a possibility that a larger sample size might yield a somewhat different result.

Participants were asked to indicate the most frequently observed actions taken by builders when developing sites crossed by HVOTLs (Table 6-20). These were found to be placing low cost and social housing nearest the line and introducing a buffer zone. It was difficult to prove or disprove whether this perception was accurate in relation to social housing, as social housing is now owned by Housing Associations or private landlords (Worcestershire Development Services). Valuers and agents may have gained this information through knowledge of their local market.

[xlii] See footnote iv above and Chapter Four 4.4.3

The responses indicated that, valuers and agents had not observed an increase in the plot size of homes near a HVOTL. Over 30% indicated that developers 'Never' increased plot size. This was a surprising result, considering that the valuation data analyses (Chapter Five) observed plot size to be generally larger for houses nearest the HVOTL than similar houses further away.

One question not addressed in the questionnaire was, **'On what basis'** valuers calculated the impact of a HVOTL on residential house values and how estate agents determined the asking price. Whilst it was assumed that valuers would use comparable house sales and some element of 'guesstimation' to arrive at a figure, this issue needed to be addressed through a number of telephone interviews (see paragraph 6.5 below).

Residents' Survey

The Residents' survey indicated that over 31% of the respondents from within each group (those living 'Near' HVOTLs and those living 'Not near') were extremely concerned about all aspects of HVOTLs. Further analyses revealed some differences between the opinions of the two cohorts which indicating that respondents living 'Near' HVOTLs were less concerned about the visual impact and more concerned about the association with a health risk than those living 'Not near'. It was expected that the sub-group with children would be more concerned about living near the HVOTL than those with no children. Interestingly, the sub-group found to be most concerned was the cohort without children. [xliii]

Asking residents about their **'willingness to pay'** to have the HVOTL removed based on a hypothetical increase in the value of their home, showed that 32% of respondents would be willing to pay to have a HVOTL removed. A further 28% were only 'willing to pay' if it increased the value of their home.[xliv] Overall, very few residents were willing to pay more than 5% of the increase value of their home.

There were a number of more qualitative aspects of living near a HVOTL, which could not be answered in a short postal questionnaire; in particular, why residents had chosen to live on an estate where there was a HVOTL. There were also questions raised by the results of the transaction data analysis that required an explanation, most specifically, the fluctuations in annual determinants of transaction price for houses in the Blackwood area.

[xliii] See 6.4.4 and Table 6-21 above.

[xliv] It is possible that some confusion arose with regard to the wording of this question, as participants were asked to indicate what percentage they would be willing to pay to have the HVOTL removed based on the hypothetical increase of 10% of the current value of their house which might occur if the HVOTL was not visibly present.

Therefore, to support the findings from the data gathered through case studies and surveys, a number of face-to-face and telephone interviews were conducted with property professionals, residents living in the case study location, and employees from the electricity utility.

6.5 INTERVIEWS

Aim and Purpose of the Interviews

The main aim of conducting interviews was to provide an additional source of data within the multi-method approach adopted for the research which would enable the results from the 'Valuation Research' and the postal surveys to be further informed, thus improving the reliability and validity of the research finding.

6.5.1 Residential interviews

Residential interviews were conducted as an alternative method of obtaining occupiers opinions towards living near HVOTLs. The 'Buyers' postal survey had indicated that attitudes towards HVOTLs were generally negative. However, due to design constraints, justified earlier,[xlv] the postal survey was unable to generate the explanatory data required to understand the *"paradoxical behaviour"*(Slovic, 1987[15]; Kasperson, 1992[16]) of buyers, who expressed negativity towards HVOTLs but still made the choice to live near one, possibly due to limited resources and the fact that residential units were cheaper than comparable units in the same area (see Chapter Five: 5.3.4.4). In addition, conducting face-to-face interviews with residents enabled other previously unexplored, although related, issues to be raised.

6.5.1.1 Methodology

30 doorstep interviews were conducted with residents living in the valuation case study locations. 10 willing participants were found in Blackwood, St Peter's and Walmley. This was the method chosen to address the issue of poor response from the postal survey. The method of obtaining an interview was through 'cold calling'. An ID badge was worn. One person carried out all interviews to ensure consistency.

Scotland:	All interviews took place on Friday 25th September 2003.
St Peter's:	All Interviews took place during October and November 2003.
Walmley:	All Interviews took place during July and September 2003.

Schedule of Questions

The following questions were ask all interviewees:

How long have you lived in this house?

[xlv] Previous research and piloting had indicated that the response rate was inversely correlated with the length of the questionnaire. See Chapter Four: 4.4.7 and Clarke (1972).

What was it about this neighbourhood that made you choose to move here?

Do you have children?

More specifically: what do you like about this neighbourhood?

What do you dislike about living here?

How do you feel about .... A list of environmental features specifically relating to each neighbourhood was given. The relevant features were introduced into the interview when necessary (if they were not mentioned by the interviewee) including the HVOTL. This was to avoid focusing specifically on this feature. The features were:

- **The lake**
- **The local shops**
- **The green open space**
- **The overhead power lines**
- **Public transport**
- **Local schools**
- **Access to the motorway network**
- **Football stadium**
- **Mobile phone base station**
- **Substation**

Interviews were brief and notes were made during and immediately after the interview then typed-up later (see Appendix XIII). Names and addresses have been withheld to maintain confidentiality and substituted with an Interview number (I.N.) from 1 to 30.

6.5.1.2 Results From The Residential Interviews

Overall the response to the question '**How do you feel about the overhead power line?**' indicated that residents are generally unconcerned by the presence of a HVOTL on the estate.

18 residents out of 30 interviewed indicated that they were either unconcerned or did not notice the HVOTL (Appendix X111: I. N., 1,3,5-13,16,18,22-24,29,30).

Seven occupants stated that they had heard about potential health risks in the media, but felt that the HVOTL was too far away from their house to be a health risk (Appendix XIII: I.N., 2,4,15,17,20,26,29,30).

Five occupants indicated that they were unconcerned about the HVOTL but would not want to live any closer (Appendix XIII: I.N., 14,17,20,21,26).

One occupant who lived next to the line stated that he had heard of the health risks associated with living near HVOTLs, but did not feel that the risk was very great. By comparison, one resident who had developed a chronic illness since moving into his house with a HVOTL at the bottom of the garden was now very concerned about the potential health risk (Appendix XIII: I.N., 25).

One occupant (Appendix XIII: I.N.,4) revealed that there had been a recent postal survey undertaken on their estate, however, although the questions related to the presence of HVOTLs, she did not believe it was from Oxford Brookes University. She had not completed the questionnaire and indicated that she was concerned that ongoing research into the health effects might have a negative impact on the value of her house in the future. Although it could not be confirmed that the questionnaire originated as part of this research, this factor highlighted one of the concerns associated with undertaking residential surveys namely; the risk of raising awareness of the publicised potential health risks associated with living near HVOTLs and subsequently creating negative impacts on the residential market which did not previously exist (See Chapter Four: 4.6.1).

Five occupants could hear buzzing from the line but were otherwise unconcerned. Overall, residents living next to HVOTLs, or alongside the 'right of way' did not notice any 'buzzing' from the lines except when it was very damp.

No residents stated that they had a problem with bird mess, although, in most cases, the lines did not pass directly over their garden.

One occupant interviewed had heard a rumour that the line was being removed (Appendix XIII: I.N.,25). Only one resident associated the presence of the HVOTL with the benefits of open green space (Appendix XIII: I.N., 23).

In response to the question, **'What was it about this neighbourhood that made you choose to move here?** economic considerations for choosing the location were indicated by nearly half those interviewed (Appendix XIII: I.N., 2-6, 13, 15, 16, 18-20, 27-29) suggesting that, residential units on estates where there is a HVOTL, are less expensive than similar units elsewhere. These findings supported Mundy's (1992[17]) earlier research in which he concluded that buyers would often disregard the presence of the HVOTL if house prices were reduced relative to comparable units in the same location. The respondents from all three locations indicated that their neighbourhoods were quiet and trouble free.

It was noted that the use of land around the HVOTL was treated differently on each estate. In Blackwood, the HVOTL was sited in a ROW, which seemed generally unused by the local residents. The Blackwood Estate was, however, surrounded by countryside and a lake. In St Peter, the power line corridor was used as a cycle path and in Walmley the HVOTL was sited in green fields used by the residents for leisure purposes.

Whilst expressed attitudes were observed to be generally negative towards the presence of HVOTLs, respondents with children were found to be more concerned about mobile phone base stations and substations than HVOTLs. Gallimore and Jayne 1999[18] and Jayne's[5] later research, had observed a relationship between the level of concern expressed by respondents towards HVOTLs and the number of children they had. Whilst the findings from the current research clearly indicate a different result, this may simply be indicative of a recent shift in public concern away from HVOTLs and towards the more publicised perceived health effects from living near a mobile phone base station[xlvi], rather than an indication than 'number of children' is not a factor (referred to as a heuristic[xlvii]), which can influence a person's estimation of risk. The most frequently cited reasons for choosing to live in the case study locations were; the estate was trouble-free, quiet and, in support of Mundy's[17] research, that houses were affordable.

The most frequently cited reasons for moving to the location were a desire to live in that area, location of work or location of family. These aspects appear to be the main drivers in the decision to live in the case study locations for the occupants interviewed.

6.5.2 Valuers and Agents Interviews

The main aim of conducting the valuer and agent interviews was to establish which methods were normally used to determine the impact of HVOTLs on value or asking price.

6.5.2.1 Methodology

Estate Agents and Chartered Surveyors were contacted in areas where there were known to be homes near HVOTLs. Agents and valuers were often difficult to interview as they were frequently away from the office. 16 interviews were conducted over the phone. Interviews were brief and undertaken by one interviewer to ensure consistency. Notes were made during the interview and typed up afterwards. two people requested not to be named. All participants were allocated an interview (I.N.) number between 33 and 49. All interviews can be found in Appendix XIII.

One question was asked of all participants, namely; **What method do you use to determine the value or asking price of a house sited near a HVOTL?**. Other questions evolved in response to statements made by the respondents. Other questions asked when relevant included:

[xlvi] This may be due to recent media attention focused on mobile phone base stations, due to the increasing demand for network coverage and a perceived relationship between living near base stations and cancer. See Chapter Three: 3.4.1 and Chapter One: 1.6.

[xlvii] See Chapter Three: 3.1.2.

- **Have you valued property near a HVOTL?**
- **Do you reduce value by a set figure?**
- **Does the current state of the market have an impact on the effect of a HVOTL?**
- **Does the presence of a HVOTL reduce the number of interested buyers?**
- **Which has a more negative impact, the line or the pylon?**

6.5.2.2 Results of The Valuer/Agents Interviews

Overwhelmingly, valuers and agents were found to use comparable evidence as a starting point 'or anchor'[xlviii] for the valuation process (I.N., 33-49). Three interviewees said they used floor area, in addition to comparables (I.N., 34,36,48). This was informed by knowledge of the local market and *"a little guesswork"* (I.N.,34), to determine the value or asking price of HVOTL-proximate houses. Gallimore (1996[19]) Diaz (1990a[20]; 1990b[21]) and Daly (2001[22]) found that valuers had a tendency to anchor to list price and were, on occasion, inappropriately influenced by it. It was, however, difficult to determine whether or not valuers anchored to list price and sought out, or only accepted, information which supported preconceived perceptions of the impact of a HVOTL on value (Gallimore, 1996[18]; Slovic and Lichtenstien, 1971[23]; Fischhoff, 1985[24]).

Only half of the participants interviewed indicated that the HVOTL would have some negative impact on value. The degree of impact, however, depended on the individual house (I.N., 34,36,40,44,45,46,48,49) and whether, or not, the market was buoyant (I.N., 34,37,38,40,41,43,44,46). Agents and valuers indicated that they preferred to 'let the market drive the price down' rather than actively adjusting for the presence of a HVOTL (Appendix XIII: I.N., 34,35,36,37,38,40). One valuer stated that for mortgage purposes, asking price could be adjusted down by as much as 10% if a pylon was very near to the building; however, he said there was 'no rule of thumb' (I.N., 45). By contrast a reduction of up to 25% was indicated by another valuer (I.N., 40) which suggested that opinions of diminution can vary considerably.

Two agents stated that residential units would 'eventually sell' at around asking price (I.N., 37,38) which perhaps correlated with a reduction in the number of interested buyers (I.N., 36,38,49). Other agents/valuers indicated that, prospective buyers were only 'put off' by the HVOTL when the market was not very buoyant and there were substitute homes available. (I.N., 34,38). One interviewee indicated that demand was so high for new houses in the Sutton Coldfield area that the presence of the HVOTL had had no impact on sale-ability and houses was selling like 'hotcakes' (I.N., 39).

[xlviii] See Chapter Three: 3.1.3

Lending companies: According to one surveyor (I.N., 45), lending companies can be particularly risk-averse towards lending if lines cross over buildings. He revealed that the Alliance and Leicester standard paragraph reference for mortgage valuations, sub-section 'Electro-Magnetic Fields' states:

> *"There is high voltage electrical supply equipment close to the property. Possible effects of electromagnetic fields have been the subject of media coverage. The National Radiological Protection Board (NRPB) an independent body with responsibility for advising on electromagnetic fields has advised that, following studies in 2000 and 2001, there may be a risk in specific circumstances, to the health of certain categories of people. Public perception may, therefore, affect marketability and future value of the property."*

This added support to the findings from an earlier UK study Dent and Sims (1999[25]) and a study in the USA by Kinnard and Worzala (1996[26]) which had concluded that lending institutions were more averse towards lending on residential units sited close to, or under a HVOTL. Another valuer was aware of a recent study conducted by the National Grid in connection with SWEB (South Western Electricity Board) which suggested a 4% - 7% reduction in value due to the presence of a HVOTL[xlix] (I.N., 40).

Of most interest was information regarding the successful claim for loss of value compensation against the electricity utility for a residential unit that was neither touched nor crossed by a HVOTL. The pylon, which supported a 440kV line owned by NGC, had been sited so close to the boundary fence of the property on which it stood, that it over-shadowed the adjacent building causing Injurious Affection. Less than 40 comparables were used to establish the negative impact on value and an out-of-court settlement was made (I.N., 48).

6.5.2.3 Summary

Overall, the interviews indicated that comparable evidence is the method most frequently used to establish asking price. Asking price is rarely significantly reduced when the unit first comes on the market. Agents prefer to let buyer behaviour drive the asking price down rather than actively making an allowance for the possible negative impact of the HVOTL. HVOTLs have less impact on the value and desirability of a house when the market is buoyant. For mortgage purposes, the HVOTL is taken into consideration; however, there is no 'rule of thumb', although if a pylon is close, or the HVOTL touches or crosses property, value will be reduced. The visible presence of the

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[xlix] Following this conversation, several calls were made to the National Grid and SWEB by the author to obtain the results of this study. However, no one was able to provide any further information. Information was later provided by John Swanson EMF Scientific Advisor for National Grid Transco (See I.N., 33).

HVOTL will reduce the number of willing buyers; however, this appears to depend on the availability of substitute units and current market conditions. Finally, a pylon would have a more negative impact on asking price than the line.

6.5.3 Residential Developer Interviews

The main aim of the residential developer interviews was to establish developers' attitudes towards land crossed by a HVOTL.

6.5.3.1 Methodology

Phone calls were made to the land-buying departments of seven residential developers. Only four were able to give a brief interview.[1] Notes were made during the interview and typed up afterwards. Two key questions were asked. These were; **Does your company buy land crossed by HVOTLs for residential development?** if yes, **Do you have a policy regarding developing the land? And if so, what is it?**

6.5.3.2 Results of the Residential Developers Interviews

All interviewees indicated that, although they do buy land where HVOTLs are sited, they will generally only do so if they can move the lines and either re-site them underground or around the planned development (Barratt Homes, East Scotland Division; Taylor Woodrow, Midlands; Persimmon Homes, Midlands; Peveril Homes, Derby (I.N., 50-53).

All indicated that the visible presence of a HVOTL had made it difficult to sell some new homes in the past. The Land Buyer at Taylor Woodrow stated that they had been forced to let some houses go at 'silly prices' just to get rid of them (I.N. 50) If no other suitable site is available, they would rather pay the electricity utility to underground or re-site lines and pylons than risk selling at well below market price when the development is complete. Persimmon Homes (I.N. 51) preferred to treat each case on its own merit, although if they were building more than 1000 homes they stated it was *'more cost effective'* to pay to remove the HVOTL and re-site elsewhere or underground the line. The cost of moving the HVOTL is reflected in the bid price for the land. No developer placed buildings under lines.

Although only four developers were available to participate in an interview, all had similar attitudes towards the presence of HVOTLs on land for residential development. This indicated that developers might be even more averse towards building on land where HVOTLs were sited than

[1] Busy work schedules or unavailability were the reasons given for non-participation.

first indicated by the recent change in the way this type of land has been developed.[li] These findings were supported by information obtained from Power Gen which indicated that the utility had recently moved HVOTLs for Persimmon Homes and Bellway Homes prior to development of land for residential use (I.N., 31).

6.5.4 Electricity Utility Interviews

The local electricity company (Power Gen) and National Grid Transco (NGC[lii]) were contacted for their views on the development of land crossed by their equipment, in particular, the problems this may cause with regard to obtaining access to their equipment to maintain the electricity service.

6.5.4.1 Methodology

Three face-to-face interviews were held (I.N., 31-33) with Ian Lee, Finance Manager for Power Projects, Power Gen, West Midland; Catherine Lowe, Head of Planning and Development, (NGC) and John Swanson EMF Scientific Advisor, NGC.

NGC are responsible for 275kV and 400kV high voltage transmission lines used to deliver electricity across the entire United Kingdom. Power Gen is a regional electricity company responsible for distributing electricity to homes, business and institutions in their location. This is done via 132kV overhead and underground lines, in addition to a number of lower voltage lines, the lowest of which is 11kV (I.N., 31).

6.5.4.2Schedule of Questions

The first interview, with Catherine Lowe; Head of Planning and Development, NGC adopted an open-ended question based style, which enabled other related issues to emerge. Interviews with Ian Lee and John Swanson were therefore, conducted in the same manner.

The following questions were asked, when appropriate, during the course of each interview, in no specific order.

> **Does the development of land crossed by equipment create problems with regard to the provision of an efficient electricity service?**
>
> **Do you have problems with landowners terminating wayleaves?**
>
> **How difficult is it to underground electricity lines? and how costly is it compared to siting lines overhead?**

[li] See Chapter Four: 4.4.5

[lii] NGC is now known as National Grid Transco but referred to as NGC.

Do you issue any planning guidance to developers?

How do you proceed with claims made against you for loss of value compensation as a result of the presence of HVOTLs?

6.5.4.3 Results of the Electricity Utility Interviews

There was a noticeable difference between the attitudes expressed by NGC and Power Gen towards the development of land crossed by HVOTLs. This appeared to stem from the ease with which an overhead electricity line could be placed underground (I.N., 31,32). Catherine Lowe explained that, NGC's transmission lines were very costly to underground and involved digging a dual carriageway width trench to enable cables to be cooled, using oil filled pipes.[liii] NGC's approach toward the development of land where their equipment is sited is currently to encourage developers to build away from the lines and pylons. However, rather than use the linearity of the power line for either a long corridor of grassland or as the route of the road through a residential estate,[liv] they have designed a set of guidelines to inform developers of ways in which land where HVOTLs are sited can be developed to reduce the negative impact from the visual presence of pylons whilst enabling them to remain in situ.

By comparison, due to the design of a new cable known as XLPE, Power Gen were able to underground all lines (11kV to 132kV) in roads, pavements or canal tow paths (I.N., 31). This was still more costly than siting overhead; for instance; an 11kV line normally found on small wooden poles, would cost around 1½ times more to underground than to site overhead. 33kV and 66kV lines sited overhead on larger wooden poles, would cost around 2½ times more to place underground. Mr Lee stated that under-grounding lines resulted in a more reliable service by eliminating the problems caused by outage through wind damage, or tree damage.

It was more difficult and more costly (on average, 4-5 times more) to underground a 132kV line. 132kV lines are normally sited on metal pylons and are the HVOTL most frequently associated with residential development[lv] (It is this aspect of electricity distribution equipment; in addition to

[liii] Sense of Place Guidelines for the Development of Land Near HVOTLs. National Grid Transco. (2003).

[liv] This had been found to increase the negative impact of the HVOTL on the desirability and possible market value, of nearby houses (Interview number 32, 33).

[lv] The current research has focused on the impact of electricity lines supported by metal pylons. These include 132kV lines owned and operated by the local electricity suppliers and 275kV and 400kV lines owned by the NGC.

275kV and 400kV lines; also supported by metal pylons, that has provided the main focus for the current research).[lvi]

The decision to underground lines owned by Power Gen is largely economic, according to Lee, as all distribution equipment-siting decisions are made on a cost basis, except occasionally when the company is put under "*extreme pressure by residents terminating wayleaves*" (I.N., 31). A recent example of this was on a residential estate in Monkspath, near Solihull, where a group of residents terminated their wayleave for a HVOTL that ran across their property. Lee states that, "*under these circumstances, the Utility has to make a choice between spending many months fighting cases in court to obtain necessary wayleaves* (see Chapter One: 1.3.1) *or remove the pylons and re-site the line underground*"[lvii]. Obtaining a necessary wayleave provides "*no guarantee that there will not be future problems with wayleaves*". Under-grounding does provide a guarantee of no future wayleave problems and therefore a guarantee of a reliable service in the foreseeable future. Lee stated that "*in real terms, the cost of placing lines underground in this situation is only 30% - 40% more*" than the cost of obtaining necessary wayleaves. Power Gen would prefer it if more lines were placed underground as it reduces wayleave problems[lviii]. Recently "*we moved two 132kV overhead lines at cost,* (no profit was made by Power Gen) *for Persimmon Homes and Bellway Homes*" who were re-developing land for residential use (*ibid*).

Regarding loss of value compensation claims, Lee stated that compensation is only awarded to the owner of a property touched or crossed by distribution equipment. The utility prefers "*out of court settlements rather than risk the courts establishing a precedent for future cases*" [lix]. He was aware that the utility were currently negotiating to buy up Deeds of Grant to reduce the problems with wayleave terminations.

John Swanson, EMF Scientific Advisor for National Grid Transco, revealed the fact that to provide the utility with information to negotiate wayleave and compensation claims, research had been carried out by, and on behalf of the utility to establish a) the likely impact on property values and b) public opinions towards HVOTLs. Valuation impacts were estimated by obtaining and analysing post-code level data for houses near HVOTLs, then comparing the results with the national house

[lvi] See Chapter One generally.

[lvii] Under the New Road & Street Works Act 1991, the utility has the right to place services in roads and pavements without obtaining planning permission.

[lviii] Lines placed underground in roads and pavements would not be subject to wayleaves.

[lix] See Interview number 48, where NGC was reported to make an out-of-court settlement for loss of value compensation on a house that was neither touched nor crossed by distribution equipment.

price index.[lx] This information had not been published. Mori[lxi] was instructed to research public opinions towards HVOTLs. One question asked what impact participants felt a HVOTL would have on the value of their house. The results indicated that:

22% of the public think value is reduced by 5%.
33% = 6-10% reduction.
20% = 11-25% reduction.
11% = over 25% reduction, and
14% don't know.

John Swanson stated that the electricity utility has, until now, been very reluctant to enter into dialogue with anyone from outside the industry regarding the issue of EMF and the perceived impact on house values. NGC is trying to change this, largely because of the amount of planned new residential development that is likely to be undertaken on land crossed by HVOTLs (I.N., 33). In view of this, NGC feel it is time to address the problems (in particular, obtaining access to their equipment for maintenance purposes) caused by developing close to HVOTLs and promoting development that will enhance residential schemes (I.N., 31,32 and 'A Sense of Place, Guidelines for the Development of Land near HVOTLs').

6.6 CONCLUSIONS OF THE PERCEPTUAL RESEARCH

Two methods of generating data were adopted. The first; a postal survey, gathered data on the opinions of valuers, agents and occupiers towards factors associated with residential property sited near HVOTLs. The second used interviews to further inform the results from this research.

6.6.1 Valuers Attitude Studies

The postal survey established that valuers and agents shared similar perceptions towards the impact of a HVOTL on house price and marketability regardless of the type of property participants normally valued. This result did not support the findings from the only previous study to compare the opinions of both cohorts (Bond, 1995[27]).

The majority of valuers and agents perceived the impact on value to range between 5% and 10%; a similar result was obtained from other research in this area (Mitteness and Mooney, 1998[28];

[lx] No actual amount of value diminution was given. However, analysis of the graphs from a draft conference paper obtained from John Swanson appear to indicate a reduction of between 4%-10%. Analysis of the data on which the graphs are based is required before an accurate assessment of the results of their research can be made.

Gregory von Winterfeldt, 1996[29]; Bond[27]). A reduction in value of between 10% and 20% was indicated by 15% of agents and 14% of valuers. In addition, a small minority from both cohorts (4% agents, 3% valuers) indicated a value reduction in excess of 20% (Figure 6-4).

There was some evidence to suggest that participants who were more familiar with valuing or marketing HVOTL-proximate units, perceived a more negative impact on value than those with less experience in this area (Tables 6-2, 6-3). This did not support the findings from earlier research in this area (Kinnard *et al.*, 1988[30]; Delaney and Timmons[31]; Gallimore and Jayne[18]), which had suggested that participants who were less familiar with valuing this type of house would perceive a greater negative impact on value leading to what Gallimore and Jayne (*ibid*) termed as 'circularity'[lxii], due to overcautious valuers overestimating the negative impact of a HVOTL on value[lxiii]. Although this result may be explained by the small number of respondents in this sub-group (see Tables 6-2, 6-3), the results, when compared with transaction data (Chapter Five: 5.3), indicated that the real impact on selling price might be underestimated by valuers and agents.

Frequency analysis indicates that both valuers and agents consider that the main reasons for value diminution were concern over future value, potential health risks, visual presence and noise Causality tests showed that value was most affected by concerns about the future value, health risks and noise from the line (see Tables 6-10, 6-9, 6-6, 6-7 and Model 6-1 above). Regarding marketing this type of property, frequency analysis indicated that concern over the visual presence, future value, publicised health risk and to a lesser degree noise, were the factors most likely to increase marketing time. Causal analysis only found a significant relationship between an increase in marketing time and a concern over the future values (see Tables 6-13, 6-17, 6-16, 6-14 and Model 6-2 above). The finding supported, in part, those of Mitteness and Mooney[28], who observed that valuers also considered noise to be a significant factor contributing to a reduction in house price, although in this study noise was observed to have a more negative impact on value than health concerns (future value was not addressed). These results supported the findings from other studies (Priestley and Evans, 1990[32]; Delaney and Timmons[31]; Bond and Hopkins, 2000[33]).

Telephone interviews revealed that valuers and agents use comparable evidence and occasionally floor space to provide a starting point for the valuation of this type of residential unit. Agents stated that they rarely reduce asking price before the unit is placed on the market, preferring the market to drive the price down in response to buyer behaviour. The results of the 'Valuation Research' analysis for asking price data indicated otherwise (Chapter Five: 5.4, 5.5) where the asking price of

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[lxii] See Chapter Three: 3.4.10

[lxiii] Gallimore and Jayne[7] did not ask participants to indicate the impact on value in percentage terms.

units sited near a HVOTL were found to be up to 20% lower than similar units sited further away on the same estate.

Valuations for mortgage purposes take the impact of the HVOTL into consideration and value was perceived to be reduced by up to 10% (One valuer suggested a diminution of up to 25%). There is, however, no 'rule of thumb', although generally, if a pylon is close to the building or the HVOTL touches or crosses boundary line of the property, value will be reduced. Valuers and agents indicated that a pylon would have a more negative impact on asking price than the line.
The visible presence of the HVOTL was thought to reduce the number of willing buyers (Tables 6-8, 6-9; I.N., 36,38,39) and increase marketing time. However, this appeared to depend on the availability of substitute units and current market conditions[lxiv], despite this, the results from interviews with agents and valuers concurred with Rikon's (1996[34]) study indicating that units near HVOTLs sold eventually.

The impact of a HVOTL on the desirability and value of a nearby house was found to be related to market cycles. This meant that the presence of a HVOTL was likely to have a more negative impact on value and marketability when the market was buoyant (I.N., 34,38,39 and 6.5.2.3.above).

Earlier research had indicated a tendency of developers to place low cost and social housing closest to the HVOTL (Dent and Sims[25]; Gell, 1999-2003[35]). Valuers and agents responses supported these findings with the results indicating that the most frequently observed actions taken by developers were observed to be a tendency to place social and low cost housing next to the HVOTL and use buffer zones to mitigate potential negative impacts on value.

6.6.2 Residential Attitude Studies

The residents' postal survey and the face-to-face interviews produced very different results.
Questionnaire Results: The results from the buyers' postal questionnaire suggested that over 31% of respondents who either lived **'near'** HVOTLs or **'not near'** (on another residential estate where there was no HVOTL), were extremely concerned about all aspects of HVOTLs. Respondents living **'near'** HVOTLs indicated that they were 'less concerned' about the visual impact, although 'more concerned' about the association with a health risk than those living **'not near'**. The sub-group found to be most concerned about HVOTLs were respondents without children[lxv]. The cohort having children were observed to be more concerned about substations and mobile phone base

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[lxiv] See 6.5.2.2 above.

[lxv] See paragraph 6.4.4 and Table 6-21 above.

stations which may indicate a shift in public concern away from HVOTLs towards the more recently publicised perceived health risks associated with living near a mobile phone base station (see 6.4.4; Table 6.1.2; Figure 6.6 and Figure 6.8 above).

Asking residents about their **'willingness to pay'** to have the HVOTL removed based on a hypothetical increase in the value of their home showed that 32% of respondents were 'willing to pay' to have the HVOTL removed and an additional 28% would be 'willing to pay' only if the value of their home was increased[lxvi]. Overall, few residents were willing to pay more than 5% of the increased value of their home.

By comparison, face-to-face interviews revealed that buyers were generally unconcerned about the HVOTL on their estate. The main drivers for buyers' decision to purchase or rent a unit on the estate were, the trouble–free and peaceful atmosphere of the estate and the affordability of units compared to other similar units in the same location (see 6.5.1 and I.N., 2-6, 13, 15, 16, 18-20, 27-29).

Overall, the most important reasons for wanting to live in the area were related to the perception that the area was desirable; it was convenient for work or it was close to family. Whether or not a resident had children made little difference to the opinions expressed. Responses to the interviews suggested that residents were not as concerned about living near HVOTLs as indicated by the results of the 'Buyers Survey'.

6.6.3 Residential Developers

Although only four developers were available to participate in an interview, all had similar attitudes towards the presence of HVOTLs on land for residential development. This indicated that developers might be even more averse towards building on land where HVOTLs are sited than indicated by the change in the way this type of land has been developed during the last 5-10 years (see Chapter Four: 4.4.5) All developers interviewed stated that they would remove HVOTLs prior to developing the land for residential use. This was supported by information from the electricity utility (see 6.5.4 above and I.N., 31) who had recently moved two overhead lines for Persimmon Homes and Bellway Homes, on land that was being redeveloped for residential use. Whilst the cost of moving lines is great, leaving lines has, according to representatives from Bryant Homes (now Taylor Woodrow, West Midlands) and Persimmon Homes (I.N., 50-53) been found to have a

[lxvi] It is possible that some confusion arose with regard to the wording of this question, as participants were asked to indicate what percentage they would be willing to pay to have the HVOTL removed based on the hypothetical increase of 10% of the current value of their house which might result if the HVOTL was not visibly present.

negative impact on the value of houses. It is therefore more economically viable to pay the utility to move the line. The cost of this negatively affects the bid price for the land

6.6.4 Electricity Utility

There is a large amount of existing and future residential development planned on land crossed by HVOTLs (Chapter One: 1.0; Chapter Six, paragraph 6.5.4 and I.N., 33). This includes land where 275kV and 400kV overhead lines are sited, that cannot easily be moved or placed underground. NGC who own and operate this equipment, have designed a set of guidelines (too large to include as an appendix) to encourage residential development around HVOTLs that will attempt to reduce the negative impact of the pylons. Overall, the guidelines appear well thought out, taking into consideration the size, type and orientation of the pylon, although the impact could be reduced further by adopting a similar strategy to that found in Canada and the USA, where tree planting along the power line ROW is encouraged, screening both pylon and line from sight (Crawford, 1955[36]; Colwell, 1990[37]; Rosiers 2002[38]; Chapter Two 2.2.0.). This also adds a degree of privacy which has been found to reduce the negative impact on value (Rosiers[38]). By contrast, Power Gen and all other electricity distributors around the UK own and operate electricity lines up to a maximum voltage of 132kV. 132kV lines are around 4 or 5 times more expensive to site underground than overhead lines. Due to the recent introduction of a new type of insulating cable (XLPE), lines can now be placed under pavements, roads, or canal towpaths (see 6.5.4 and I.N.,31). Although Power Gen would prefer all lines near houses to be placed underground, because of the potential problems caused by wayleave terminations, their siting decisions are made largely on an economic basis, which results in lines being sited above ground, except when placed under extreme pressure from residents who have wayleave agreements with the utility (I.N.,31). Compensation claims for loss of property value are normally settled out-of-court, to avoid setting future precedents (*ibid*). The lack of any legal evidence to the contrary would seem to support this statement[lxvii]. To avoid problems caused by wayleave terminations, namely; the legal right to cross land not owned by the utility to access, maintenance and repair their equipment, the electricity utility are currently negotiating to buy up deeds of grant from landowners to prevent any wayleave terminations for a period of 50 years.

6.6.5 Hypothesis Testing

Two hypotheses were tested by the valuers postal survey. These were:

Hypothesis 1. Chartered Surveyors would perceive a greater negative impact on the value of residential property than Estate Agents.

[lxvii] Only Lands Tribunal cases relating to compensation claims for injurious affection on land and buildings within the UK were found. See Chapter One: 1.3.1.

It was thought that the inclusion of P.S. 3.7. in the RICS 'Red Book' from 1995 to 2003 (and subsequently excluded from the latest edition), which cautioned valuers that negative public perceptions may affect the future value and marketability of property near HVOTLs, may have produced a more negative response from valuers than agents towards the perceived impact of a HVOTL on house prices. However, no difference was observed between the cohorts for all variables tested, with the exception of the impact of 'Birds on Lines'[lxviii] where differences between groups were observed (f value = 15.805,df = 7, p= .027). Therefore, excepting this single factor, Hypothesis 1 was rejected (Chi^2 = 8.267; df = 6; sig= .219).

	F. Value	*Significance*	**Accept or Reject**
Hypothesis 1	8.267	.027	Reject

Hypothesis 2. Surveyors and Agents who had no experience of valuing HVOTL proximate property would perceive a greater degree of value diminution than those familiar with the valuation of this type of property.

A Chi square test revealed an insufficient number of cases within each category to ensure a reliable result. Data were therefore aggregated into 2 subsets; those who 'never' or 'rarely' valued houses near HVOTLs and those who 'often' or 'frequently' valued HVOTL-proximate houses. No significant differences were observed between the groups (Chi^2 = 5.851, df=6, sig,= .440). Hypothesis 2 was therefore rejected with some reservation (see 6.4.9 above).

	F. Value	*Significance*	**Accept or Reject**
Hypothesis 2	5.851	.400	Reject

6.6.6 Triangulation

The following Chapter (Chapter Seven) triangulates the results from all empirical research. This will enable comparisons to be drawn between the results from the perceptual data, the transaction data and the 'on the market' valuation experiment, thus producing a more accurate determination of the value and desirability of houses near HVOTL.

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Chapter Seven

A Drawing Together of the Empirical Research

&

Final Conclusions and Further Research

7.0 INTRODUCTION TO THE CHAPTER

This chapter has been divided into two parts. The first part is a drawing together of the analyses of transaction price data, asking price data and perceptual data, which have been gathered from the different approaches adopted for the current research.[i] A three-way comparison is then undertaken with the aim of developing robust conclusions drawn from the empirical research. The second part presents a summary of the thesis, the conclusions drawn, and suggested direction for further research in this area.

7.1 A DRAWING TOGETHER OF THE EMPIRICAL RESEARCH

This research adopted a research strategy referred to as a multi-method approach, which, by using several research strategies, enables the results to be triangulated, thus allowing the researcher "*to pinpoint the values...more accurately by sighting in on it from different methodological viewpoints*" (Brewer J. and Hunter A. 1989[1] and Chapter Four: 4.2.4). The theoretical foundation of this approach is based on the assumption that, if the results from each approach yield similar answers, the analyst can be more confident of having obtained a valid result (Creswell 1994[2]). This is a particularly important strategy for the current research, due to the limited availability of transaction data within England.

Perceptions of the impact of a HVOTL on house price have been gathered from several sources using different methodological paradigms (Figure 7-1). Following analysis of the perceptual data, the results are compared with a benchmark constructed from actual transaction data gathered from a case study location where a HVOTL is sited, to determine how accurately perceived impacts are likely to reflect real impacts.

Figure 7-1: Source And Type of Data Collected for the Current Research

Perceived Impact On Value:	Postal Surveys = Valuers, Agents, Occupiers
	Interviews = Valuers, Agents, Occupiers, Electricity Utility, Developers
	Case Studies = Asking Price Data From Walmley and St Peter
Real Impact On Value:	Case Study = Transaction Data from Blackwood

7.2 CREATING A RESEARCH BENCHMARK FROM TRANSACTION DATA

As transaction data were available in Scotland, a benchmark was developed using data from a residential estate in Blackwood, Scotland (See Chapter Four: 4.10.1) where mid price range, single-family homes could be found near and not near a HVOTL, to enable a within case study rather than a between case study analysis, thus enabling a causal relationship to be established.

[i] See Chapter Four: 4.3; Chapter Five and Chapter Six generally.

Blackwood, whilst not necessarily representative of the average house built near HVOTLs in Scotland, particularly in Glasgow and Edinburgh[ii], was considered to be representative of recent residential developments in England and therefore a suitable location to generate the data necessary to create the research benchmark.

A hedonic approach to data collection was found to be the most appropriate and was therefore adopted (see Chapter Four: 4.8). 'Property', 'HVOTL' and 'topography' specific variables were collected for each unit and analysed using appropriate statistical tests.

7.2.1 Establishing the Main Determinants of Value

Causal analysis was undertaken, using stepwise regression, to establish the significant determinants of house prices in Blackwood (after data had been aggregated and adjusted for inflation)
This produced the following equation:

Value = f (SEMI, LNPLOT, N.BEDRM, LNPYLON, TERRACE, REAPYL3, FLAT, PARKING, FORS, REARPYL6, REARPYL1, REARLINE, e).

where,

Value = £37551.01 + £-12510.318 x semi, + £11910.31 x log of plot size + £4864.53 x number of bedrooms, + £8085.077 x log of metre from the pylon, + £-12549.85 x terraced, + £-17620.59 x rear view of 3/4 pylon + £-11989.62 x flat + £2928.51 x parking + £2580.07 x side view of the HVOTL from the front of the house + £-2921.36 x rear view of 2 or more pylons + £-5580.10 x rear view of ¼ pylon + £2165.33 x rear view of line + error.

This showed that the selling price of a house with a partial rear view of 1 pylon is between £5,580 and £17,621 lower than a detached house sited at least 400m away from, and having no view of a HVOTL. However, a house with a more pronounced view (which would also have a view of the ROW, open countryside or the lake) was only reduced by £2,580. This supported the work of Rosier (2002)[iii] who concluded that the benefits of an open view of a power line corridor can offset the negative impact of the HVOTL on value. A side view of the HVOTL from the front of a house increased selling price by £2,580 and the value of a house having a rear view of the line (but not the pylon) would be increased by £2,165, compared to a similar house having no view of the line[iv] supporting Bond and Hopkins' (2000[3]) conclusions that pylon had a more negative impact on value than the line.

[ii] Many locations where houses were built near HVOTLs were found to be either deprived areas or the housing was low cost, mixed single and multi-family dwellings (flats).

[iii] See Rosiers (2002)[5] and Chapter Two: 2.6.0.

[iv] See Chapter Five: 5.3.4.4.

7.2.2 House Type in Relation to the HVOTL

The Blackwood Estate is divided by a power line corridor (ROW)[v]. The case study area is to the eastside of the ROW. This part of the estate has been designed in a manner providing large amounts of screening for much of the housing. The results from an analysis of house types in relation to, a) distance from the HVOTL and, b) the visual impact, suggests that flats tend to be built nearer lines and pylons, rather than further away on this estate. Developers seem more willing to place semi-detached and detached houses within 50m of a line than a pylon (there were no 4 x bed detached houses sited within 50m of the HVOTL in this case), indicating that the presence of a pylon rather than a line, has more influence over the type of house built on the estate. By comparison, on the west side of the estate, social housing has been placed in one block, next to the ROW with a direct view onto several pylons. No attempt has been made by developers to screen the ROW. The two main house types in this location and also in Walmley and St Peter case study locations used in the empirical research, were identified as being, 3 x bed semi-detached and 4 x bed-detached houses.

7.2.3 Plot Size in Relation to the HVOTL

The plot size of each house type was considered in relation to the distance from the HVOTL. This showed that semi detached and detached houses within 100m of the HVOTL had a far larger plot than other similar units further away from the HVOTL on this estate[vi]. This was investigated further

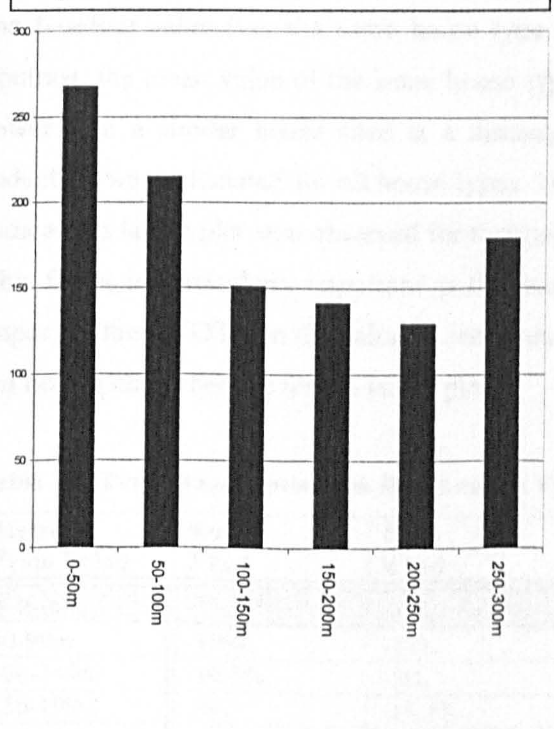


Figure 7-2: Plot size of a 3x Bed Semi-Detached

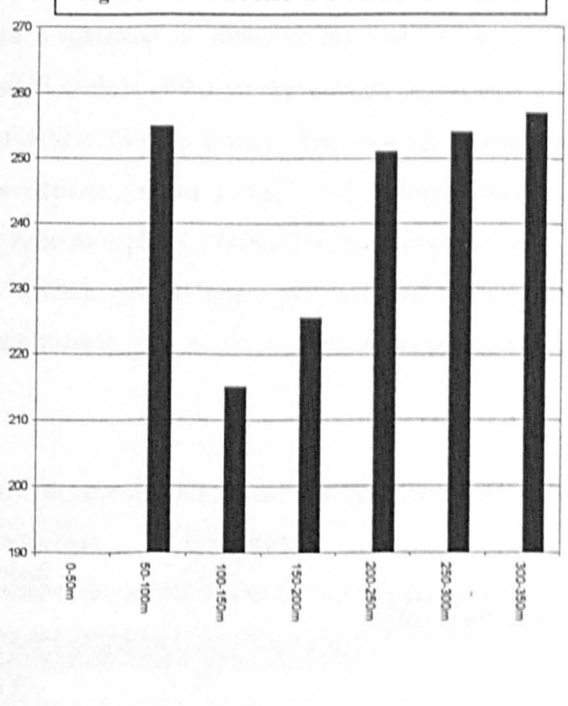


Figure 7-3: Plot size of a 4 x Bed Detached

[v] See Chapter Four: 4.10 and Appendix VII

[vi] Chapter Five: Figure 5-8 and 5-9)

by examining the two main house types on the estate and revealed that a 3 x bed semi-detached house within 50m of the HVOTL had the largest plot for this house type (Figure 7-2), with plot size gradually reducing until units reached a maximum threshold of 250m from the HVOTL. By contrast, there were no 4 x bed detached houses within 50m of the HVOTL. However, the plot size of this house type when sited between 50m and 100m of the nearest pylon (Figure 7-3) was shown to be much larger than similar units further away (between the ranges of 100m and 300m from the HVOTL).

7.2.4 Impact on Value

The impact of the HVOTL on transaction (selling) price was analysed in relation to; 1) physical distance from the line and pylon, and 2) visual encumbrance of the line and pylon, between the ranges of 0-400m from the HVOTL. Tables 7-1 show the percentage reduction observed for houses sited within each 50m band and Table 7-2 shows the percentage reduction observed for varying degrees of visual encumbrance compared to a similar house with no view of the HVOTL.

Distance to a Pylon: The impact on transaction price in relation to distance from a pylon, was measured using the selling price of a particular house type sited at least 400m away from the nearest pylon as the base-line. This produced a benchmark value from which a percentage increase or decrease could be calculated; for instance, Table 7-1 shows that the mean value of all 3 x bed semi-detached houses sold within the range of 300-350m of the nearest pylon was 7% higher than the baseline value (i.e. the same house type sited a distance of 400m (50m further away). By contrast, the mean value of the same house type sited within 100m of the nearest pylon was 10% lower than a similar house sited at a distance of 400m from a pylon. The average percentage reduction was calculated for all house types. In the data presented in Table 7-1, a highlighted cell indicates a larger plot size observed for that house type at a given distance from the nearest pylon. This factor is particularly important as the results showed that a larger plot reduced the negative impact of the HVOTL on the value of semi-detached houses. The average value of detached houses did not appear to benefit from a larger plot.

Table 7-1: Percentage Diminution Based on the Value of House at 400m From the Nearest Pylon

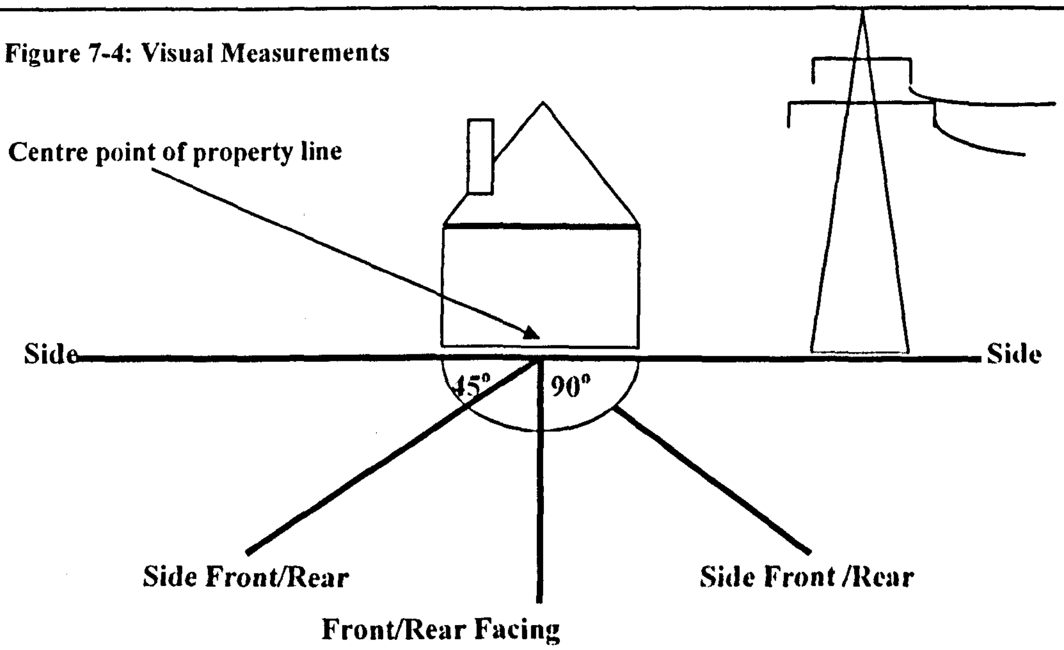
Metres From Pylon	Semi 3 bed	Semi 4 bed	Detached 4 bed	Detached 5 bed	
0-49m	-1%	+5%	-	-	Large plot size
50-99m	-10%	-21%	-17%	-8%	
100-149m	-10.5%	-5%	-18%	-4%	
150-199m	-9%	-10.4%	-12%	-12.5%	
200-249m	-10%	-7%	-4%	-8%	
250-299m	-5%	+1%	+4%	-16%	
300-349m	+7%	-	-0%	+0%	

Visual Proximity to Line or Pylon: The visual impact was measured using the transaction price of each house type with 'no view' of either line or pylon as the benchmark.

The value of similar units, with varying degrees of visual encumbrance,[vii] were measured against the benchmark and a percentage increase or decrease in value was calculated for each house type (Table 7-2). It was difficult to establish a pattern of value diminution, although values appeared to drop in response to a slight view of the HVOTL from the front of the house and were often observed to rise again, until units had a more pronounced view. No obvious pattern of value diminution was observed for units having a rear view of either line or pylon (see Chapter Five: 5.3.2.2).

Orientation of the Line or Pylon: The orientation of the HVOTL was observed to have an impact on the degree of diminution suffered. The degree of diminution was expressed as a percentage increase or decrease by using the mean value of a side view for each house type as the benchmark and then calculating the percentage difference for the same house type having a facing view (see Table 7-2 and Figure 7-4)[viii].

Figure 7-4: Visual Measurements



[vii] See Chapter Five: 5.3.2.2

[viii] Measurements were taken at the centre point of the building on the property's boundary line.

Table 7-2: Percentage Diminution Based on the Value of a House with No View of Line or Pylon (where possible).

View from Front of House	Semi 3 bed	Semi 4 bed	Detached 3 bed	Detached 4 bed	Detached 5 bed
Line Only	-8%	-3%	-15%	+2.5%	-7%
¼ Pylon	-16%	-18%	-6%	-4%	-1%
½ Pylon	+8%	-1%	-7%	+1%	-
¾ Pylon	+5%	-	-4%	-2%	-
1 Pylon	-5%	-9%	-3%	-4%	-6%
2+ Pylons	-5%	-5%	-24%	-8%	-5%
Orientation Impact of a facing view compared to a side view	-0% to -18%	-3% to -23%	+17% =line only -28% =2+ pylon	+10% to –16%	+6% to –11%
View from the Rear of a House: Values fluctuate between – 17% and +11%. No obvious pattern has been observed.					

7.3 ASKING PRICE DATA

Blackwood data enabled the creation of a benchmark of value diminution relative to physical proximity and visual impact. The results from a) the two 'Asking Price' (also referred to as 'On the Market Price') case studies in St Peter[ix] and Walmley[x] and, b) the perceptual research consisting of postal surveys and interviews, were then compared with the benchmark.

Prior to triangulating the results, all perceptual research results had to be converted into useable data for a comparative analysis to be undertaken.

The same methodological approach (hedonic approach) used to gather and analyse transaction data from Blackwood, had been adopted for the collection and analysis of asking price data from residential estates in Walmley and St Peter where similar units could be found 'near' and 'not near'[xi] the HVOTL. Asking price data were collected over a period of two years, to determine whether valuers and agents perceive a negative impact on value from the HVOTL and adjust the asking price accordingly. The results were converted into usable data by taking the asking price for a particular house type sited at least 400m away from the nearest pylon as the benchmark value from which a percentage increase or decrease could be calculated.

[ix] See Chapter Five: 5.4

[x] See Chapter Five: 5.5

[xi] Kinnard[6] classified '*property within 200ft* [of a HVOTL] = *proximate* [near] *and; property outside the 200ft mark = distant* [not near]'.

7.3.1 Case Study One: St Peter.

Regression analysis using the same variables available in all data sets established that:

Asking price = f (N.BEDRM, PLOTSIZE, SEMI, TERRACE, FLAT, PARKING, RORSF, RORF, FORF, REARPYL4, RORS, e)

This produced the following equation,

Value = £84615.36 + £24942.54 x number of bedrooms, + £40,38 x plot size + -£310222.96 x semi detached house + £-34127.09 x terraced house + £-33202.42 x flat + £6174.89 x parking + £-15641.23 x a side facing view from the rear + £-8401.49 x a facing view from the rear + £-6918.89 x a facing view from the front + £10705.53 x a rear view of 1pylon + £6593.26 x a side view from the rear + error.

Based on the figures in this equation, a view of one pylon from the rear of a house increased asking price by £10,706 and a side view from the rear increased value by £6,593 compared to a house sited 400m away from and having no view of a HVOTL. By contrast, a fairly pronounced view (side facing) of the HVOTL from the rear of a house reduced value by £15,641 although a pronounced view (facing) from the rear had less impact, reducing value by only £8,401. This was similar to the impact from a front facing view of the HVOTL (£-6919). These findings perhaps lend some support to the results from the Blackwood case study and Rosiers'(1998[4]; 2002[5]) earlier research, which indicated that a clear view of a HVOTL does not always reduce value, due to the increased privacy or more open aspect enjoyed by some homeowners.

7.3.1.1 House Type in Relation to the HVOTL

Using data obtained from plot maps, the housing estate was sectioned into 50m bands from the centre of the HVOTL. House types within each band were counted and analysed using frequency analysis. This established that the majority of terraced houses built on the estate were sited within 50m and flats were generally sited within 100m of the HVOTL supporting, to some extent, the theory that developers prefer to place low cost and smaller housing nearest the HVOTL[xii]. Surprisingly, the highest proportion of the different house types, found within 50-100m of the HVOTL was detached housing and the majority of all semi-detached houses built on the estate were sited within 100m of the HVOTL. Overall, this suggested that, if developers have any

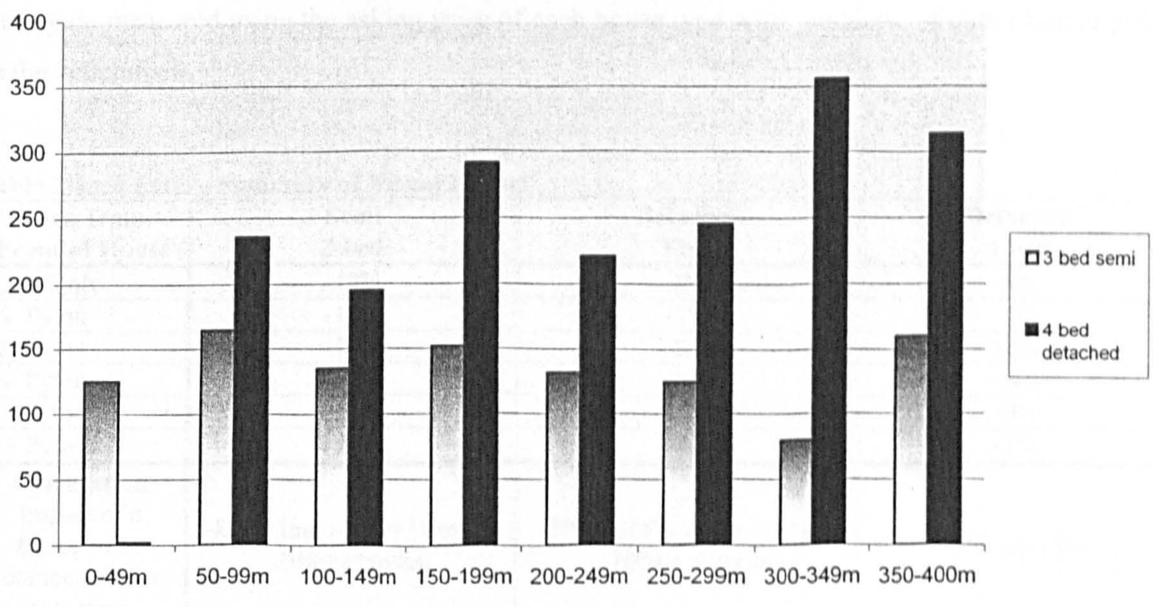
[xii] See Chapters One: 1.4; Two: 2.7.2; Reese[9].

concerns about the impact on value from proximate HVOTLs, their concerns are limited exclusively to the first 50m[xiii].

7.3.1.2 Plot Size Relative to Distance from the HVOTL

Analyses[xiv] showed that detached and terraced houses sited within 50m of a pylon have a larger plot than the same house type sited further away. Flats were also observed to have a larger floor area than those sited elsewhere on the estate. Focussing on the two main house types on this estate (3 x bed semi and 4 x bed detached houses) revealed that a 3 x bed semi at 50 -100m from the nearest pylon had the largest plot size on this estate. The plot size of a 4 x bed detached house, at 50-100m, was greater than similar house at 100-150m, with houses at 300-350m having the largest plot size for this house type. These findings supported, to some degree, the results from earlier research by Kinnard (1967[6]), Clarke (1972[7]) and Colwell and Foley (1979[8]), which had indicated that developers compensate HVOTL-proximate units with an increased plot size.

Figure 7-5: St Peter-Plot size of 3 x bed semi and 4 x bed detached houses relative to distance from the nearest pylon



7.3.1.3 Impact on Asking Price

The percentage impact of the HVOTL on asking price was calculated in the same manner as for Blackwood transaction data.

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xiii See Chapter Five: Figure 5:16

xiv See Chapter Five: 5.4

Distance to a Pylon: Using the mean value of the asking price for 3 x bed semi and 4 x bed detached houses sited at 400m from the HVOTL as a benchmark value enabled the percentage reduction in asking price at various distances from a pylon to be calculated (Table 7-3). A highlighted cell in Table 3, indicates a larger plot size observed for that house type at a given distance from the nearest pylon, which might reduce the negative impact of the HVOTL.

Table 7-3: St Peter-Percentage Difference in Asking Price Based on the Asking Price of a House at 400m From the Nearest Pylon

Metres From Pylon	Semi 3 bed	Detached 3 bed	Detached 4 bed	
0-49m	-20%	-4%	-	Large plot size
50-99m	-13%	-7%	-9%	
100-149m	-15%	-3%	-8%	
150-199m	-13%	-4%	-10%	
200-249m	-1%	-7%	-6%	
250-299m	-12%	+9%	-6%	
300-349m	-4%	-2%	+1%	

Visual Proximity to Line or Pylon: Table 7-4 indicates the percentage change in asking price in relation to the degree of visual encumbrance suffered by a certain house type. The visual impact was again measured using the asking price of each house type with 'no view' of either line or pylon as the benchmark.

Table 7-4: St Peter –Summary of Visual Impact

View from Front of House	Semi 3 bed	Detached 3 bed	Detached 4 bed
Line Only	-13%	-0%	-4%
¼ Pylon	-11%	-1%	-1%
½ Pylon	-14%	+13%	+5%
¾ Pylon	-18%	-6%	+9%
1 Pylon	-11%	-3%	-0%
2+ Pylons	-6%	-2%	-1%
Orientation Impact of a facing view compared to a side view	-8% = line; -8% = ¼ pylon -0%= 1+pylon	-5% to -15% up to ½ pylon +10% = ¾ pylon	-3% to -15%

View from the Rear of a House:

- Values fluctuate between -4% and -18% for a 1+pylon view for a 3x bed semi. No obvious pattern has been observed with other house types.
- The impact of the orientation of the HVOTL on asking price ranges from -2% to -5% for a facing view, compared to a side view.

7.3.2 Case Study Two: Walmley

Using stepwise regression to establish the main determinants of asking price for all house types in Walmley established in summary:

Asking price = f (PLOTSIZE, N.BEDRM, SEMI, FLAT, F.OR, VISPYL5, e)

This yielded the following equation:

Asking Price = £74418.485 + 246.595 x plot size + £23221.834 x number of bedrooms + £-27700.514 x semi detached house + £-33599.510 x flat + £-17821.183 front facing view of the HVOTL + £36428.112 x a front view of more than 1 pylon + error

Based on this equation, the asking price of a house with a view of more than one pylon from the front of the house would be increased by £36,428. However, a facing view of the HVOTL from the front of the house would reduce asking price by £17,821 compared to a similar unit with no view.

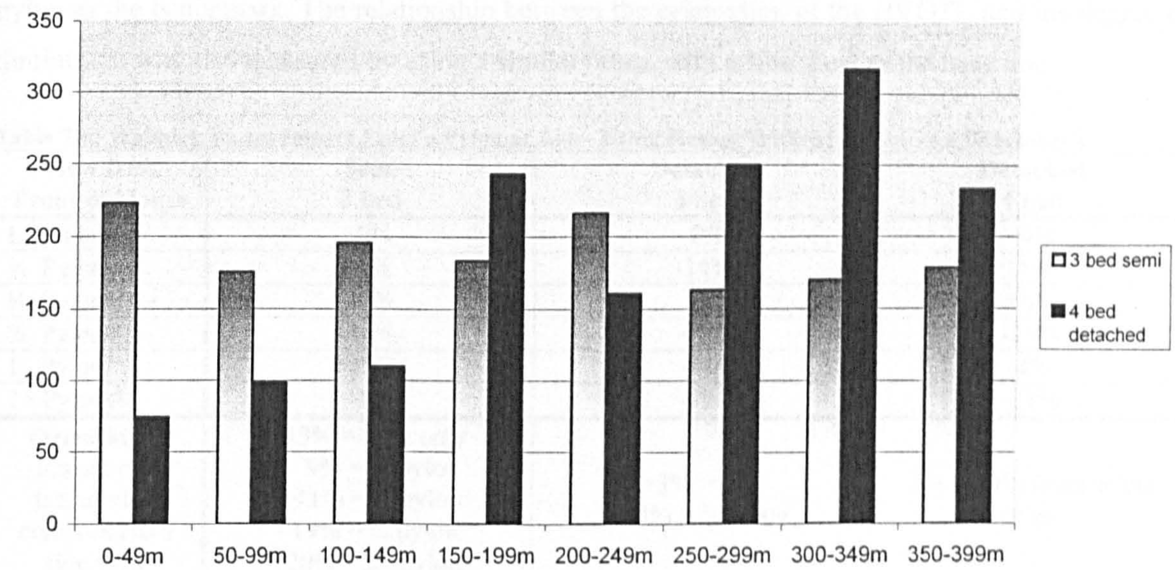
7.3.2.1 House Type

The method used to categorise house types within each 50m band in the Blackwood and St Peter locations was adopted for this part of the analysis. This showed that, the majority of detached and semi-detached houses were sited over 400m away from the HVOTL. The majority of terraced units were sited within 100m of the HVOTL and a significant number of flats were sited between 100m and 150m due, largely, to three blocks of flats, known to be social housing. This supported earlier research indicating that developers placed low-cost and social housing nearest the HVOTL (Reese 1967[9] and paragraph 7.22 above).

7.3.2.2 Plot Size Relative To Distance From the HVOTL

Larger plot sizes were observed for terraced and semi detached houses within 50m of the pylon. By comparison, detached houses closest to the HVOTL were found to have a smaller than average plot size and the overall floor space of a flat was observed to increase with distance from the HVOTL. Focusing on 3 x bed semi-detached and 4 x bed detached houses (Figure 7-8) indicated that 3 x bed semi-detached houses within 50m of a pylon had the largest plot for that house type. Detached houses had relatively small plots compared with other similar units elsewhere in Walmley. This was a similar finding to that observed in St Peter, where semi-detached houses within the range of 50-99m had the largest plot size for that house type on the estate.

Figure 7-6: Walmley Plot Size: 3 x bed semi and 4 x bed detached house relative to distance from the nearest pylon



7.3.2.3 Impact on Asking Price

The results were transformed into a percentage increase or decrease in asking price, compared to the same house type sited at least 400m away from the HVOTL. This enabled the impact on the value of different house types within in each 50m band to be calculated.

Distance to a Pylon: Table 7-5 indicates the percentage reduction in the asking price of the three main house types (in this database), at various distances from the HVOTL, compared to the same house type at a distance of 400m. A highlighted cell indicates a larger plot size observed for that house type at a given distance from the nearest pylon, which may reduce the negative impact of the HVOTL.

Table 7-5: Walmley Asking Price Data - Diminution Based on the Value of House at 400m from the Nearest Pylon

Metres From Pylon	Semi 3 bed	Detached 3 bed	Detached 4 bed	
0-49m	-0%	-13%	-	Large plot size
50-99m	-8%	-4%	-18%	
100-149m	-5%	-13%	-2%	
150-199m	-1%	-39%	+11	
200-249m	+7%	-14%	+2%	
250-299m	-3%	-6%	-10	
300-349m	-5%	-3%	+10%	

Visual Proximity to Line or Pylon: Table 7-6 indicates the percentage change in asking price in relation to the degree of visual encumbrance suffered by a certain property type. The visual impact was again measured using the transaction price of each house type with 'no view' of either line or pylon as the benchmark. The relationship between the orientation of the HVOTL and the degree of diminution was also measured by using a similar house with a side view as the base line.

Table 7-6: Walmley Visual Impact From a Pylon or Line- Using Houses Without a View as a Benchmark

View from Front of House	Semi 3 bed	Detached 3 bed	Detached 4 bed
Line Only	-0%	-8%	-4%
¼ Pylon	-0%	-14%	-1%
½ Pylon	+4%	-	+6%
¾ Pylon	-10%	+1%	-17%
1 Pylon	-10%	-9%	-4%
2+ Pylons	-0%	-9%	-23%
Orientation Impact of a facing view compared to a side view	- 13% = Line only - 9% = ¼ pylon + 11% = ½ pylon - 19% = ¾ pylon - 20% = 2+ pylon	+3% = line -34% = ¼ pylon	-1% to -4% insufficient cases

View from the Rear of a House:

- Semi Detached Houses = 3xbed semi: visual impact increases value. A facing view of a pylon can reduce value by between –21% and –27%.
- Detached Houses = 3xbed detached: visual impact is mixed but not significant.
  4xbed detached, visual impact generally reduced value by a maximum of 28%.
  Having a facing view was found to reduce value by 17%

7.4 TRIANGULATING THE RESULTS

Comparing the regression analysis results from the three case studies (Blackwood-selling price; Walmley and St Peter-asking price) showed that in Blackwood and St Peter, physical distance from the HVOTL was a significant factor. However, there were more 'property specific' variables available in the data gathered from St Peter's. Therefore, stepwise regression was undertaken using only those variables available in Blackwood (Chapter Five: 5.4.5 Model 5-26). This time, distance was no longer a significant factor, however the position of the HVOTL (orientation) was. This highlighted the importance of including all available variables in the analysis, since omitting a number of 'property specific' variables had significantly altered the result. Further comparison between case studies using the results from regression analysis was, therefore, not possible at this stage. Table 7-7 shows the impact on the value of units in Blackwood and St Peter at various distances from the nearest pylon, based on the results of the regression analysis.

7.4.1 Percentage Value Reduction Based on the Mean Value of Different House Types.

A comparative analysis between the three case studies was undertaken using the mean value of different house types within each 50m band from the nearest pylon (Table 7-8 and 7-9). Due to the small number of cases within some house types, only 3 x bed semi detached and 4 x bed detached houses were examined. Diminution was based on the average asking price of both house types at a distance of at least 400m from the nearest pylon. This produced a benchmark to enable a percentage reduction or increase to be calculated.

Table 7-8 shows that, where a unit has a large plot size, the impact on transaction or asking price is reduced. Value is generally observed to increase with distance from the pylon; however, the impact is not linear and there are some anomalies in value diminution that have remained unexplained by further analysis.

Table 7-7: Impact on All House Types Based on the Equations Produced by Regression Analysis

Distance from Pylon	**Blackwood: Transaction Data**[xv]	**St Peter: Asking Data**[xvi] Using all available variables
50m	**-£15319.5**	-£13180
100m	**-£13,131**	-£9885
150m	**-£10,942.5**	-£8237.5
200m	**-£8753**	-£6590
250m	**-£6565.5**	-£4942.5
300m	**-£4377**	-£3295
350m	**-£2188.5**	-£1647.5
400m	**-£0**	-£0

Table 7-8: Percentage Change in Asking Price at Various Distances From The Nearest Pylon

3 Bed Semi-Detached House				**4 Bed Detached House**			
Metres From Pylon	**Blackwood Benchmark**	**St Peter**	**Walmley**	**Metres From Pylon**	**Blackwood Benchmark**	**St Peter**	**Walmley**
0-49m	-1% *	-20%	-0% *	0-49m	-	-	-
50-99m	-10%	-13%	-8%	50-99m	-17%	-9%	-18%
100-149m	-10.5%	-15%	-5%	100-149m	-18%	-8%	-2% *
150-199m	-9%	-13%	-1%	150-199m	-12%	-10%	+11
200-249m	-10%	-1%	+7%	200-249m	-4%	-6%	+2%
250-299m	-5%	-12%	-3%	250-299m	+4%	-6%	-10%
300-349m	+7%	-4%	-5%	300-349m	+/-0%	+/-1%	+10%

*Units within this range have a larger plot size, which may offset the negative impact of the HVOTL on value.

[xv] Based on Model 5-18

[xvi] Based on Model 5-25

Tables 7-9 and 7-10 compare the visual impacts on the value on different units within each case study location using the average price (selling or asking) of different house types with no view of either pylon or line as the benchmark. The percentage difference is calculated in relation to the degree of visual encumbrance suffered.

Tables 7-11 and 7-12 were created to show the actual and perceived impact on selling and asking price from all sources of data. This consisted of 'selling price' data from Blackwood, 'asking price' data from St Peter and Walmley and the results from the 'Valuers' postal survey. The range of value diminution and the mean percentage reduction is given, which can be compared with valuers' and agents' opinions of diminution. This comparison indicated that valuers' and agents' stated opinions with regard to the impact of physical proximity to a pylon, correlated well with impact on value of 3 x bed semi detached houses in Walmley and Blackwood and 4 x bed detached houses in St Peter. However, their stated perception of a reduction in value of between 5% and 10%, was much less than the actual impact on the transaction price observed for a 4 x bed detached house in Blackwood.

The average percentage reduction observed in relation to the visual encumbrance of a HVOTL on a 4 x bed detached house, was found to relate fairly accurately to agents' and valuers' stated opinions of value diminution. A far more varied impact, both within case study and between case study, was observed towards the impact on the selling/asking price of a 4 x bed detached house. A further table was created (Table 7-13) to compare the percentage reduction, or increase, in relation to the orientation of the line or pylon. The percentages shown indicate the difference in selling/asking price of a unit having a facing view of either pylon or line compared to a more peripheral view (side view).

Table 7-14 linked together agents' and valuers' perceptions towards the features associated with a HVOTL which cause value diminution, with residents' attitudes towards the presence of HVOTLs near residential homes. This comparison indicated that residents were most concerned about perceived health risks and the visual unsightliness of the HVOTL which valuers and agents perceived to be the two main causes of negative impacts on the value and marketability of HVOTL-proximate homes. Doorstep interviews with occupiers, which supplemented this primary data, revealed a degree of concern over the future value of their home, a factor also perceived by valuers and agents to be a significant reason for a diminution in value.

Table 7-9: Percentage Difference in Asking Price- Relative to Visual Encumbrance from the Front of a 3 x Bed Semi-Detached House

3 bed semi	Blackwood	St Peter	Walmley
Line Only	-8%	-13%	-0%
¼ Pylon	-16%	-11%	-0%
½ Pylon	+8%	-14%	+4%
¾ Pylon	+5%	-18%	-10%
1 Pylon	-5%	-11%	-10%
2+ Pylons	-5%	-6%	-0%
Orientation The percentage increase/decrease in asking price for a unit having a facing view of a pylon or line. Based on the asking price of a unit with a side view of a pylon/line		Line = -8%	Line = -13%
	¼ pylon = -17%	¼ pylon = -8%	¼ pylon = -9%
	½ pylon = +18%		½ pylon = +11%
			1 pylon = -19%
	2+pylon = -26%		2+pylon = -20%

View from the Rear of a House:

Blackwood = visual impact increases value. However having a direct, facing view of a pylon can reduce value by between –21% and –27%.

St Peter = value diminution fluctuates between –4% and –18% for a 1+ pylon view.

Walmley = value fluctuates between –1 and –4% no obvious pattern emerged.

Table 7-10: Percentage Difference in Asking Price- Relative to Visual Encumbrance from the Front of a 4x Bed Detached house

Detached 4 Bed	Blackwood	St Peter	Walmley
Line Only	+2.5%	-4%	-4%
¼ Pylon	-4%	-1%	-1%
½ Pylon	+1%	+5%	+6%
¾ Pylon	-2%	+9%	-17%
1Pylon	-4%	-0%	-4%
2+ Pylons	-8%	-1%	-23%
Orientation The percentage increase/decrease in asking price for units having a facing view of a pylon or line. Based on the asking price of a unit with a side view of a pylon/line	Line = -1%	Line = +2%	
		¼ pylon = -15%	¼ pylon = -4%
		½ pylon = -8%	
	¾ pylon = +11%	¾ pylon = -17%	
	1 pylon = -3%	1 pylon = -5%	1 pylon = +7%
	1+ pylon = - 4%		
	2+ pylon = +3%	2+ pylon = -3%	

View from the Rear of the House:

Blackwood = diminution fluctuates between –17 and +11% No obvious pattern emerged.

St Peter = no obvious pattern of value diminution emerged

Walmley = diminution fluctuates between –1% and –4% No obvious pattern emerged

Table 7-11	Distance from HVOTL	Blackwood	St Peter	Walmley	Range of Diminution	Mean % Reduction	Valuers' Opinion	Agents' Opinion
Value Diminution in Relation to **Distance to HVOTL** 3 x Bed Semi	0-50m	**-1%***	-20%	**-0%***	-1% to -20%	**-10%**	Mean = -7.5% -5% to -10%	Mean = -7.5% -5% to-10%
	100m	**-10%**	**-13%***	-8%	-8% to -13%	**-10.5%**		
	150m	**-10.5%**	-15%	-5%	-5% to -15%	**-10%**		
	200m	**-9%**	-13%	-1%	-1% to -13%	**-7%**		
	250m	**-10%**	-1%	+7%	+7% to -10%	**-1.5%**		
	300m	**-5%**	-12%	-3%	-3% to -12%	**-8.5%**		
	350m	**+7%**	-4%	-5%	-5% to +7%	**+1%**		
Value Diminution in Relation to **Distance to HVOTL** 4 x Bed Detached	0-50m	**-**	-	-	-	**-**		
	100m	**-17%***	-9%*	-18%	-9% to -17%	**-13%**		
	150m	**-18%**	-8%	-2%	-2% to -18%	**-10%**		
	200m	**-12%**	-10%	+11%	-12% to +11%	**-0.5%**		
	250m	**-4%**	-6%	+2%	-6% to +2%	**-2%**		
	300m	**+4%**	-6%	-10%	-10% to +4%	**-4%**		
	350m	**-0%**	+1%	+10%	0% to +10%	**+5%**		

***Indicates a larger plot size which may offset the impact on selling or asking price**

Table 7-12	Distance from HVOTL	Blackwood	St Peter	Walmley	Range of Diminution	Mean % Reduction	Valuers' Opinion	Agents' Opinion
Value Diminution in Relation to **Visual Impact of a Pylon** 3 x Bed Semi	Line only	**-8%**	-13%	-0%	-0% to -13%	**-7.5%**	Mean = -7.5% -5% to -10%	Mean = -7.5% -5% to -10%
	¼ Pylon	**-16%**	-11%	-0%	-0% to -16%	**-8%**		
	½ Pylon	**+8%**	-14%	+4%	+8% to -14%	**-3%**		
	¾ Pylon	**+5%**	-18%	-10%	+5% to -18%	**-7.5%**		
	1 Pylon	**-5%**	-11%	-10%	-6% to -11%	**-8.5%**		
	2+Pylons	**-5%**	-6%	-0%	-0% to -8%	**-4%**		
Value Diminution in Relation to **Visual Impact of a Pylon** 4 x Bed Detached	Line Only	**+2.5%**	-4%	-4%	+3% to -4%	**-0.5%**		
	¼ Pylon	**-4%**	-1%	-1%	-1% to -4%	**-1.5%**		
	½ Pylon	**+1%**	+5%	+6%	+1% to +6%	**+2.5%**		
	¾ Pylon	**-2%**	+9%	-17%	+9% to -17%	**-4%**		
	1Pylon	**-4%**	-0%	-4%	-0% to -17%	**-8.5%**		
	2+Pylons	**-8%**	-1%	-23%	-1% to -23%	**-11%**		

Table 7-13

Value Diminution in Relation to **Orientation of the Pylon**	Degree of Visual Encumbrance	Blackwood	St Peter	Walmley
3 x Bed Semi Front of House	Line	+17%	-8%	-13%
% difference in mean house price for a unit having a more direct view of either line or pylon.	¼ pylon	-18%	-8%	-9%
% shown is the difference between a 'side view' and a 'side front' or 'facing' view.	½ pylon	-	-	+11%
	1 pylon	-0%	-0%	-19%
	2+ Pylon	-26%	-	-20%
Value Diminution in Relation to **Orientation of the Pylon**	Line	-1%	+2%	-0%
4 x Bed Detached Front of House	¼ pylon	-	-15%	-4%
	½ pylon	-	-8%	-
	¾ pylon	+11%	-17%	
	1 pylon	-3%	-5%	+7%
	1+ pylon	-4%	-	-
	2+pylon	+3%	-3%	-

Impact From the Rear of the House:

Blackwood: Value diminution fluctuates between -17% and +11%. No obvious pattern has been observed

St Peter: Value diminution fluctuates between -4% and -18% for a view of 1 pylon and part of another, from a 3 x bed semi. No obvious pattern has been observed with other house types.
Orientation: A facing view increased the degree of diminution suffered by between -2% and -5% compared to a side view

Walmley: Value diminution fluctuates between -1% and -4%. However, there were an insufficient number of cases to produce a clear pattern.

Table 7-14

Cause of Negative Value Impacts

Valuers and agents were asked to rank each of the most frequently quoted reasons for a reduction in the value of a house sited near a HVOTL according to the degree of impact they perceived it had on house prices.
0= no impact; 5= moderate impact; 10= very large impact.

Residents living 'near' and 'not near' a HVOTL were asked about the degree of concern they felt towards a HVOTL.

Reason for Diminution	Valuers	Agent	Residents	
Visual Unsightliness	**78%** = moderate to very large impact	**81%** = moderate to very large impact	**Case** **Control**	**47%**= extremely concerned **55%**= extremely concerned
Noise Produced (buzzing)	**67%** = moderate to very large impact	**68%** = moderate to very large impact	**Case** **Control**	**34%**= extremely concerned **36%**= extremely concerned
Safety Issues (Line breaking/ pylon falling)	**41%** = moderate to very large impact	**46%** =moderate to very large impact.	**Case** **Control**	**31%**= extremely concerned **31%**= extremely concerned
Perceived Health risks	**87%** = moderate to very large impact	**87%** = moderate to very large impact	**Case** **Control**	**45%**= extremely concerned **36%**= extremely concerned
Concern about Future Value	**79%**= moderate to very large impact	**82%**= moderate to very large impact	**Doorstep interviews indicated a slight degree of concern linked to the publicity surrounding health research.**	
Restricted Land Use	**29%**= moderate to very large impact	**22%**= moderate to very large impact	**This question was not found to be relevant to residents**	
Bird Mess	**13%**= moderate to very large impact	**2%**= moderate to very large impact	**This question was not asked in the survey. Doorstep interviews indicated there was no concern.**	

7.4.2 First Conclusions

A three-way comparison between the results from transaction price data, asking price data and perceptual data enabled the following conclusions to be drawn on the basis of this analytical framework.

1. The benchmark created from transaction data shows that selling price is reduced by up to 18% for a unit within 150m of a HVOTL compared to similar unit sited 400m away. Asking price can be reduced by up to 20% for units sited within 50m of the HVOTL compared to similar units sited at least 400m away. By comparison, valuers and agents estimate a reduction of between 5% and 10%.

2. Relative to the visual impact, transaction data indicates a reduction of up to 16% for homes with a view of part of a pylon. By contrast, asking price was reduced by 23% for a house with a pronounced view of two or more pylons. Valuers and agents estimate a reduction of between 5% and 10%.

3. The orientation of the pylon appeared to have a significant impact on the degree of diminution a residential unit suffered. However, it was difficult to find a consistent pattern of diminution.

4. There was an observed increase in plot size for some units in each case study location, which possibly indicated that developers provide larger plots for units near the HVOTL, perhaps to offset any negative impacts. Valuers and agents rarely observed this factor in their responses to the postal questionnaire (Chapter Six: 6.3.5).

5. In all case study locations, developers showed some preference for using land nearest the line, and in particular the pylon, for social and low cost housing. Evidence of this trend was reinforced by the opinions of valuers and agents in response to the 'Valuers' questionnaire (*ibid*), and confirmed by developers during the course of the interviews.

6. The factors associated with HVOTLs that residents were most concerned about in response to the postal survey were found to correlate with valuers' and agents' perceptions of the factors having the greatest negative impact on value.

It would appear from the triangulated results that valuers' and agents' stated opinions towards the impact on value tend to underestimate the actual impact of a HVOTL on transaction price. However, asking price was often observed to be more negative than the transaction data would indicate was necessary. These findings are particularly interesting, especially when compared with the content of the telephone interviews with valuers and agents (Chapter Six: 6.5.2.2), in which the majority of participants expressly stated that they did not actively adjust the asking price of HVOTL-proximate residential units downwards, preferring to let current market conditions and the response from potential buyers, drive the asking price. These data would indicate the opposite, and as such raises a number of issues, which will be highlighted in the following section: Final Conclusions and Further Research.

7.5 FINAL CONCLUSIONS AND FURTHER RESEARCH

The principal aim of this research was to determine the impact of electricity distribution equipment on the value of residential homes in the UK. This part of the concluding chapter presents a summary of the thesis, the conclusions drawn and suggested areas for further research

7.5.1 Final Conclusions

The thesis is the first body of work undertaken to attempt to determine the impact of HVOTLs on the value of residential units in the United Kingdom. This is an area of research not addressed by previous studies within the UK and one which is likely to receive a growing level of interest due to the increased use of this type of land for residential housing (partly in response to planning guidance given in PPG3[xvii]).

An initial review of the existing literature highlighted two main factors; first, whilst many studies had been conducted in the USA, Canada and to a lesser degree New Zealand (Callanan and Hargreaves, 1995[10]; Bond and Hopkins[3]; Rosiers[5]; Colwell, 1990[11]), there had only been three published studies in the UK. All three investigated public and professional attitudes exclusively, having no regard for the impact on house price (Syms, 1996[12]; Gallimore and Jayne, 1999[13]; Jayne, 2000[14]). These studies identified the lack of available transaction data for analysis as the main barrier towards determining the impact of a HVOTL on house price in the UK. In addition, a more detailed review of the literature established that, although postcode level data are freely available in the UK, the success of such an investigation relied heavily on being able to isolate the physical and visual characteristics of distribution equipment relative to each individual house type, thus enabling comparisons with unencumbered units to be made.

Second; the perception of an association between living near HVOTLs and a number of health risks (albeit unproven) had been found to have a negative impact on the desirability of this house type (Jayne *ibid*; RICS[15]). Earlier research had shown that using perceptual studies as a measure of

[xvii] See Chapter One: 1.1.4

likely buyer behaviour could prove misleading, as expressed buyer behaviour rarely reflected actual buyer behaviour (Chapter Three: 3.4.9). By contrast, valuers' and agents' perceptions of the impact of HVOTLs on house prices had been found to be surprisingly accurate when compared with transaction data for the same location (Bond and Hopkins[3]). This factor was particularly relevant to this thesis, since a large part of the primary research would be based on public and professional perceptions, opinions and attitudes.

Initial investigations showed that transaction data were available for every residential unit sold in Scotland, whereas only asking price or postcode level data were freely available for residential units sold in England. This led to the development of a research strategy, which used Scottish transaction data to determine the actual impact of distribution equipment on the selling price of residential property and asking price data from two case study locations in England. These data were supported by opinion surveys and interviews, to enable a three-way comparative analysis or triangulation to be undertaken.

Following a thorough literature review and a number of exploratory indicator interviews, the direction of the research was narrowed down to focus exclusively on HVOTLs; rather than other aspects of distribution equipment. The research strategy was further developed into a multimethod approach towards data gathering; drawing on both qualitative and quantitative research paradigms to generate the necessary data to fulfil the research objectives and test the hypotheses (Chapter One: 1.5). This data would establish;

I. The real impact of HVOTLs on house price, which could be developed into a benchmark of value diminution relative to physical proximity and visual impact.
II. Whether or not asking price reflected the impact of a HVOTL on selling price.
III. Whether valuers' and agents' stated opinions of value impacts were a) the same and b) reflected the actual impact of a HVOTL on house price.
IV. Whether professional experience influenced the perceived impact on house price.
V. Which features associated with HVOTLs caused any negative impacts on the value and marketability of such property.
VI. Whether or not developers were taking any actions to mitigate negative impacts through careful design of new housing estates.
VII. Whether stated occupier opinions reflected likely buyer behaviour.

Developing the Hypothesis

Four hypotheses were developed (see Chapter One: 1.5; Chapter Four: 4.1.5) based on a detailed review of the existing literature, in addition to information gained from preliminary interviews with property professionals (ibid). These would test both qualitative and quantitative aspects of this research. Hypotheses 1 and 2 tested certain aspects of the perceptions of the two professional bodies (members of the Royal Institution of Chartered Surveyors and members of the National Association of Estate Agents) who are qualified to value residential property within the UK (see Chapter Six: 6.6.5).

Previous research (undertaken in the USA Canada and New Zealand) strongly indicated that the visual impact of the HVOTL had a more negative impact on value than physical proximity and that it was the pylon, not the overhead line, which had the most influence on the degree of value diminution suffered (Bond and Hopkins[3]; Rosiers[4 & 5] and Chapter Two generally). This lead to the development of Hypotheses 3 and 4, which would test these findings using data gathered in the UK.

The stated hypotheses (Hypotheses 1, 2, 3 and 4) were either accepted or rejected, based on the results of the analyses. These finding are now presented.

7.5.2 The Impact on Selling Price

To fulfil Research Objectives 3[xviii] and 6[xix], Scottish transaction data were gathered and analysed using a hedonic approach with multiple regression, frequency analysis and other statistical tests where appropriate[xx]. The literature reviewed in Chapters Two and Three established this method as the most appropriate to undertake the principle aim of the research[xxi]. Each residential unit included in the case study was broken down into its constituent parts and variable were constructed to represent 'property specific' (although these data were somewhat limited in Blackwood[xxii]), 'HVOTL specific' and 'locational specific' characteristics, thus enabling causal relationships to be identified[xxiii]. The main determinants of value were sufficiently stable over time to enable aggregated data to be used. This eliminated the possibility of spurious results due to annual fluctuations in house prices as a result of factors such as inflation rates, the availability of substitute properties or the impact of media attention focussing on the perceived health risks from living near HVOTL and other sources of EMF (e.g., mobile phone base stations).

[xviii] Objective 3. To determine whether there is a measurable correlation between the physical distance of HVOTLs and value, and visual encumbrance and value.

[xix] Objective 6. To establish the impact of the presence of a HVOTL on house prices in the UK.

[xx] See Colwell[11]; Rosiers[5]; Rossini, (2002); Theriault *et al.*, (2003); Chapter Four: 4.8.3.1; Chapter Five:5.2

[xxi] See Chapter Four: 4.8.3.1 and Chapter Five.

[xxii] See Chapter Four: 4.10.2.

[xxiii] See Chapter Four: 4.8.3.2.

Regression analyses of these data established that a causal relationship existed between the presence of a HVOTL (line and pylon) and the selling price of all house types. This relationship was significant and showed that the physical presence of the pylon had a negative impact on value. By contrast, the results also showed that the presence of a line at the rear of a house could increase house values, which supporting the findings of previous research (Rosiers[5]), which had indicated that residential units adjacent to a ROW with no view of a pylon could enjoy an increased level of privacy, which may offset the negative impacts of the HVOTL. This part of the research tested Hypotheses 3[xxiv] and 4[xxv] though the gathering and analysis of data gathered from the three case study locations (Blackwood, St Peter and Walmley). The result from the analyses of these data enabled Hypothesis 3 to be rejected and Hypothesis 4 to be accepted. Early interviews had indicated that, due to the demand for new houses, the true impact on value was often not apparent until a house was resold (Gell, 1999-2003[16]). Analysis of the outliers proved otherwise, as 13 new houses, which were either sited close to, or had a pronounced view of the HVOTL were sold at around half the price of the same house type further away.

These data enabled a table of value diminution to be developed using the mean value of each house type relative to physical distance and visual impact from the HVOTL, thus fulfilling Research Objective 6[xxvi] and providing a benchmark to measure opinions of value diminution against (Research Objective 4[xxvii]). The table showed that values were reduced by between 1% and 18%, with the most negative impact on value occurring between the ranges of 100-149m from the pylon. Whilst there were few large houses in the case study, the results indicated that the larger the house, the greater the degree of diminution suffered although, the impact on all house types diminished to nothing at a distance of 350m from the nearest pylon.

Whilst the results showed that the impact on the value of units nearer the HVOTL was less negative, this result proved to be very misleading as both semi-detached and detached houses nearest the HVOTL had larger than average plot sizes, which undoubtedly offset the degree of negativity suffered (see Chapter Five: 5.3.3.2). The use of larger plots for units sited within the first 100m of the HVOTL was also observed in Walmley and St Peter (the two 'Asking Price' case

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[xxiv] Hypothesis 3. The visual impact of HVOTLs has a greater negative impact on the value of residential property than physical proximity. See Chapter One: 1.5.

[xxv] Hypothesis 4. The visual presence of a pylon has a greater negative impact on value than the line. See Chapter One: 1.5.

[xxvi] Objective 6. To establish the impact of the presence of a HVOTL on house prices in the UK. See Chapter One: 1.5.

[xxvii] Objective 4. To establish the degree to which attitudes can be relied upon to provide an accurate determination of the value of residential units in close proximity to HVOTLs. See Chapter One: 1.5.

study locations, See Chapter Five: 5.4.4.2; 5.5.3.2), adding further support to the findings from previous research, which concluded that the practice of giving larger plots to units adjacent to a power line indicated that developers were already compensating for the presence of the power line (Reese[9]; Kinnard[6]).

Taking into consideration the positive effect on value due to a large plot size, the percentage diminution relative to physical distance was found to be approximately linear. However, the visual impact produced a more varied pattern, which indicated that a slight view of either line or pylon produced an initial reduction in selling price. House prices were shown to increase until suffering a more pronounced view of 1 pylon when values dropped again, rising gradually after this point (see Appendix IX). A similar fluctuation in selling price relative to physical distance was observed, which also indicated that values dropped for a second time at a distance of around 150 - 200m from the HVOTL. This phenomenon may be explained by the orientation of the HVOTL, as the results confirmed that a facing view of a pylon could have a more negative impact on value than a less pronounced view and therefore, arguably, a facing view of a pylon at 150m would be more visually intrusive than a side view of a pylon at 50m.

Whilst there was clearly a negative impact on value relative to the visual impact, no linearity in results was established. An alternative method of measuring the visual encumbrance might arguably, yield a more linear or logical pattern of diminution, and should be considered for future research. This may include calculating the height of the pylon, in addition to distance and orientation, particularly in relation to rural property where there is little screening from other buildings.

7.5.3 The Impact on House Type

The presence of the HVOTL was found to influence the type of house built on the estate relative to physical distance to both line and pylon. Analysis of plot maps from the Blackwood case study showed that developers placed the majority of flats near the HVOTL (see Chapter Five: 5.3.3.1). There was also evidence to suggest that developers differentiated between the line and pylon, as more semi-detached and detached homes were sited within 50m of the line than the pylon (see Chapter Five: Tables 5-19 and 5-20), which appeared to indicate that they were less averse to building larger units near a line than a pylon.

These findings were supported further by evidence from the St Peter and Walmley case study locations, where the majority of terraced houses and flats were built within 50m of the HVOTL (see Chapter Five: 5.4.4.1; 5.5.3.1). In addition, the Walmley estate provided evidence of a change in developers' attitudes towards developing land crossed by a HVOTL for residential use. The older part of the estate, built during the late 1980s, showed no apparent differentiation between the type of housing built 'near' and 'not near' either line or pylon, whereas, the development undertaken more recently (during the late 1990s) revealed a trend towards placing low-cost and social housing near the HVOTL. This indicated that developers' attitudes towards building on this type of land had changed, arguably due to perceived impacts on house prices from the proximate HVOTL. This was supported by evidence from interviews with residential developers who now prefer to move the line rather than risk selling new houses at below market value (Appendix XIII: I.N. 50,51,52,53).

Further weight was added to these findings by the results of the 'Valuers' survey (see Chapter Six: 6.3.5), which concluded that the most frequent actions taken by developers when building on land crossed by a HVOTL was to place low cost or social housing nearest the line, and to introduce power line corridors. Previous research suggested that these actions were taken by developers to reduce or *"avoid the full impact of what they conceive to be a detrimental influence"*(Reese[xxviii]). However, interviews with residential developers suggested that these actions have not managed to diminish the negative effects of a visible HVOTL on house price and some residential developers are now reluctant to buy land where there is a prominent HVOTL[xxix] unless it can be moved. This cost is passed onto the landowner, and taken off the bid price for the land.

7.5.4 The Cause of Negative Impacts on HVOTL Proximate Residential Units

Previous research suggested that the visual impact of a pylon has the most negative impact on value (Colwell[11]; Bond and Hopkins[2]), whilst other studies cited fear over perceived health risks as the main cause of value diminution or negative attitudes (Kung and Seagle, 1992[17] Rikon, 1996[18]). It became apparent, however, during the initial stages of this research, that there was an inherent relationship between the visual presence of the HVOTL and the association with a health risk. Other previous studies acknowledged this relationship and the difficulty of trying to separate the visual impact from the association with health risks and attribute negativity to one or the other (Gregory and von Winterfeldt, 1996[19]; Mitteness and Mooney, 1998[20]). This research did not attempt to differentiate between negative perceptions resulting from the visual presence and those resulting from a fear of perceived health risks. Whilst occupiers living near HVOTLs were found to be most concerned about potential health risks, those living on an estate without a HVOTL were most concerned about the visual impact. Interestingly, despite exhibiting extreme concern in

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[xxviii] Reece[9] ; See also Chapter One: 1.4; Chapter Two: 2.2; Chapter Three 3.4.3; Chapter Four: 4.4.5; and 4.9.1.3.

[xxix] One which would remain highly visible following development. A HVOTL crossing the corner of a plot of land available for a large residential development would probably be considered acceptable (Barratt Homes Appendix XIII: I.N. 52).

response to the postal questionnaire, few occupiers of homes near a HVOTL were prepared to pay more than a minimum amount of the potential increase in the value of their house, to have it removed (see Appendix IV). This indicated that although occupiers state they are extremely concerned about all aspects associated with the presence of a HVOTL near residential units (see Chapter Six: 6.4.3; Table 6-22), there might be other reasons driving their decision to rent or buy in that location. Interviewing occupiers from the three case study locations highlighted one likely driver of their decision process. Over half stated that lower house prices had enabled them to either afford to buy a house, or buy more house for their money (see Appendix XIII: I.N. 2,3,4,5,6,13,14,15,16,17,18,19,20,27,28,29), which suggested that financial consideration could outweigh other concerns (see Chapter Six: 6.4; Table 6-22; Figures 6-5 to 6-8). Therefore, using buyers' stated opinions towards a HVOTL as a measure of the likely impact on house prices might prove misleading.

Whilst occupiers were found to be generally negative towards all aspects of a HVOTL, valuers and agents were arguably more objective, since their personal perceptions were informed by a combination of professional experience and knowledge of the local market. It was hypothesised (Hypothesis 2[xxx]) that valuers and agents who were less familiar with valuing or marketing this type of residential unit, would perceive a greater percentage reduction in price. However, the findings did not support this hypothesis and there was some evidence, albeit limited, that familiarity actually increased the perceived degree of diminution (see Chapter Six:6.3). It was also hypothesised (Hypothesis 1[xxxi]) that valuers and agents would not share the same opinions towards the impact on value. This hypothesis was found to be false and therefore rejected, as both had very similar perceptions towards the impact of a HVOTL on the value and marketing of proximate homes. Objective 1[xxxii] of the research was designed to pinpoint which features associated with a HVOTL were responsible for negative impacts on value, thus providing information which could be used by developers and planners to reduce any negative impact on value through careful design. The findings revealed that house prices were most negatively affected by concerns about health risks, future value, and noise from the line, whereas the marketing of a unit was most negatively affected by buyers' concerns towards the perceived health risk, the visual impact and the potential impact on future value. Interviews with residents provided some explanation of the apparent concern about

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[xxx] Hypothesis 2. Surveyors and agents with no experience of valuing HVOTL proximate property would perceive a greater degree of value diminution than those familiar with the valuation of this type of property.

[xxxi] Hypothesis 1. Chartered Surveyors perceive a greater negative impact on the value of residential units than Estate Agents.

[xxxii] Objective 1. To determine the key factors influencing the value and marketability of residential units in close proximity to HVOTLs, and, to examine how these factors affect the behaviour of market participants.

the future value of homes near power lines, revealing that, although occupiers might not consider living near a HVOTL was a risk to health, the possibility that continuing health research may eventually establish one, created some doubt about the value of their house in the future.

An important question is how these findings can be used by participants within the property industry both to reduce the negative impact of a HVOTL on house price and to improve the accuracy of professions when assessing the selling price or asking price of this type of residential units.

7.5.5 Possible Uses For This Research

1) Research Objective Five (see Chapter One: 1.5) set out to establish a set of criteria for measuring the likely impact of HVOTLs on the value of residential units. Whilst it was hoped a linear pattern of value diminution would emerge, the impact on the average (mean) value of different house types was shown to fluctuate (see Chapter Five: 5.3.2.1; 5.3.2.2). However, the results from this research can be used as a basis for the valuation process. To facilitate this, a table of value diminution has been developed (Table 7-11, 7-12, 7-13) which has shown that the percentage value diminution relative to physical distance (Table 7-11) from the HVOTL is approximately linear, unlike the percentage reduction calculated in relation to the visual impact, which was found to be more varied (Table 7-12, 7-13). Using distance to the HVOTL as a predictor of value diminution is likely to be more reliable and as such, the data in this table would provide a guideline for agents and valuers when valuing and marketing mid-range mix-type residential houses in urban locations. One important consideration frequently overlooked by valuers and agents[xxxiii] was the fact that houses near the HVOTL often had a larger plot, which reduced the negative impact on price. Plot size should therefore always be considered.

2) The comparison between selling price data and asking price data revealed some similarities between real impacts and perceived impacts and, although the range of diminution was much wider than expected and the degree of diminution, relative to distance from the HVOTL, less linear, these data could provide a general indication of the likely impact of an environmental feature on selling price. However, one serious concern was that, despite valuers and agents stating they did not adjust the price to compensate for the impact of the HVOTL in interviews, in addition to indicating a mean value reduction of between 5 and 10% in the postal survey, evidence from both asking price case studies has shown that agents, in particular, actively reduce asking price by as much as 20%. Comparing this with selling price data suggests that they may be overcompensating for the negative

[xxxiii] See Chapter Six: 6.4

effects of the HVOTL. These results may provide further guidance to agents when marketing property and sellers when instructing estate agents.

3) The main causes of value diminution have been established as; the perceived health risk, concern about the future value and the degree of noise produced by the line. Interviews with residential developers have revealed that, despite careful planning to minimise the negative impacts of the HVOTL on the value of their investment[xxxiv], these measures do not reduce the negative impact to a level where they can avoid making a reduced profit on some new units when a development has been completed (Appendix XIII: I.N.50-53). New residential developments may only be undertaken where lines can be removed (ibid). One other measure rarely used in the UK, although frequently employed in Canada and the USA, involves placing HVOTLs in a corridor screened by trees. This creates a wooded area, increases privacy and has been observed to reduce the negative impacts on value caused by the HVOTL (Kinnard[6]; Colwell[11]; Rosiers[4, 5]). This strategy could be of particular use to land crossed by overhead lines owned by NGC, as they are much more costly and difficult to bury.

4) This information could provide a basis for compensation for injurious affection as a result of the presence of a HVOTL. Currently, NGC is offering to buy Deeds of Grant from property owners with wayleaves, to reduce the possibility of an unreliable electricity service caused by wayleave terminations. This table of value diminution would provide a starting point in this negotiation process, or at the very least provide guidance on establishing a methodology to determine the impact on house prices.

7.6 The Objectives of the Research. Were they achieved?

Overall, the multi method strategy adopted for the research successfully enabled the stated research objectives (Chapter One 1.5) to be fulfilled. The first objective (Objective 1) sought to identify the key factors influencing the value and marketability of residential units in close proximity to HVOTLs and to examine how these factors affect the behaviour of market participants, using both research paradigms (qualitative and quantitative), towards data collection. It was thought that this might provide information to market participants, in particular developers and planners, which would enable them to mitigate any loss of property value through careful design and landscaping of this type of residential development. The valuation research results showed that physical proximity to the HVOTL is likely to have a more negative impact on value than the visual presence and a pylon has a more negative impact than a line (Chapter Five). The results of the perceptual data identified the likely causes of value diminution (Chapter Six) and are stated above in 7.5.5

[xxxiv] By placing low cost and social housing near the line or introducing power line corridors or a buffer zone.

paragraph 3. This research has, however, only identified the likely impact on urban housing.

Objective 2 sought to establish valuers' and agents' perceptions towards the perceived impact of HVOTLs, since they were the property professionals who were qualified to place a value on residential homes. More importantly, as sales data is largely unavailable in the UK and has, until very recently, been prohibitively expensive to purchase from the Land Registry, research to investigate the impact of environmental features on property values has relied largely on the opinions of these two cohorts. Comparing the results from the different methods of gathering perceptual data showed that using different methods of data collection can produce very different results. For example; interviews generally indicated that no adjustment is made to the asking price to compensate for a proximate HVOTL. Whereas, a postal survey indicated that both cohorts perceived a reduction in value of, on average, between 5% and 10%. By contrast, asking price data clearly showed that the asking price could be reduced by up to 20% for a house sited near a HVOTL, compared to a similar one sited further away. This data enabled a comparative analysis to be undertaken with transaction data to achieve Objective 4.

Objective 4 was to establish how well perceptions of value impacts reflected reality, by comparing the results from the perceptual research with actual sales data from a case study in Blackwood Scotland. This revealed that, in general, when a house is marketed, the asking price reflects what the market is willing to pay, however there was some indication that asking price may be reduced more than transaction data indicates is necessary to achieve a sale.

In achieving research Objectives 2 and 4, it has become apparent that property researchers should not rely too heavily on one method of obtaining perceptual data where transaction data is scarce, since the results could lead to a spurious conclusion. In this instance, a multimethod approach to data collection is clearly preferable.

Achieving Objectives 3, 5 and 6 relied on transaction (sales) data from a case study location within the UK to first, establish the impact of the presence of a HVOTL on house price and second, determine whether there is a measurable correlation between the physical distance of a HVOTL and value, or visual encumbrance and value. The results clearly identified that both physical distance to, and visual presence of, a HVOTL has a significant and, in general, negative impact on house price. This has enabled a set of criteria to be established for measuring the likely impact on the value of residential units in the UK. These criteria have been used to produce a set of tables (Tables 7-11, 7-12, 7-13) to provide a simple but effective guide to likely value diminution based on physical proximity and visual encumbrance, thus achieving the final objective (Objective 6).

7.6 FURTHER RESEARCH

This research has focused on the impact of HVOTLs on mid-range, mixed type residential units in an urban environment and has aided the development of a theory of the relationship between the presence of HVOTLs and house prices in the UK. More importantly it has provided a foundation for the assessment of value diminution of this type of housing in an urban environment, by converting data into a table of likely value diminution in a user-friendly form. The usefulness of results may be limited with regard to assessing the impact of a HVOTL on residential homes in rural locations where HVOTLs are often 400kV transmission lines supported by large pylons. Due to the size of the pylons and the fact that there are often few other buildings in situ to reduce the impact through screening, HVOTLs in this location tend to be more visually intrusive. Some adjustment to the hedonic model used for this research would be required as housing in rural locations tend to be more individual and therefore, using floor area and pylon height relative to distance from the building may be more appropriate for a comparative analysis.

The use of a multimethod strategy has demonstrated how different approaches towards data collection within both quantitative and qualitative research paradigms can produce different results. This is particularly useful information for property researchers especially within the UK, since opinion and perceptual studies are often relied upon where sales data is scare. The results of this investigation has shown how using a multimethod strategy can minimise the risk of obtaining a spurious result by relying on one approach towards data collection.

This body of work has also provided a foundation for future work in this area research. For instance, a comparative analysis of the development of this type of land, and the impact of HVOTLs on house prices could be undertaken between the UK and other countries, in particular, where screening has been used to reduce the negative impact. This would provide additional and very useful information to planners, developers and the electricity utilities to ensure the appropriate siting and subsequent development of this land to minimise negative impacts on either value or amenity.

In addition, an opportunity now exists to undertake a comparative analysis of the relationship between the asking price and the selling price for units in St Peter and Walmley, by purchasing data from the Land Registry. This would provide another source of data showing the impact of a HVOTL on selling price, and reveal whether asking price was a reliable indication of the likely effect on price.

Finally, the methodological strategy adopted for this research can be used to generate and analyse both qualitative and quantitative data to determine the impact of other environmental features on house prices. Opportunities for further research could include, mobile phone base stations;

frequently reported in the media as an environmental feature concerning homeowners and wind farms; another environmental feature likely to become more prevalent, due to the governments support for renewable energy sources.

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Government and public bodies. And I am instructing English Partnerships to use their new role on brownfields to search out and deliver even more land for housing... to produce more sustainable development we must use land more efficiently in order to reduce overall land-take".

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Relevant Web Sites

Governments PPG3 Website

www.planning.detr.gov.uk

Halifax House Price Index:
www.hbosplc.com/economic/historical_data.xls
Henshaw D. Professor of Physics at Bristol University
http://www.electric-fields.bris.ac.uk

Independent Expert Group on Mobile Phones (IEGMP
http://www.iegmp.org.uk/)

Inflation Multiple Index (regional and national changes in house price)
www.hbosplc.com/economic/historical_data.xls

National Radiological Protection Board
http://www.nrpb.org/publications

Regional House Prices Land Registry Postcode Level Data
www.upmystreet.com

APPENDICES

APPENDIX I

ELECTRIC AND MAGNETIC FIELDS: TERMS AND DEFINITIONS

Electric and Magnetic Fields: Terms and Definitions

Electric and magnetic fields, collectively known as EMFs, are produced by anything that uses or transmits electricity.

Electric fields are present where there is a voltage (i.e. whenever a household appliance is plugged in) and are quite easy to screen. They are measured in volts per metre[1] (see Figure 1)

Magnetic fields are only present when the current is flowing and they are very difficult to screen. For this reason, health studies have generally concentrated on the effects of the magnetic fields on human health. Burying power cables produces an increase in the magnetic field directly above. These fields are measured in microtesla[28] (see figure 1)

Figure 1: Electric and Magnetic Fields - Units of Measurement

Electric field strength: Volt per metre (V/m) or kilovolt per metre (kV/m)
1,000 volts per metre –1 kilovolt per metre
magnetic field strengths – tesla (T)
1 tesla- 1,000 millitesla (mT) 1 millitesla – 1,000 microtesla (μT)
1 microtesla – 1,000 nanotesla (nT)
There is an older unit, the gauss. 10,000 gauss – 1 tesla

Source: National Radiological Protection Board (NRPB) 1994

Each home will have different background levels, depending on the number and type of appliances plugged into the mains. For instance, the magnetic field given off by a television is between 2.5 and 50μT at 3cm. At 1 metre, field levels will have dropped to between 0.01-0.15μT (see table1)

Table 1: Comparison Magnetic Fields

Domestic Appliance	Magnetic field at 3cm *microtesla*	Magnetic field at 1metre *microtesla*
Clock Radio	10 – 50	0.01 – 0.02
Dishwasher	3.5 – 20	0.07 – 0.3
Drill	400 – 800	0.08 – 0.02
Fluorescent desk lamp	40 – 400	0.02 – 0.25
Fridge	0.5 – 1.7	0.01
Vacuum cleaner	200 – 800	0.13 – 2
Iron	8 – 30	0.01 – 0.025
Shaver	15 - 1.7	0.01 – 0.3
Electric Blanket (body average)	0.2 - 1.3	Not applicable
Oven (Microwave)	75 – 200	0.25 – 0.6
Washing Machine	0.8 – 50	0.01 - 0.15
Vacuum Cleaner	200 - 800	0.13 - 2
Hair Dryer	6 - 2,000	0.01 - 0.3
Storage Heater	2 – 10	0.05 - 0.3

Source: NRPB and National Grid Transco

Most of these appliances are only on for a short period of time compared to the constant output from either a 132kV, 275kV or 400kV line. The reading directly below a 400kV line is 40µT, while below a 132kV line it is similar (11µT) to a typical lightning strike at a distance of 1km. These levels do not fall off as quickly as domestic appliances and levels as high as 0.2µT have been found over 200m away from the line. At the perimeter fence of a substation, the reading is about 1.6µT.

UK Exposure Guidelines

The UK has no statutory regulation of the maximum exposure levels of electric and magnetic fields. The National Radiological Protection Board (NRPB) is an independent scientific body which has the responsibility of recommending 'safe exposure limits' to the Government, the Electricity Utility and other relevant bodies (e.g., the Health and Safety Executive). Its advice is given after considering the most recent scientific evidence from health studies conducted worldwide. Current UK exposure levels (1600µT) are based on the results of the 1996 Finnish study by Verkasalo[2], which found no evidence of a link between adverse health effects and residential exposure to EMFs. The NRPB's position on this subject has been summarised by Lord Inglewood, who stated, "*...the evidence does not establish that exposure to EMF is a cause of cancer, although it does provide some evidence to suggest the possibility exists, which justifies moving forward with research.*"[3] Subsequently, despite an apparent, although unexplained, relationship between living close to HVOTLs and an increase in the incidence of childhood leukaemia[4], exposure levels have remained virtually unchanged since first introduced in the 1950s and therefore still only recognise electric shock, central nervous system responses and, at high frequencies, body tissue heating. As a result, other more subtle effects on human physiology are not considered (see Chapter Three).

The Precautionary Principle

To address this issue, in May 1994, all E.C. Governments were called on to take initiatives, for standards and regulations, aimed at limiting the exposure of workers and the general public to EMFs.[5] This included introducing power line corridors (referred to as a power line 'right of way' [ROW]), like those found in the USA and Canada, where building is prohibited. The principle behind this was one of "*Prudent Avoidance*" as stated in Article 130r of the European Treaty, (amended by the Maastricht Treaty) "*... member states would, in matters of health, operate in a precautionary manner.*" The signing of the Treaty obliged all Member States to act under that principle. The British Government's commitment to the precautionary principle was founded on the ruling in *Regina v Secretary of State for Trade and Industry, ex parte Duddridge and Others* (6 Oct 1995), when it was decided that the unproven possibility that the electric and magnetic fields from high voltage transmission lines might increase the risk of leukaemia, was not enough to impose on the Secretary of State for Trade and Industry an obligation, either under domestic or European law, to issue regulations limiting such electric and magnetic fields. The Court of Appeal refused leave to appeal against the decision and refused an application for judicial review of the Secretary of State's decision not to issue regulations limiting EMFs from cables laid by National Grid Tranco or other licence holders under the Electricity Act 1989.

Despite the fact that the Electricity utilities and the planning authorities are working within the exposure guidelines set by the NRPB, the UK Government announced in 1992 that epidemiological research carried out to establish whether or not a correlation existed between residential exposure to EMFs from high voltage overhead power lines and childhood leukaemia found *"evidence, albeit not statistically that clear, of a slightly elevated risk of childhood leukaemia in association with very high mains power fields at levels that are not usual in Britain."*[6] Dr Michael Clark, spokesman for the NRPB, said, *"the weak association is nothing new. The advisory group will be reporting on whether the regulations might be changed."* Other research examined by the expert group came from Professor Denis Henshaw of Bristol University in 1999. After carrying out tests near 2,000 power lines, he found that the magnetic fields around cables attracted particles linked with cancer, such as benzene and radon, which he claims is a plausible causal link between living in close proximity to HVOTLs and cancer. However, no research has established 'conclusively' whether or not living in close proximity to power lines is a health risk.

Exposure Guidelines In Different Countries.

Many countries have either adopted the International Commission for Non Ionising Radiological Protection (ICNIRP) guidelines or have introduced their own guidelines to reduce public exposure to EMFs (see table 2). The USA and Canada site HVOTLs in a right of way (ROW), a corridor of land where building is prohibited. Some States in the USA (e.g. Florida and New York) have also imposed magnetic field strengths on new and future construction of ultra high voltage power lines (over 500kV) This requires that the ROW must be wide enough for the magnetic field measurement to be equivalent to that of the standard lower voltage lines at the edge of the 'right of way'. This figure is based on the assumption that current levels are publicly acceptable and not on any scientific evidence (CENLEC, 1994[7]).

Table 2: Comparison Exposure Guidelines

Country / Organisation	Micro Tesla	Comments
NRPB / UK	1600μT	Based on thermal effects
ICNIRP	100μT	General Recommendation
Switzerland	1μT	Limit for new installations
Queensland, Australia	0.4μT	New Substation Installation
Italy	2μT	Close to School:- under discussion
Italy	5μT	Max exposure level for living/working more

		than 4 hours per day (under discussion)

Source: Health Effects of EMFs (Henshaw D. Dec 2002)

[1] National Radiological Protection Board (1994) "Electric and Magnetic Fields: From the Use of Electricity" At-A-Glance Series Published by the NRPB.
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[2] Verkassalo P., Pukkala E., Kaprio J., *et. al.* (1996) "Magnetic fields of high power lines and risk of cancer in Finnish adults: nationwide cohort study." British Medical Journal 313 (26-Oct 1996): 1047-51

[3] Rice P. and Maier A. Dr (1997) "Is there a link between electricity and Cancer?" Estates Gazette February 22nd. 1997: 127-130.

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[6] Blakemore C. Professor. (1992) Brain specialist at Oxford University and member of the Advisory Group on Non-ionising Radiation (1992 NRPB Advisory Committee).

[7] CENELEC 1994 'Human Exposure to Electric and Magnetic Fields' Environment. 50166 November 1994

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Appendices 2, 5, 6, 7, 13 and 14

APPENDIX II

DEVELOPMENT NEAR LINES

APPENDIX III

VALUERS'POSTAL QUESTIONNAIRE AND LETTER

OXFORD
BROOKES
UNIVERSITY

Directorate of **Human Resources**

Department of Real Estate Management

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ocrem@brookes.ac.uk

23-9-02

Dear
I am currently completing a research studentship at Oxford Brookes University, School of Architecture. My work is principally concerned with the effects of electricity distribution equipment on land use and property valuation. This involves, in part, a study of the perceptions of surveyors, valuers and agents and therefore your experience and opinions are much valued in this research.

This questionnaire will take less than 5 minutes of your time to complete and can be returned in the SAE provided. If you would like to receive a copy of the results or would be prepared to participate in a follow up interview, please fill in your name, address and contact number at the bottom of this page. Any additional information can be placed on the back of the questionnaire.

Replies are coded to ensure confidentiality and any direct quotations taken from the findings will not be attributed to individuals. My thesis, when finished will be deposited in the university library.

Thanking you in advance for your co-operation

Sally Sims
Department of Real Estate Management
School of Architecture

Name____

Address______________________________________

____

Contact Number__________________________________

Email address___________________________________

Please Tick the Appropriate Box if Applicable

Please send me the results of this survey ☐

Yes I would be willing to participate in a follow up survey / interview ☐

OXFORD
BROOKES
UNIVERSITY

Directorate of Human Resources

Department of Real Estate Management

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ocrem@brookes.ac.uk

7-3-03

Dear
I recently contacted you to ask if you would participate in a study I am conducting for a research studentship at Oxford Brookes University, School of Architecture. My work is principally concerned with the effects of electricity distribution equipment on land use and property valuation. This involves, in part, a study of the perceptions of surveyors, valuers and agents and therefore your experience and opinions are much valued in this research.

This questionnaire will take less than 5 minutes of your time to complete. If you would like to receive a copy of the results or would be prepared to participate in a follow up interview, please fill in your name, address and contact number at the bottom of this page. Any additional information can be placed on the back of the questionnaire.

Replies are coded to ensure confidentiality and any direct quotations taken from the findings will not be attributed to individuals. My thesis, when finished will be deposited in the university library.

Please disregard this letter if you have already returned a questionnaire. If you do not carry out valuations please return the questionnaire unanswered and I will remove your name from my database.

Thanking you in advance for your co-operation

Sally Sims
Department of Real Estate Management
School of Architecture

Name________________________________

Address________________________________

____

Contact Number________________________________

Email address________________________________

Please Tick the Appropriate Box if Applicable

Please send me the results of this survey ☐

Yes I would be willing to participate in a follow up survey / interview ☐

Valuation Questionnaire

Please tick the appropriate box or use the space provided

1. **Where is your business based?** ____________________

2. **How long have you been a practising valuer?**
   Less than 5 yrs ☐ 5 – 10 yrs ☐ 11 – 15 yrs ☐ More than 15 yrs ☐

3. **What type of property do you normally value?**
   Commercial ☐ Residential ☐ Mixed ☐

4. **How much of your time is spent valuing residential property?**
   None ☐ Up to 25% ☐ Up to 50% ☐ Up to 75% ☐ More than 75% ☐

5. **Have you ever valued residential property near power lines?**
   Never ☐ Rarely ☐ Often ☐ Frequently ☐

6. **Have you found that the presence of overhead power lines near residential property?**

Please tick appropriate boxes	0 Never	1 Rarely	2 Sometimes	3 Often	4 Always
Increases residential property value					
Reduces residential property value					
Removes some potential buyers from the market place					
Increases the time it takes to sell a property					
Negatively affects the availability of mortgage finance					
Would not consider marketing this type of property					

7. **On average what is the effect on market value?**
   No effect ☐ Less than 1% ☐ 2 – 3% ☐ Up to 5% ☐
   5 –10% ☐ 10-20% ☐ Greater than 20% ☐

8. **What contributes to any negative value impact or increased marketing time?**

Please rank the degree of impact from 0 to 10 0=No impact 10=Very large impact	Reduces Value	Increases Marketing Time
Visual unsightliness		
Noise produced (buzzing / humming)		
Unsafe (fear of being electrocuted)		
Possible health risks (e.g. cancer)		
Concern over property value in the future		
Restricted land use (growing trees etc.)		
Birds nesting on lines		

8a.

Is marketing time increased by	
Months?	**Years?**

9. **Have you observed any changes in the way house builders have conducted development in the last 5-10yrs to offset any negative effects associated with power lines and pylons?**

Please tick appropriate box	0 Never	1 Occasionally	2 Sometimes	3 Often	4 Always
Proximate property had a larger plot					
Proximate property had a lower price					
Proximate property had a buffer or landscaping to hide the lines					
Low cost housing placed closest to the line					
Social housing placed closest to the line					
Power line corridors through a housing estate (sometimes used for parking, rubbish, or dog walking)					
Reject site for housing development					
Reject site completely					
Other please specify					

Thank you for completing this questionnaire

APPENDIX IV

BUYERS' POSTAL SURVEY AND LETTERS

OXFORD BROOKES UNIVERSITY
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ocrem@brookes.ac.uk

25-6-03

Dear Resident,

We are carrying out a study to help property professionals improve the quality of existing and future residential environments.

Part of this study is focusing on the opinions of local residents towards living near a number of environmental features recently featured in the local and national press. Your views and opinions are very important to us.

This questionnaire will take less than 5 minutes of your time to complete and can be returned in the SAE provided. If you would like to receive a copy of the results or would be prepared to participate in a follow up interview, please fill in your name, address and contact number on the slip provided. Any additional information can be placed on the back or the questionnaire.

Replies are coded to ensure confidentiality and any direct quotations taken from the findings will not be attributed to individuals. This results of this study will be made available to property professionals, government planning departments and the electricity industry and will form part of a thesis, which when finished, will be deposited in the university library.

Thanking you in advance for your co-operation

Sally Sims Researcher
Department of Real Estate Management
School of Architecture.

If you would like to receive the results of this survey when published or would be willing to participate in a follow up survey or interview, please fill in and return the section below.

Name________________________________

Address________________________________

____

Contact Number________________ **Email Address**________________

Please send me the results of this survey ☐ **Yes I would be willing to participate in a follow up survey/interview** ☐

The following topics have been the subject of recent press coverage.

1. How much do they concern you, if at all?

'Please tick one box per row'	1 Not at all concerned	2 Slightly concerned	3 Moderately concerned	4 Very concerned	5 Extremely concerned	6 Don't Know
Electricity Sub-station						
High Voltage Overhead Electric Power Line						
Overhead Telephone Lines						
Mobile Phone Base Station						

2. If YES to any of the above- Why do they concern you?

The following drawbacks have been associated with sub stations, power lines, telephone lines and mobile phones aerials. Please rank them according to how much they would concern you if you lived close to them (within 100m)

a.

Please tick box	Visual unsightliness 1=not concerned 5=very concerned				
	1	2	3	4	5
Sub-station					
Electricity Power line					
Electricity Pylon					
Telephone line					
Mobile phone aerial					

b.

Please tick box	Noise (humming/buzzing) 1=not concerned 5=very concerned				
	1	2	3	4	5
Sub Station					
Electricity power line					
Electricity Pylon					
Telephone line					
Mobile phone aerial					

c.

Please tick box	Danger from- line breaking, pylon falling, electrocution 1=not concerned 5=very concerned				
	1	2	3	4	5
Sub-station					
Electricity Power line					
Telephone line					
Mobile phone aerial					

d.

Please tick box	Fear of long term health risk 1=not concerned 5=very concerned				
	1	2	3	4	5
Sub Station					
Electricity power line					
Telephone line					
Mobile phone aerial					

3. Do you live near (within 100m) any of the following ?

Please tick one box per row	Live near? Yes	No
Electricity Sub-station		
High Voltage Overhead Electric Power Line		
Electricity Pylon		
Overhead Telephone Lines		
Mobile Phone Aerial		

4. Are any of them visible from your house?

Please tick one box per row	Visible from house? Yes	No
Electricity Sub-station		
High Voltage Overhead Electric Power Line		
Electricity Pylon		
Overhead Telephone Lines		
Mobile Phone Aerial		

5. Have you considered buying / renting a house near any of the following in the last 5-10 years -if Yes, did the presence of any of the following negatively affect your purchase decision

	No	Yes	If YES... please grade according to how much influence these factors had on your decision NOT TO BUY that property: Unsure 0	No influence 1	Some Influence 2	Moderate influence 3	Large influence 4	Very large influence 5
Electricity Sub-Station								
High Voltage Overhead Power Line								
Electricity Pylon								
Overhead Telephone Line								
Mobile Phone Aerial								

6. If the home you now live in had any of the following close to the house (within 100 metres) **would that have made a difference to your purchase decision: Would you have?**

Please tick one box per row	Not bought or rented that property	Offered a lower price	Offered a lower price only if visible from house	Would not make any difference
Electricity Sub-station				
High Voltage Overhead Power line				
Electricity Pylon				
Overhead Telephone Lines				
Mobile Phone Aerial				

7. If you would have offered a lower price in Q5, how much lower?

Please tick one box per row	Don't Know	1-5% lower	5-10% lower	10-15% lower	15-20% lower	25-30% lower	30-40% lower	50% lower	More than 50%
Electricity Sub-station									
High Voltage Overhead electricity power line									
Electricity Pylon									
Overhead telephone line									
Mobile phone aerial									

8. If you lived close to any of the following, would you pay to have them removed or placed out of sight (underground)?

'Please tick one box per row'	no	yes	Only if it increased the value of my home
Electricity Sub-station			
High Voltage Overhead electricity power line			
Electricity Pylon			
Overhead telephone line			
Mobile phone aerial			

9. Hypothetically, if removing some of these features from your neighbourhood increased the present value of your house by 10%, would you be willing to pay part of that 10% increase towards the cost of their removal? If YES then how much? (Theoretically, you would not pay this sum until you sold your house)

Please remember this is only hypothetical and not based on any factual information.

	0%	Up to 5%	Up to 10%	Up to 20%	Up to 30%	Up to 50%	Up to 75%	More than 75%
Electricity Sub Station								
High Voltage Overhead Power Line								
Electricity Pylon								
Overhead Telephone Line								
Mobile Phone Aerial								

---

10. About you

Your Age group:- Under 20 yrs ☐ 20-40 yrs ☐ 40-60 yrs ☐ Over 60 yrs ☐

Do you have children at home? Yes ☐ No ☐

If you do have children, what ages are they? (tick one or more boxes) 0-5yrs ☐ 5-12 yrs ☐ 12-18 yrs ☐

Do you live in a:- Flat ☐ Maisonette ☐ Terraced House ☐ Semi-detached House ☐ Detached House ☐

How long have you lived at this address? ____________yrs

Are you : The Owner ☐ Related to the Owner ☐ A Tenant ☐ Other ☐

Thank you for completing this questionnaire

Please return in the stamped addressed envelope

Form wor1

APPENDIX V

WALMLEY CASE STUDY LOCATION MAP

APPENDIX VI

ST PETER CASE STUDY LOCATION

APPENDIX VII

BLACKWOOD CASE STUDY LOCATION

APPENDIX VIII

VISUAL IMPACT DATA COLLECTION SHEET

Topography: very hilly		Slightly hilly		flat		valley	

House number:																					
Feature																					
Open space																					
Woodland																					
Other houses																					

FRONT																					
2 or more pylons																					
1 & part of another																					
1 pylon																					
¾ pylon																					
½ pylon																					
¼ pylon																					
No pylon																					
Line and pylon																					
Line																					
No line																					
Substation																					
Mob base station																					

Rear																					
2 or more pylons																					
1 & part of another																					
1 pylon																					
¾ pylon																					
½ pylon																					
¼ pylon																					
No pylon																					
Pylon not obvious																					
Line and pylon																					
Line																					
No line																					
Line Not obvious																					
Substation																					
Mob base station																					
Sub/mob not obvio																					

APPENDIX IX

TABLES AND CHARTS DIRIVED FROM DISAGREGATED DATA IN BLACKWOOD

Table and Charts Derived from Disaggregated Data in Blackwood

Graphs (Figures 1-9) produced a much clearer visual picture of the impact of a pylon and showed that for most property, values drop at around 50m from a pylon and again at a distance of around 150m. Value then appears to increase until property reaches a distance of about 250m away from the HVOTL after this point the value of detached property has a tendency to fall, whereas in general, the value of semi-detached property continues to increase.

Table 1a: 1994 Semi detached/ 3 bed

Distance from pylon	Number	Mean value £	Std. Dev
50m	7	53274.29	4555.4
100m	6	54045.8	5992.9
150m	2	52950	24021.6
200m	4	50685	4935.6
300m	3	64050	2475.8
350m	5	62050	1861.3
400m	3	62950	00

Table 1b: 1994- Detached/ 4bed

Distance from pylon	Number	Mean Value £	Std. Dev
50m	1	76995	
100m	1	28550	
150m	2	74350	6222.5
200m	21	78073.8	5372.3
250m	10	81550	8870.83
300m	2	77725	1096
350m	3	77650	785.81

Table 1c: 1994 Detached /3 bed

Distance from pylon	Number	Mean value £	Std. Dev
200m	6	71083.3	3942.29
250m	2	68750	8838.8
300m	3	75866.67	1587.7
350m	4	76412.5	1127.2
400m	1	75000	

Table 2a: 1995 Semi Detached / 3 bed

Distance from pylon	Number	Mean value £	Std. Dev
49m	1	52995	-
50m	2	57722.50	8807.01
100m	8	49323.75	11002.39
150m	13	55901.54	10925.20
200m	6	54407.50	5085.19
300m	2	56550	4879.04
350m	6	56469.17	4911.18
400m	5	55225	4344.11

Table 2b: 1995 Semi Detached / 4 bed

Distance from Pylon	Number	Mean Value £	Std. Dev
100m	3	61831.67	291.56
150m	6	62830	1327.91
200m	3	61498.3	1325.7
250m	3	67096.67	2681.8
300m	3	66400.	1402.68

Table 2c: 1995 Detached/3 bed

Distance from pylon	Number	Mean value £	Std. Dev
150m	2	75921.5	12687.62
200m	1	75000	-
250m	4	64247.5	13252.48
300m	2	70000	-
350m	6	77761.67	2969.93

Table 2d: 1995 Detached / 4 bed

Distance from Pylon	Number	Mean Value £	Std. Dev
50m	1	79495	
100m	4	57661	17060.12
150m	10	69388.5	18026.12
200m	10	66549.5	18026.11
250m	14	79474.64	16816.17
300m	5	80840	5200.65
350m	2	79332.5	1530.89

Table 2e: 1995 Detached / 5bed

Distance from Pylon	Number	Mean value £	Std. Dev
50m	2	78495	-
100m	2	76000	2828.43
150m	4	74623.75	4783.09
200m	1	75000	-
300m	2	80032.50	116.67
350m	3	80131.67	276.6
400m	2	80642.50	321.73

Table 3a: 1996 Semi detached / 3 bed

Distance from Pylon	Number	Mean value £	Std. Dev
<49m	2	50750	28637.82
50m	1	54450	-
100m	3	54331.67	4617.36
150m	2	67300	282.84
200m	1	54950	-
250m	1	55500	-
400m	1	52500	-

Table 3b: 1996 Detached /4 bed

Distance from Pylon	Number	Mean value £	Std. Dev
50m	4	56856.25	21082.76
100m	5	63468	17884.68
150m	5	58000	19010.69
200m	3	71666.67	21507.75
250m	1	68000	-
300m	2	78375	1237.44

Table 4a: 1997 Semi detached/ 3 bed

Distance from Pylon	Number	Mean value £	Std. Dev
50m	2	53050	2192.03
100m	2	51997.5	2844.89
150m	1	59000	-
200m	1	47400	-
250m			
300m	1	60000	-
350m	2	61250	6717

Table 4b: 1997 Detached/ 4 bed

Distance from Pylon	Number	Mean Value £	Std. Dev
50m	1	79995	-
100m	1	80495	-
150m	1	81289	-
200m	4	81375	13480.96
250m	1	82995	4269.56
300m	2	75750	3889
350m			

Table 5a:1998 Semi detached/3bed

Distance from pylon	Number	Mean value £	Std. Dev
50m	4	52112.5	2192.03
100m	1	53995	-
150m	1	65500	-
200m	2	59000	4242.64
350m	1	60000	-
400m	1	63750	-

Table 5b: 1998 Detached /4bed

Distance from Pylon	Number	Mean Value £	Std. Dev
100m	1	70000	
150m	1	68500	
300m	2	86500	4949.7
350m	2	80475	3570

Table 6a:1999 Semi Detached/ 3 bed

Distance from pylon	Number	Mean value £	Std. Dev
50m	1	57500	-
100m	2	53997.5	1410.68
150m	2	52500	707.11
200m	1	63995	-
300m	1	67500	-

Table 6b: 1999 Detached/ 4 bed

Distance from Pylon	Number	Mean Value £	Std. Dev
100m	1	68795	-
150m	3	71430	3154.55
200m	2	84750	11667.26

Table 7a: 2000 Semi detached /3bed

Distance from pylon	Number	Mean value £	Std. Dev
50m	1	53500	-
150m	4	48623.	3036.75
200m	1	49000	-
350m	1	54995	-
400m	3	64333.3	1154.7

Table 7b: 2000 Detached /4bed

Distance from Pylon	Number	Mean Value £	Std. Dev
50m	1	47250	-
100m	1	79000	-
150m	1	66500	-
300m	2	78750	14495.69
250m	1	87000	-
300m	1	78850	-

Table 8a: 2001 Semi detached /3bed

Distance from Pylon	Number	Mean value £	Std. Dev
<49m	2	61000	8485.28
50m	2	59025	7035
100m	5	59898	3470.7.2
150m	4	64000	7735.2
200m	4	57248.75	5560.95
350m	2	60747.5	6006.8
400m	1	59995	-

Table 8b: 2001 Detached /4bed

Distance from Pylon	Number	Mean Value £	Std. Dev
100m	1	84000	-
150m	2	78250	-
200m	4	86125	6032.9
250m	5	86799	7155.03
300m	1	83250	-

Table 9a: 2002 Semi Detached / 3bed

Distance from Pylon	Number	Mean value £	Std. Dev
<49m	2	66102.63	9786.34
50m	3	62833.3	2466.44
100m	2	63000	1414.21
150m	4	59625	10306.74
200m	2	61000	5656.85
250m	2	65250	353.55
300m	1	95000	
350m	2	71225	1803.12
400m	1	80000	

Table 9b: 2002 Detached /4 bed

Distance from Pylon	Number	Mean Value £	Std. Dev
50m	3	80058.33	28456.29
100m	1	74000	
150m	1	88000	
200m	3	100666.67	3214.55
250m	3	102000	7000
300m	1	97950	
350m	3	91833.3	4072.26

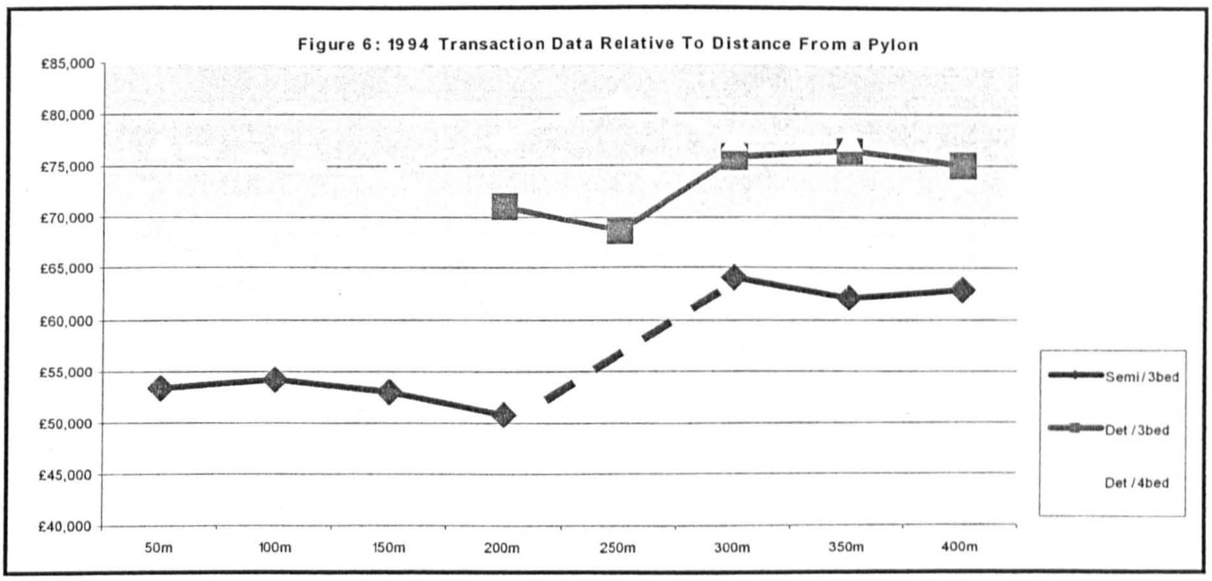


Figure 6: 1994 Transaction Data Relative To Distance From a Pylon
£85,000
£80,000
£75,000
£70,000
£65,000
£60,000
£55,000
£50,000
£45,000
£40,000
50m
100m
150m
200m
250m
300m
350m
400m
Semi / 3bed
Det / 3bed
Det / 4bed

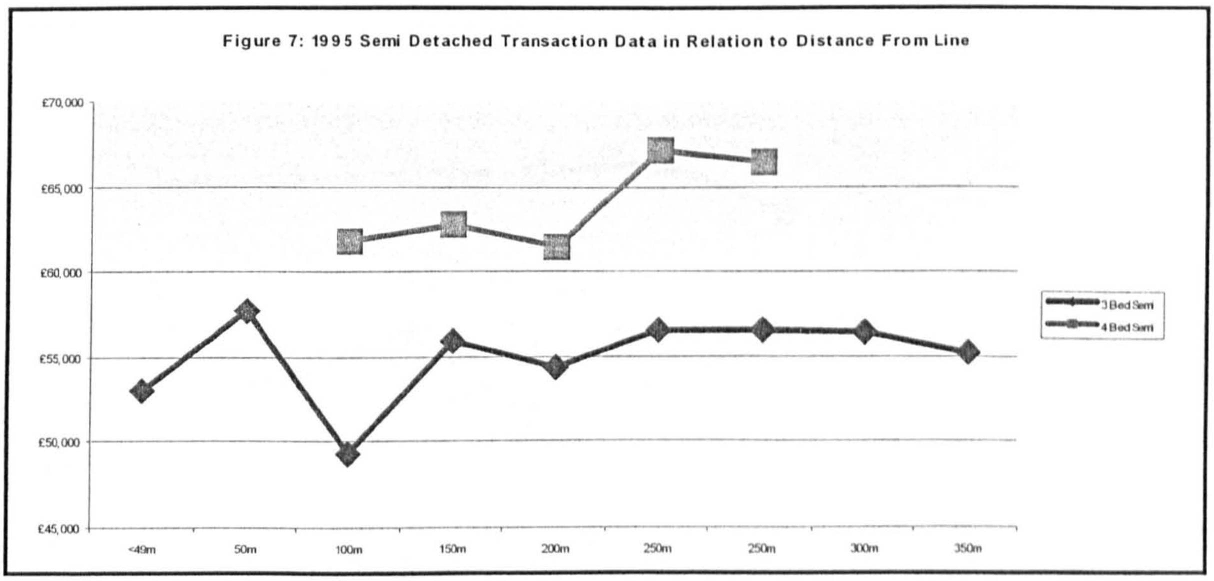


Figure 7: 1995 Semi Detached Transaction Data in Relation to Distance From Line
£70,000
£65,000
£60,000
£55,000
£50,000
£45,000
<49m
50m
100m
150m
200m
250m
250m
300m
350m
3 Bed Sem
4 Bed Sem

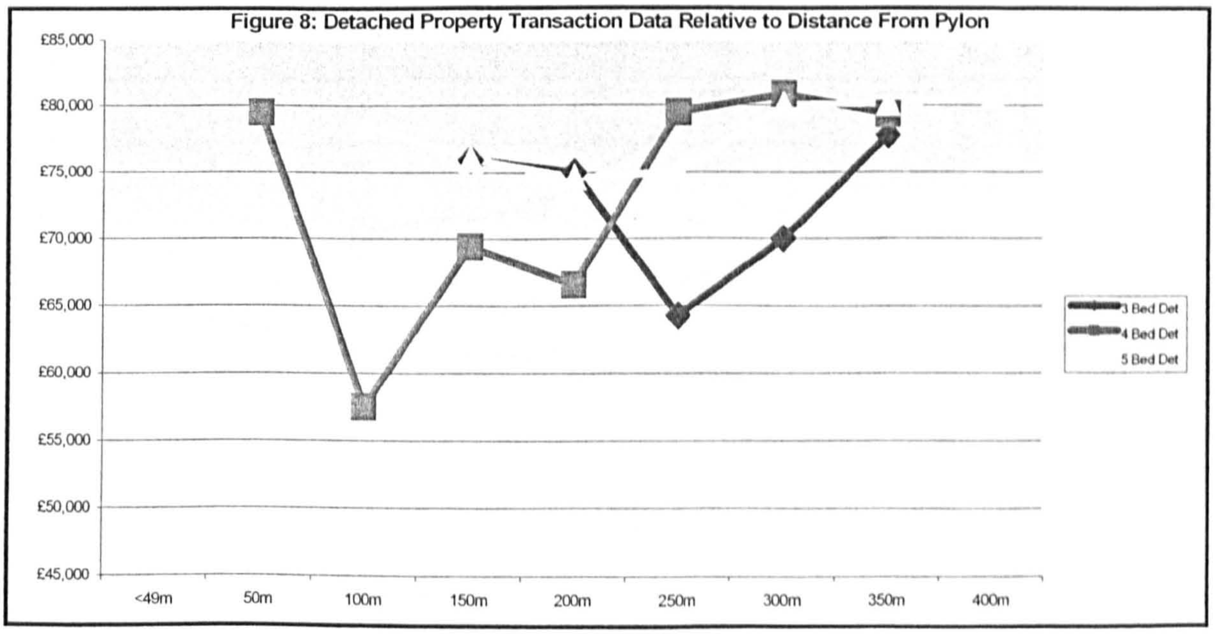


Figure 8: Detached Property Transaction Data Relative to Distance From Pylon
£85,000
£80,000
£75,000
£70,000
£65,000
£60,000
£55,000
£50,000
£45,000
<49m
50m
100m
150m
200m
250m
300m
350m
400m
3 Bed Det
4 Bed Det
5 Bed Det

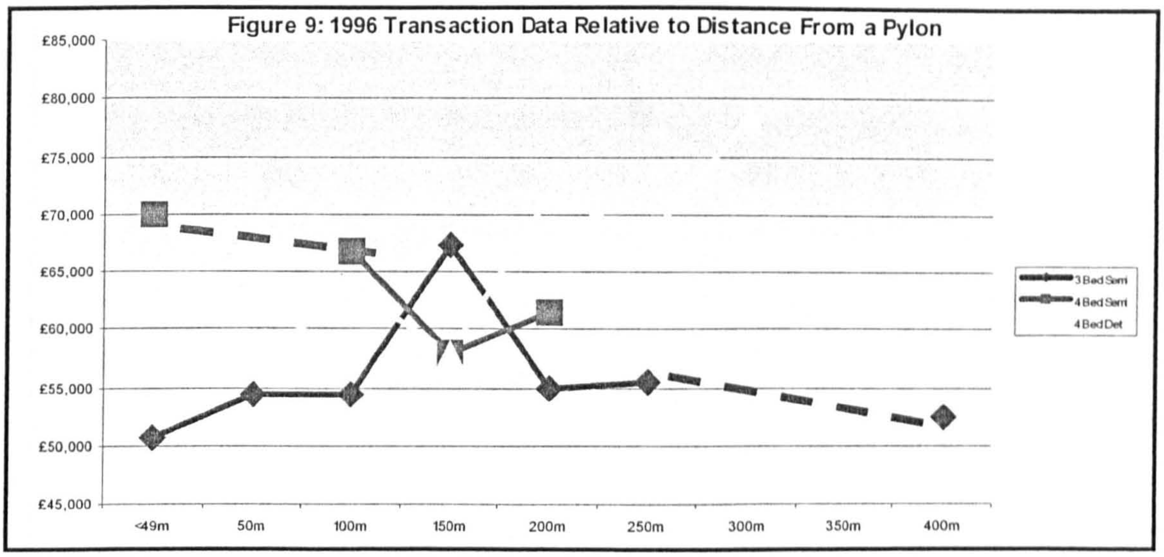


Figure 9: 1996 Transaction Data Relative to Distance From a Pylon
£85,000
£80,000
£75,000
£70,000
£65,000
£60,000
£55,000
£50,000
£45,000
<49m
50m
100m
150m
200m
250m
300m
350m
400m
3 Bed Semi
4 Bed Semi
4 Bed Det

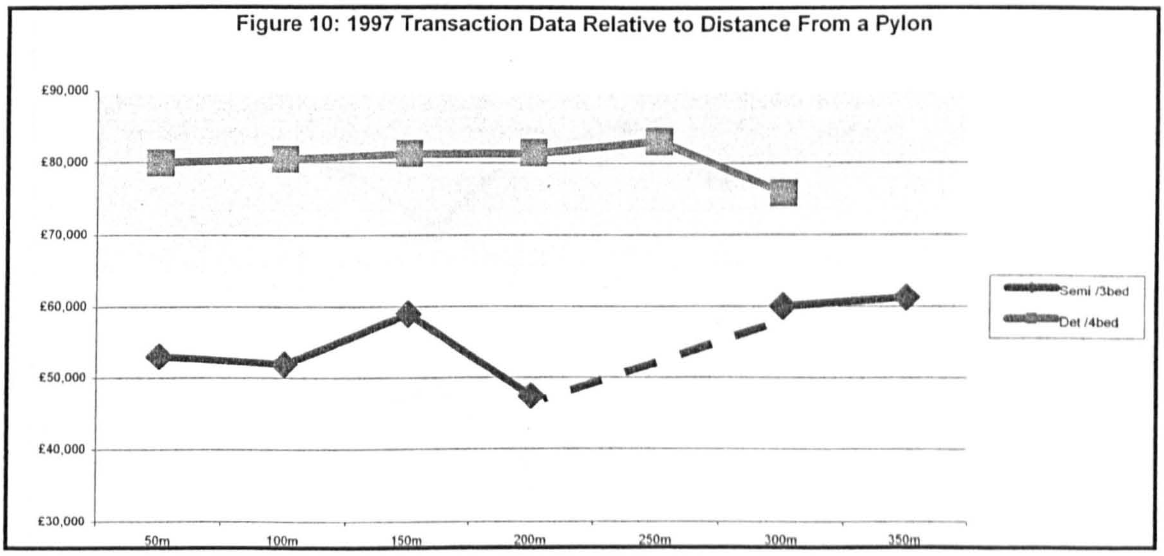


Figure 10: 1997 Transaction Data Relative to Distance From a Pylon
£90,000
£80,000
£70,000
£60,000
£50,000
£40,000
£30,000
50m
100m
150m
200m
250m
300m
350m
Semi /3bed
Det /4bed

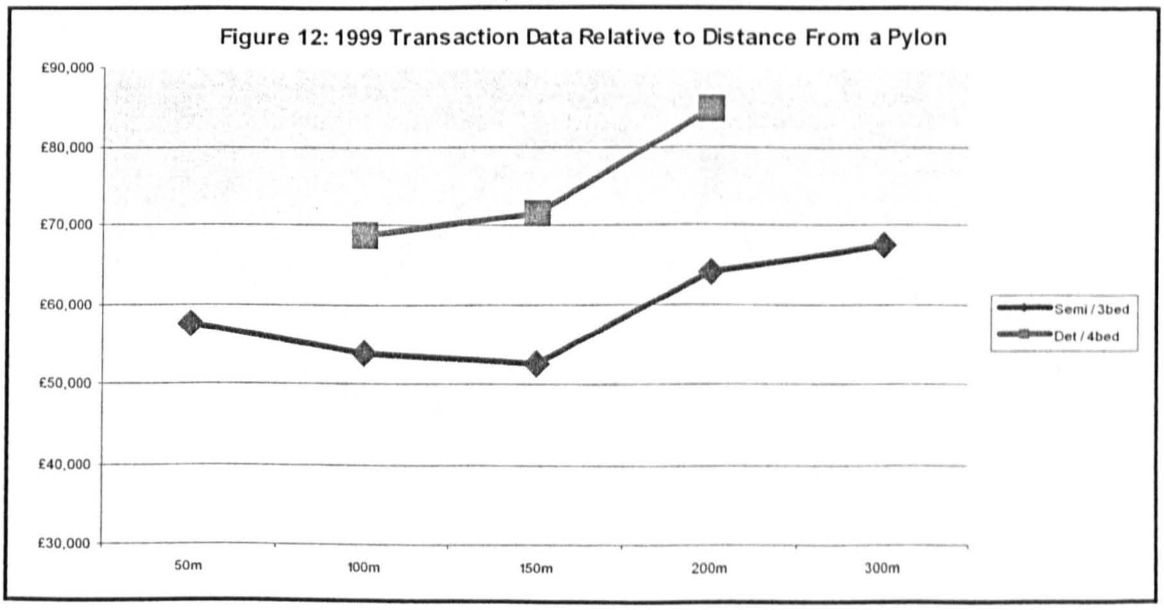


Figure 12: 1999 Transaction Data Relative to Distance From a Pylon
£90,000
£80,000
£70,000
£60,000
£50,000
£40,000
£30,000
50m
100m
150m
200m
300m
Semi / 3bed
Det / 4bed

Figure 13: 2000 Transaction Data Relative to Distance From a Pylon

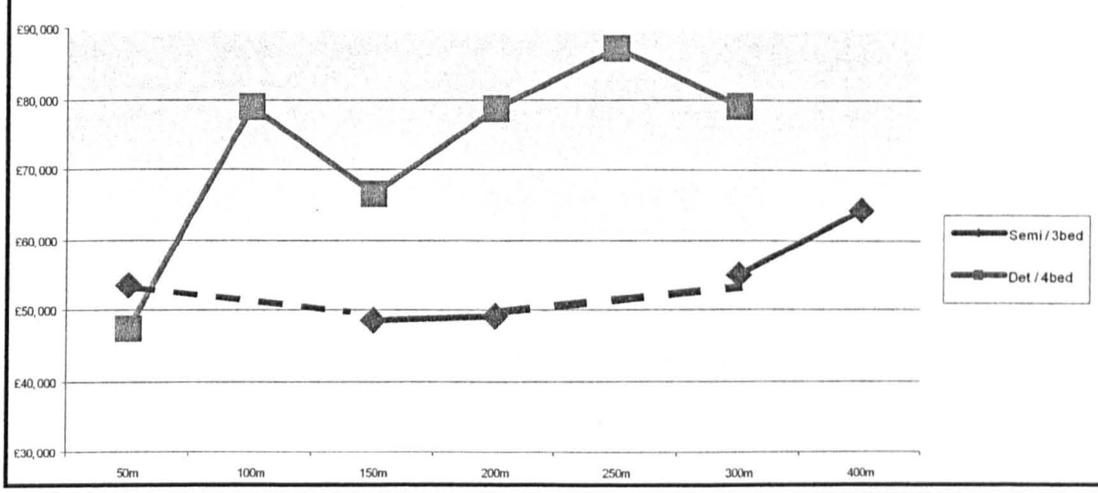


Figure 14: 2001 Transaction Data Relative to Distance From a Pylon

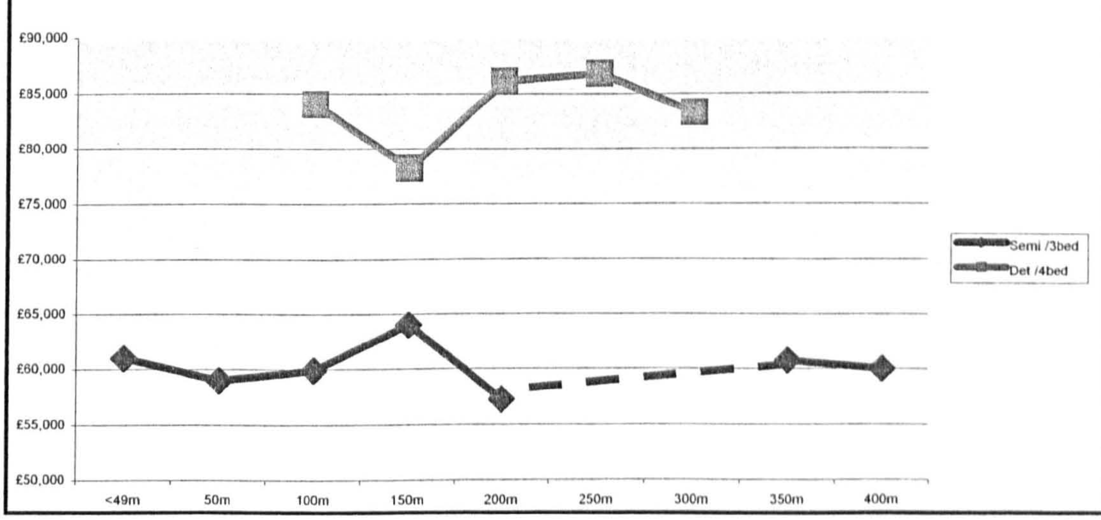
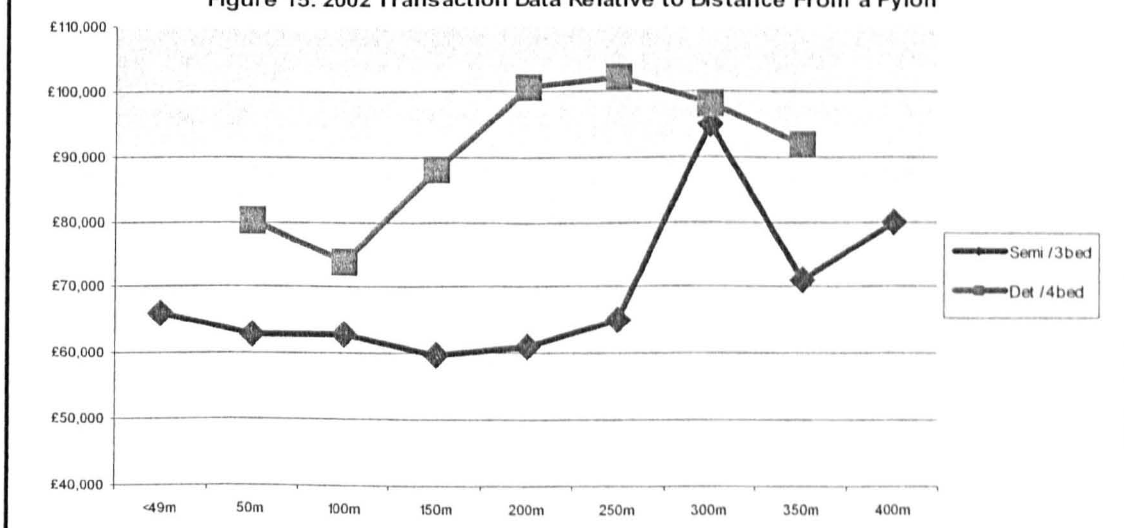


Figure 15: 2002 Transaction Data Relative to Distance From a Pylon



APPENDIX X

CORRELATION MATRIX FOR BLACKWOOD DATA

Correlation Matrix for Property Specific Variables Including Topography In Blackwood

Upper quadrant = Pearson Correlation Coefficient
Lower quadrant = Kendall's Tau_b
CC = Correlation Coefficient

= High degree of correlation between variables therefore, one variable will be excluded in the analysis

		1	2	3	4	5	6	7	8
1. FLAT	CC		-.023	-.106	-.120	-.137	-.141	-.224	-.043
	Sig. (2-tailed)		.581	.011	.004	.001	.001	.000	.303
2. TERRACE	CC	577		-.173	-.197	-.045	-.231	-.280	-.070
	Sig. (2-tailed)	-.023		.000	.000	.282	.000	.000	.091
3. SEMI	CC	-.106	-.173		-.904	-.496	-.548	-.333	.037
	Sig. (2-tailed)	.011	.000		.000	.000	.000	.000	.376
4. DETACHED	CC	-.120	-.197	-.904		.542	.664	.488	.000
	Sig. (2-tailed)	.004	.000	.000		.000	.000	.000	.995
5. N.BEDRM	CC	-.136	-.036	-.492	.534		.496	.317	-.077
	Sig. (2-tailed)	.000	.358	.000	.000		.000	.000	.064
6. PARKING	CC	-.141	-.231	-.548	.664	.511		.387	.019
	Sig. (2-tailed)	.001	.000	.000	.000	.000		.000	.645
7. PLOTSIZE	CC	-.167	-.240	-.353	.480	.294	.372		-.010
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.809
8. VEIW	CC	-.043	-.070	.037	.000	-.050	.019	-.013	
	Sig. (2-tailed)	.302	.091	.375	.995	.202	.644	.711	

Correlation Matrix for HVOTL Specific Variables in Blackwood:

Upper quadrant = Pearson's Correlation Coefficient.
Bottom quadrant = Kendall's Tau_b
CC=Correlation Coefficient

= High degree of correlation between variables therefore, one variable will be excluded in the analysis

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. M.PYL	CC		.966	-.015	-.100	.116	.005	.156	.048	.018	-.021	-.205	.129	.366	-.067	.038	-.199	-.042	-.126	-.148	.042	.029	.061	.198	-.030	-.299
	Sig. (2-tailed)		.000	.723	.016	.005	.913	.000	.250	.660	.613	.000	.002	.000	.108	.359	.000	.318	.002	.000	.320	.491	.145	.000	.467	.000
2. M.LINE	CC	.838		-.050	-.110	.116	-.017	.178	.056	-.006	-.006	-.185	.152	.370	-.109	.034	-.175	-.114	-.123	-.123	.015	.029	.039	.201	.008	-.331
	Sig. (2-tailed)	.000		.232	.008	.005	.692	.000	.183	.893	.895	.000	.000	.000	.009	.412	.000	.006	.003	.003	.721	.482	.344	.000	.856	.000
3. VISLINE	CC	.009	-.008		.032	-.123	.046	.025	.047	.180	-.030	-.126	-.012	-.123	.014	.033	-.065	-.166	.157	.051	.096	.058	.049	-.057	-.010	.083
	Sig. (2-tailed)	.789	.809		.441	.003	.269	.550	.256	.000	.474	.002	.775	.003	.731	.426	.119	.000	.000	.223	.021	.166	.242	.171	.815	.045
4. REARLINE	CC	-.070	-.086	.032		-.042	.073	.044	.124	-.070	-.018	.012	-.448	.149	.135	.087	.266	.079	.100	.111	-.053	-.048	.128	.255	.071	.342
	Sig. (2-tailed)	.042	.012	.441		.311	.078	.295	.003	.093	.662	.772	.000	.000	.001	.037	.000	.056	.016	.008	.204	.251	.002	.000	.088	.000
5. VISPYL0	CC	.092	.101	-.123	-.042		-.133	-.106	-.086	-.376	-.056	-.328	.076	.005	.003	.013	-.023	-.073	-.039	.107	-.171	-.062	.090	-.096	-.025	-.019

	Sig. (2-tailed)	.008	.003	.003	.311		.001	.011	.040	.000	.178	.000	.069	.896	.947	.749	.584	.081	.351	.010	.000	.138	.032	.022	.556	.647
6. VISPYL1	CC	.014	.001	.046	.073	-.133		-.055	-.044	-.194	-.029	-.169	-.064	-.059	.388	.090	-.051	-.011	-.037	-.063	-.137	.273	-.046	.153	.114	-.180
	Sig. (2-tailed)	.676	.978	.268	.078	.001		.191	.289	.000	.487	.000	.125	.156	.000	.031	.224	.793	.375	.131	.001	.000	.274	.000	.006	.000
7. VISPYL2	CC	.142	.158	.025	.044	-.106	-.055		-.035	-.155	-.023	-.135	-.066	-.007	-.038	-.025	.006	.008	.081	.064	-.071	.019	-.036	-.068	.055	.026
	Sig. (2-tailed)	.000	.000	.549	.294	.011	.191		.399	.000	.580	.001	.113	.873	.357	.554	.890	.848	.052	.124	.087	.644	.384	.101	.188	.534
8. VISPYL3	CC	.044	.040	.047	.124	-.086	-.044	-.035		-.125	-.019	-.109	-.127	.306	-.031	-.020	.104	-.032	-.050	.137	-.073	-.077	-.029	.126	-.040	.028
	Sig. (2-tailed)	.201	.249	.256	.003	.040	.289	.398		.003	.654	.009	.002	.000	.455	.631	.013	.443	.234	.001	.080	.063	.481	.003	.338	.496
9. VISPYL4	CC	.003	-.020	.180	-.070	-.376	-.194	-.155	-.125		-.082	-.480	.023	-.016	-.096	.005	-.100	-.081	.114	.068	.130	-.196	.021	-.073	-.059	.112
	Sig. (2-tailed)	.928	.558	.000	.093	.000	.000	.000	.003		.048	.000	.575	.702	.021	.907	.017	.051	.006	.103	.002	.000	.622	.082	.154	.007
10. VISPYL5	CC	-.013	.005	-.030	-.018	-.056	-.029	-.023	-.019	-.082		-.072	-.050	-.025	-.020	.122	-.040	-.021	.073	-.010	-.010	.033	-.019	-.049	.093	-.016
	Sig. (2-tailed)	.696	.878	.473	.662	.177	.486	.580	.653	.048		.086	.228	.549	.624	.003	.335	.615	.081	.820	.813	.430	.643	.241	.026	.693
11. VISPYL6	CC	-.167	-.153	-.126	.012	-.328	-.169	-.135	-.109	-.480	-.072		.029	-.057	-.077	-.077	.122	.168	-.100	-.207	.148	.126	-.045	.075	-.009	-.021
	Sig. (2-tailed)	.000	.000	.002	.772	.000	.000	.001	.009	.000	.086		.480	.168	.066	.066	.003	.000	.016	.000	.000	.002	.279	.071	.826	.608
12. REARPYL0	CC	.118	.152	-.012	-.448	.076	-.064	-.066	-.127	.023	-.050	.029		-.170	-.139	-.089	-.272	-.142	-.605	-.246	.114	.143	.232	-.067	-.308	-.394
	Sig. (2-tailed)	.001	.000	.774	.000	.069	.125	.113	.002	.575	.228	.480		.000	.001	.033	.000	.001	.000	.000	.006	.001	.000	.106	.000	.000
13. REARPYL1	CC	.266	.266	-.123	.149	.005	-.059	-.007	.306	-.016	-.025	-.057	-.170		-.042	-.027	-.082	-.043	-.182	.061	-.072	-.082	-.039	.403	-.024	-.168
	Sig. (2-tailed)	.000	.000	.003	.000	.895	.156	.873	.000	.701	.548	.168	.000		.318	.521	.049	.305	.000	.141	.085	.049	.345	.000	.559	.000
14. REARPYL2	CC	-.057	-.094	.014	.135	.003	.388	-.038	-.031	-.096	-.020	-.077	-.139	-.042		-.022	-.067	-.035	-.149	-.135	-.087	.275	-.032	.313	-.076	-.077
	Sig. (2-tailed)	.100	.007	.731	.001	.947	.000	.356	.455	.021	.624	.066	.001	.317		.600	.109	.402	.000	.001	.036	.000	.441	.000	.069	.066
15. REARPYL3	CC	.037	.036	.033	.087	.013	.090	-.025	-.020	.005	.122	-.077	-.089	-.027	-.022		-.043	-.022	-.095	.066	-.020	-.054	-.021	.028	.008	.035
	Sig. (2-tailed)	.290	.298	.425	.037	.748	.031	.553	.631	.907	.003	.066	.033	.520	.599		.303	.590	.022	.112	.639	.193	.620	.503	.857	.396
16. REARPYL4	CC	-.167	-.149	-.065	.266	-.023	-.051	.006	.104	-.100	-.040	.122	-.272	-.082	-.067	-.043		-.069	-.292	.080	.001	-.080	-.063	-.072	.039	.215
	Sig. (2-tailed)	.000	.000	.119	.000	.584	.224	.890	.013	.017	.335	.003	.000	.049	.108	.302		.099	.000	.054	.988	.054	.130	.084	.347	.000
17. REARPYL5	CC	-.029	-.104	-.166	.079	-.073	-.011	.008	-.032	-.081	-.021	.168	-.142	-.043	-.035	-.022	-.069		-.153	-.122	.090	.063	-.033	-.084	.103	.076
	Sig. (2-tailed)	.401	.003	.000	.056	.081	.793	.848	.442	.051	.614	.000	.001	.304	.401	.590	.099		.000	.003	.031	.128	.429	.045	.013	.067
18. REARPYL6	CC	-.101	-.104	.157	.100	-.039	-.037	.081	-.050	.114	.073	-.100	-.605	-.182	-.149	-.095	-.292	-.153		.242	-.078	-.163	-.140	-.154	.275	.311
	Sig. (2-tailed)	.004	.003	.000	.016	.350	.374	.052	.234	.006	.081	.016	.000	.000	.000	.022	.000	.000		.000	.060	.000	.001	.000	.000	.000
19. FORS	CC	-.131	-.109	.051	.111	.107	-.063	.064	.137	.068	-.010	-.207	-.246	.061	-.135	.066	.080	-.122	.242		-.659	-.432	-.165	-.200	-.007	.311
	Sig. (2-tailed)	.000	.001	.223	.008	.011	.131	.124	.001	.103	.819	.000	.000	.141	.001	.112	.054	.003	.000		.000	.000	.000	.000	.871	.000
20. FORSF	CC	.054	.026	.096	-.053	-.171	-.137	-.071	-.073	.130	-.010	.148	.114	-.072	-.087	-.020	.001	.090	-.078	-.659		-.320	.119	-.048	.042	-.042
	Sig. (2-tailed)	.120	.453	.021	.204	.000	.001	.087	.080	.002	.813	.000	.006	.085	.036	.638	.988	.031	.060	.000		.000	.004	.251	.313	.311
21. FORF	CC	.022	.028	.058	-.048	-.062	.273	.019	-.077	-.196	.033	.126	.143	-.082	.275	-.054	-.080	.063	-.163	-.432	-.320		.083	.282	-.015	-.303
	Sig. (2-tailed)	.531	.418	.165	.250	.138	.000	.644	.063	.000	.430	.003	.001	.049	.000	.193	.054	.128	.000	.000	.000		.047	.000	.721	.000
22. RORSC	CC	.090	.068	.049	.128	.090	-.046	-.036	-.029	.021	-.019	-.045	.232	-.039	-.032	-.021	-.063	-.033	-.140	-.165	.119	.083		-.077	-.093	-.130
	Sig. (2-tailed)	.009	.048	.241	.002	.032	.274	.384	.480	.622	.643	.278	.000	.345	.440	.620	.130	.428	.001	.000	.004	.047		.065	.025	.002
23. RORS	CC	.159	.164	-.057	.255	-.096	.153	-.068	.126	-.073	-.049	.075	-.067	.403	.313	.028	-.072	-.084	-.154	-.200	-.048	.282	-.077		-.237	-.329
	Sig. (2-tailed)	.000	.000	.171	.000	.022	.000	.101	.003	.082	.241	.071	.106	.000	.000	.502	.084	.045	.000	.000	.250	.000	.065		.000	.000
24. RORSF	CC	-.026	.018	-.010	.071	-.025	.114	.055	-.040	-.059	.093	-.009	-.308	-.024	-.076	.008	.039	.103	.275	-.007	.042	-.015	-.093	-.237		-.400
	Sig. (2-tailed)	.454	.599	.815	.088	.556	.006	.188	.338	.154	.026	.825	.000	.558	.069	.857	.347	.013	.000	.871	.313	.720	.025	.000		.000
25. RORF	CC	-.253	-.297	.083	.342	-.019	-.180	.026	.028	.112	-.016	-.021	-.394	-.168	-.077	.035	.215	.076	.311	.311	-.042	-.303	-.130	-.329	-.400	
	Sig. (2-tailed)	.000	.000	.045	.000	.647	.000	.534	.496	.007	.692	.608	.000	.000	.066	.396	.000	.067	.000	.000	.311	.000	.002	.000	.000	

APPENDIX XI

CORRELATION MATRIX FOR ST PETER DATA

Correlation Matrix for Property Specific Variables Including Topography In St Peter's

Upper quadrant = Pearson Correlation Coefficient
Lower quadrant = Kendall's Tau_b
CC = Correlation Coefficient

☐ **= High degree of correlation between variables therefore, one variable will be excluded in the analysis**

		1	2	3	4	5	6	7	8	9	10	11	12
1. FLAT	CC		-.109	-.152	-.208	-.283	-.157	-.552	-.158	-.196	.112	-.351	-.358
	Sig. (2-tailed)		.103	.023	.002	.000	.018	.000	.018	.003	.094	.000	.000
2. TERRACED	CC	-.109		-.321	-.439	-.333	-.261	-.069	-.289	-.349	.065	-.118	-.431
	Sig. (2-tailed)	.103		.000	.000	.000	.000	.302	.000	.000	.333	.079	.000
3. SEMI	CC	-.152	-.321		-.610	-.295	-.237	.096	-.312	-.310	.027	.051	-.278
	Sig. (2-tailed)	.024	.000		.000	.000	.000	.151	.000	.000	.683	.451	.000
4. DETACHED	CC	-.208	-.439	-.610		.657	.493	.204	.584	.646	-.125	.198	.751
	Sig. (2-tailed)	.002	.000	.000		.000	.000	.002	.000	.000	.062	.003	.000
5. PLOTSIZE	CC	-.262	-.284	-.230	.550		.434	.286	.478	.507	-.142	.235	.620
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.034	.000	.000
6. PARKING	CC	-.158	-.258	-.227	.481	.322		.074	.318	.384	-.173	.178	.479
	Sig. (2-tailed)	.016	.000	.001	.000	.000		.271	.000	.000	.009	.008	.000
7. GARDEN	CC	-.623	-.069	.124	.209	.270	.108		.170	.207	-.112	.318	.303
	Sig. (2-tailed)	.000	.305	.064	.002	.000	.098		.011	.002	.095	.000	.000
8. NO.BATH	CC	-.161	-.293	-.314	.590	.406	.316	.170		.878	-.072	.150	.601
	Sig. (2-tailed)	.015	.000	.000	.000	.000	.000	.011		.000	.286	.025	.000
9. NO.TOIL	CC	-.196	-.338	-.286	.615	.394	.369	.203	.813		-.075	.186	.693
	Sig. (2-tailed)	.002	.000	.000	.000	.000	.000	.001	.000		.263	.005	.000
10. VIEW	CC	.112	.065	.027	-.125	-.138	-.173	-.122	-.069	-.069		-.033	-.153
	Sig. (2-tailed)	.094	.332	.682	.062	.013	.008	.069	.296	.275		.618	.022
11. CH	CC	-.351	-.118	.051	.198	.217	.179	.357	.153	.187	-.033		.263
	Sig. (2-tailed)	.000	.079	.450	.003	.000	.006	.000	.021	.003	.617		.000
12. N.BEDRM	CC	-.280	-.387	-.279	.684	.538	.457	.274	.554	.607	-.130	.202	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.017	.000	

Correlation Matrix for HVOTL Specific Variables in St Peter:

Upper quadrant = Pearson's Correlation Coefficient.
Bottom quadrant = Kendall's Tau_b
CC=Correlation Coefficient

☐ **= High degree of correlation between variables therefore, one variable will be excluded in the analysis**

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1. METRPYL	CC	1.000	.969	-.378	-.494	.549	-.109	-.117	-.211	-.169	-.155	-.212	.469	-.034	-.155	-.160	-.298	-.187	-.157	-.094	-.184	-.308	.037	-.102	-.202	-.228
	Sig. (2-tailed)	.	.000	.000	.000	.000	.103	.081	.001	.011	.020	.001	.000	.610	.020	.016	.000	.005	.019	.160	.006	.000	.586	.129	.002	.001
2. METRLINE	CC	.842	1.000	-.382	-.498	.521	-.078	-.119	-.188	-.173	-.134	-.232	.473	-.015	-.156	-.206	-.281	-.194	-.182	-.114	-.143	-.323	.033	-.104	-.175	-.250

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Sig. (2-tailed)	.000		.000	.000	.000	.248	.076	.005	.009	.045	.000	.000	.828	.020	.002	.000	.003	.006	.088	.032	.000	.620	.120	.009	.000
3. FRONTVL	CC	-.314	-.319	1.000	.152	-.119	.017	.039	.087	.020	-.054	.053	-.718	.344	.263	.206	.187	.161	.206	.235	-.012	-.091	-.066	.436	.243	.440
	Sig. (2-tailed)	.000	.000		.022	.075	.800	.557	.195	.763	.423	.429	.000	.000	.000	.002	.005	.016	.002	.000	.862	.175	.323	.000	.000	.000
4. RVISLINE	CC	-.418	-.419	.152	1.000	-.704	.173	.290	.229	.169	.105	.181	-.225	.062	.068	-.022	.122	.079	.129	.443	.181	.320	-.106	.120	.122	-.007
	Sig. (2-tailed)	.000	.000	.023		.000	.009	.000	.001	.011	.117	.007	.001	.360	.312	.748	.067	.238	.053	.000	.006	.000	.114	.074	.069	.918
5. VISPYL0	CC	.455	.429	-.119	-.704	1.000	-.315	-.390	-.308	-.228	-.141	-.244	.156	-.003	.037	.056	-.220	-.128	-.082	-.169	-.258	-.311	.079	-.090	.001	-.047
	Sig. (2-tailed)	.000	.000	.075	.000		.000	.000	.000	.001	.035	.000	.020	.969	.583	.401	.001	.056	.222	.011	.000	.000	.240	.178	.990	.482
6. VISPYL1	CC	-.079	-.057	.017	.173	-.315	1.000	-.170	-.134	-.099	-.061	-.106	-.140	.062	-.072	-.006	.414	-.076	-.076	.113	.010	.028	-.025	-.013	.084	.041
	Sig. (2-tailed)	.150	.297	.799	.010	.000		.011	.045	.139	.360	.113	.036	.356	.283	.930	.000	.259	.259	.093	.878	.678	.712	.852	.210	.546
7. VISPYL2	CC	-.079	-.087	.039	.290	-.390	-.170	1.000	-.166	-.123	-.076	-.132	.006	.056	-.067	-.034	-.119	.206	-.034	.172	.116	.003	-.031	.021	.071	-.010
	Sig. (2-tailed)	.150	.113	.556	.000	.000	.011		.013	.066	.256	.049	.933	.408	.319	.613	.077	.002	.613	.010	.083	.960	.647	.750	.287	.879
8. VISPYL3	CC	-.187	-.162	.087	.229	-.308	-.134	-.166	1.000	-.097	-.060	-.104	-.014	-.045	.027	.068	.079	-.074	-.074	.069	.153	.036	-.024	.028	-.010	.082
	Sig. (2-tailed)	.001	.003	.195	.001	.000	.045	.013		.148	.371	.121	.832	.505	.689	.312	.238	.269	.269	.303	.022	.593	.718	.679	.878	.219
9. VISPYL4	CC	-.141	-.143	.020	.169	-.228	-.099	-.123	-.097	1.000	-.044	-.077	-.013	-.020	.036	-.055	.005	.127	-.055	-.003	.086	.110	-.018	.103	-.082	-.053
	Sig. (2-tailed)	.011	.009	.762	.011	.001	.139	.066	.147		.508	.252	.843	.766	.588	.414	.945	.058	.414	.960	.200	.100	.789	.124	.224	.431
10. VISPYL5	CC	-.141	-.115	-.054	.105	-.141	-.061	-.076	-.060	-.044	1.000	-.048	.036	.003	-.053	-.034	-.043	.107	-.034	-.081	-.056	.240	-.011	-.092	-.051	-.019
	Sig. (2-tailed)	.010	.036	.422	.117	.035	.359	.255	.369	.507		.479	.589	.968	.427	.613	.524	.111	.613	.228	.403	.000	.869	.168	.452	.774
11. VISPYL6	CC	-.191	-.204	.053	.181	-.244	-.106	-.132	-.104	-.077	-.048	1.000	-.118	-.080	.081	-.059	-.004	-.059	.456	-.100	.070	.246	-.019	.078	-.087	.015
	Sig. (2-tailed)	.001	.000	.428	.007	.000	.113	.049	.121	.252	.478		.077	.236	.225	.382	.948	.382	.000	.137	.299	.000	.775	.242	.193	.827
12. REARPYL0	CC	.388	.389	-.718	-.225	.156	-.140	.006	-.014	-.013	.036	-.118	1.000	-.492	-.361	-.230	-.290	-.230	-.230	-.252	-.054	.076	.060	-.266	-.310	-.455
	Sig. (2-tailed)	.000	.000	.000	.001	.020	.037	.933	.831	.842	.588	.077		.000	.000	.001	.000	.001	.001	.000	.418	.258	.375	.000	.000	.000
13. REARPYL1	CC	.004	.034	.344	.062	-.003	.062	.056	-.045	-.020	.003	-.080	-.492	1.000	-.141	-.090	-.113	-.090	-.090	.108	.052	-.122	-.029	.271	.085	.127
	Sig. (2-tailed)	.941	.537	.000	.358	.969	.355	.407	.504	.766	.968	.235	.000		.035	.182	.092	.182	.182	.106	.437	.069	.663	.000	.205	.058
14. REARPYL2	CC	-.129	-.122	.263	.068	.037	-.072	-.067	.027	.036	-.053	.081	-.361	-.141	1.000	-.066	-.083	-.066	-.066	.139	-.008	-.065	-.022	.109	.067	.205
	Sig. (2-tailed)	.019	.027	.000	.311	.582	.282	.318	.688	.587	.426	.225	.000	.036		.327	.216	.327	.327	.037	.907	.332	.749	.103	.318	.002
15. REARPYL3	CC	-.144	-.189	.206	-.022	.056	-.006	-.034	.068	-.055	-.034	-.059	-.230	-.090	-.066	1.000	-.053	-.042	-.042	-.030	.081	-.057	-.014	-.007	.101	.170
	Sig. (2-tailed)	.009	.001	.002	.747	.400	.930	.612	.311	.413	.612	.381	.001	.181	.326		.431	.533	.533	.651	.230	.397	.838	.918	.132	.011
16. REARPYL4	CC	-.269	-.263	.187	.122	-.220	.414	-.119	.079	.005	-.043	-.004	-.290	-.113	-.083	-.053	1.000	-.053	-.053	.012	-.027	.168	-.017	-.014	.054	.270
	Sig. (2-tailed)	.000	.000	.005	.067	.001	.000	.077	.237	.945	.522	.948	.000	.092	.215	.430		.431	.431	.861	.692	.012	.797	.840	.423	.000
17. REARPYL5	CC	-.160	-.180	.161	.079	-.128	-.076	.206	-.074	.127	.107	-.059	-.230	-.090	-.066	-.042	-.053	1.000	-.042	.155	.081	-.111	-.014	-.060	.264	.115
	Sig. (2-tailed)	.004	.001	.016	.238	.056	.258	.002	.268	.058	.111	.381	.001	.181	.326	.532	.430		.533	.020	.230	.097	.838	.368	.000	.087
18. REARPYL6	CC	-.144	-.165	.206	.129	-.082	-.076	-.034	-.074	-.055	-.034	.456	-.230	-.090	-.066	-.042	-.053	-.042	1.000	.062	-.069	.106	-.014	.100	.101	.004
	Sig. (2-tailed)	.009	.003	.002	.053	.222	.258	.612	.268	.413	.612	.000	.001	.181	.326	.532	.430	.532		.354	.302	.114	.838	.135	.132	.953
19. FORS	CC	-.069	-.093	.235	.443	-.169	.113	.172	.069	-.003	-.081	-.100	-.252	.108	.139	-.030	.012	.155	.062	1.000	-.280	-.449	-.055	.160	.238	.033
	Sig. (2-tailed)	.213	.091	.000	.000	.012	.093	.010	.302	.959	.227	.136	.000	.106	.037	.650	.861	.021	.353		.000	.000	.409	.017	.000	.621
20. FORSF	CC	-.137	-.106	-.012	.181	-.258	.010	.116	.153	.086	-.056	.070	-.054	.052	-.008	.081	-.027	.081	-.069	-.280	1.000	-.184	-.023	-.050	.108	-.033
	Sig. (2-tailed)	.013	.055	.861	.007	.000	.878	.083	.022	.200	.402	.298	.417	.436	.906	.229	.691	.229	.301	.000		.006	.736	.457	.106	.620
21. FORF	CC	-.278	-.282	-.091	.320	-.311	.028	.003	.036	.110	.240	.246	.076	-.122	-.065	-.057	.168	-.111	.106	-.449	-.184	1.000	-.036	-.052	-.165	.028
	Sig. (2-tailed)	.000	.000	.174	.000	.000	.677	.960	.592	.100	.000	.000	.257	.069	.331	.396	.012	.097	.114	.000	.006		.588	.441	.013	.679
22. RORSC	CC	.043	.041	-.066	-.106	.079	-.025	-.031	-.024	-.018	-.011	-.019	.060	-.029	-.022	-.014	-.017	-.014	-.014	-.055	-.023	-.036	1.000	-.037	-.020	-.035
	Sig. (2-tailed)	.430	.453	.322	.114	.240	.711	.646	.717	.789	.868	.774	.373	.662	.748	.838	.796	.838	.838	.408	.735	.587		.579	.762	.603
23. RORS	CC	-.067	-.069	.436	.120	-.090	-.013	.021	.028	.103	-.092	.078	-.266	.271	.109	-.007	-.014	-.060	.100	.160	-.050	-.052	-.037	1.000	-.169	-.291
	Sig. (2-tailed)	.221	.213	.000	.074	.178	.852	.749	.678	.124	.168	.241	.000	.000	.103	.918	.840	.367	.135	.017	.456	.439	.578		.011	.000
24. RORSF	CC	-.173	-.146	.243	.122	.001	.084	.071	-.010	-.082	-.051	-.087	-.310	.085	.067	.101	.054	.264	.101	.238	.108	-.165	-.020	-.169	1.000	-.159
	Sig. (2-tailed)	.002	.008	.000	.069	.990	.209	.286	.878	.223	.451	.193	.000	.205	.317	.132	.422	.000	.132	.000	.106	.014	.761	.011		.018
25. RORF	CC	-.192	-.215	.440	-.007	-.047	.041	-.010	.082	-.053	-.019	.015	-.455	.127	.205	.170	.270	.115	.004	.033	-.033	.028	-.035	-.291	-.159	1.000
	Sig. (2-tailed)	.000	.000	.000	.918	.481	.545	.878	.218	.430	.774	.827	.000	.058	.002	.011	.000	.087	.953	.620	.619	.678	.602	.000	.018	

APPENDIX XII

CORRELATION MATRIX FOR WALMLEY DATA

Correlation Matrix for Walmley

Upper quadrant = Pearson Correlation Coefficient
Lower quadrant = Kendall's Tau_b
CC = Correlation Coefficient

☐ **=Quite highly correlated but included in the analysis**

Property Specific Variables Including Topography

		1	2	3	4	5	6	7	8	9	10	11
1. FLAT	CC		-.080	-.450	-.071	-.259	-.531	-.281	-.587	-.796	-.387	.330
	Sig. (2-tailed)		.326	.000	.382	.001	.000	.000	.000	.000	.000	.000
2. TERRECED	CC	-.080		-.192	-.030	-.110	-.038	.019	-.018	-.029	-.143	-.010
	Sig. (2-tailed)	.326		.018	.709	.176	.609	.810	.828	.722	.033	.898
3. SEMI	CC	-.450	-.192		-.171	-.622	-.159	-.353	.177	.353	-.136	-.179
	Sig. (2-tailed)	.000	.018		.036	.000	.034	.000	.029	.000	.043	.028
4. BUNGALOW	CC	-.071	-.030	-.171		-.098	.012	-.107	.073	.068	-.038	.010
	Sig. (2-tailed)	.382	.709	.036		.227	.870	.176	.370	.406	.576	.898
5. DETACHED	CC	-.259	-.110	-.622	-.098		.631	.665	.265	.246	.547	-.070
	Sig. (2-tailed)	.001	.176	.000	.227		.000	.000	.001	.003	.000	.391
6. BEDROOM	CC	-.531	-.038	-.159	.012	.631		.505	.451	.549	.641	-.245
	Sig. (2-tailed)	.000	.609	.034	.870	.000		.000	.000	.000	.000	.001
7. NO.TOIL	CC	-.281	.019	-.353	-.107	.665	.505		.288	.267	.424	-.108
	Sig. (2-tailed)	.000	.810	.000	.176	.000	.000		.000	.001	.000	.169
8. CH	CC	-.587	-.018	.177	.073	.265	.451	.288		.625	.372	-.358
	Sig. (2-tailed)	.000	.828	.029	.370	.001	.000	.000		.000	.000	.000
9. GARDEN	CC	-.796	-.029	.353	.068	.246	.549	.267	.625		.457	-.318
	Sig. (2-tailed)	.000	.722	.000	.406	.003	.000	.001	.000		.000	.000
10. PLOTSIZE	CC	-.387	-.143	-.136	-.038	.547	.641	.424	.372	.457		-.170
	Sig. (2-tailed)	.000	.033	.043	.576	.000	.000	.000	.000	.000		.012
11. VIEW	CC	.330	-.010	-.179	.010	-.070	-.245	-.108	-.358	-.318	-.170	
	Sig. (2-tailed)	.000	.898	.028	.898	.391	.001	.169	.000	.000	.012	

HVOTL Specific Variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1. METREPYL	CC		.750	-.358	-.321	.445	-.016	.045	-.184	-.316	-.068	-.200	.360	-.085	-.137	-.047	-.221	-.069	-.186	.162	-.251	-.060	-.109	-.034	-.182	-.087	-.213
	Sig. (2-tailed)		.000	.000	.000	.000	.813	.499	.006	.000	.312	.003	.000	.202	.040	.487	.001	.303	.005	.016	.000	.373	.102	.607	.007	.191	.001
2. METRLINE	CC	.750		-.459	-.377	.412	-.051	.052	-.207	-.227	-.043	-.171	.406	-.163	-.143	-.122	-.228	-.004	-.188	.141	-.299	-.026	-.157	-.025	-.281	-.064	-.191
	Sig. (2-tailed)	.000		.000	.000	.000	.442	.436	.002	.001	.518	.011	.000	.015	.032	.068	.001	.950	.005	.035	.000	.699	.019	.705	.000	.342	.004
3. VISLINE	CC	-.358	-.459		.265	-.460	.153	-.012	.167	.277	.082	.189	-.153	.119	.131	.082	.018	-.144	.131	.001	.394	.235	.315	.090	.274	.131	-.082
	Sig. (2-tailed)	.000	.000		.001	.000	.060	.883	.040	.001	.313	.020	.060	.143	.107	.313	.825	.076	.107	.991	.000	.004	.000	.271	.001	.107	.316
4. REARLINE	CC	-.321	-.377	.265		-.165	.149	.036	.194	-.045	.035	-.031	-.778	.338	.248	.156	.412	.221	.248	-.009	.142	-.004	.153	.296	.654	.248	.412
	Sig. (2-tailed)	.000	.000	.001		.042	.068	.655	.017	.581	.668	.707	.000	.000	.002	.056	.000	.006	.002	.909	.081	.958	.061	.000	.000	.002	.000
5. VISPYL0	CC	.390	.337	-.460	-.165		-.343	-.389	-.236	-.389	-.115	-.265	.213	.028	-.111	-.115	-.024	-.164	-.184	.000	-.283	-.156	-.231	.031	-.117	-.111	-.071
	Sig. (2-tailed)	.000	.000	.000	.043		.000	.000	.003	.000	.157	.001	.009	.733	.175	.157	.774	.043	.023	1.000	.000	.055	.004	.701	.150	.175	.388

6. VISPYL1	CC	-.016	-.051	.153	.149	-.343		-.134	-.081	-.134	-.040	-.091	-.099	-.086	.057	.149	.125	.078	-.063	.151	.123	-.070	.079	.129	.215	-.063	-.105
	Sig. (2-tailed)	.813	.442	.060	.068	.000		.101	.320	.101	.626	.263	.224	.290	.484	.068	.124	.341	.437	.064	.132	.389	.331	.112	.008	.437	.197
7. VISPYL2	CC	.045	.052	-.012	.036	-.389	-.134		-.092	-.152	-.045	-.103	-.090	.232	-.072	-.045	-.119	.301	-.072	-.079	.169	.079	.037	.007	.009	-.072	.090
	Sig. (2-tailed)	.499	.436	.883	.655	.000	.101		.260	.063	.581	.204	.269	.004	.378	.581	.144	.000	.378	.332	.038	.333	.647	.928	.911	.378	.270
8. VISPYL3	CC	-.184	-.207	.167	.194	-.236	-.081	-.092		-.092	-.027	-.063	-.136	-.059	.287	-.027	.033	-.039	.122	.104	-.067	-.092	.293	-.052	.260	-.043	.033
	Sig. (2-tailed)	.006	.002	.040	.017	.004	.320	.260		.260	.738	.442	.094	.467	.000	.738	.683	.634	.135	.203	.412	.260	.000	.525	.001	.593	.683
9. VISPYL4	CC	-.316	-.227	.277	-.045	-.389	-.134	-.152	-.092		-.045	-.103	.000	-.098	-.072	.126	.090	-.064	.037	-.079	.009	.309	.037	-.086	-.139	.256	.020
	Sig. (2-tailed)	.000	.001	.001	.581	.000	.101	.063	.260		.581	.204	1.000	.230	.378	.122	.270	.432	.646	.332	.907	.000	.647	.293	.087	.002	.804
10. VISPYL5	CC	-.068	-.043	.082	.035	-.115	-.040	-.045	-.027	-.045		-.031	-.067	-.029	.302	-.013	-.035	-.019	-.021	-.023	.027	-.045	.105	-.025	.091	-.021	-.035
	Sig. (2-tailed)	.312	.518	.313	.668	.156	.626	.581	.738	.581		.707	.413	.722	.000	.870	.664	.816	.794	.774	.745	.581	.199	.755	.264	.794	.664
11. VISPYL6	CC	-.200	-.171	.189	-.031	-.265	-.091	-.103	-.063	-.103	-.031		-.031	-.067	-.049	-.031	-.081	-.044	.397	-.054	.224	-.025	-.046	-.058	-.129	.100	.109
	Sig. (2-tailed)	.003	.011	.020	.707	.001	.263	.204	.442	.204	.707		.707	.413	.548	.707	.319	.592	.000	.509	.006	.761	.571	.474	.113	.220	.182
12. REARPYL0	CC	.360	.406	-.153	-.778	.213	-.099	-.090	-.136	.000	-.067	-.031		-.435	-.319	-.200	-.530	-.285	-.319	-.039	-.288	.090	.092	-.091	-.377	-.319	-.530
	Sig. (2-tailed)	.000	.000	.060	.000	.009	.224	.269	.094	1.000	.413	.707		.000	.000	.014	.000	.000	.000	.632	.000	.269	.257	.266	.000	.000	.000
13. REARPLY1	CC	-.085	-.163	.119	.338	.028	-.086	.232	-.059	-.098	-.029	-.067	-.435		-.046	-.029	-.077	-.041	-.046	.235	-.028	.067	-.036	.211	.233	-.046	.123
	Sig. (2-tailed)	.202	.015	.143	.000	.732	.290	.004	.467	.230	.722	.413	.000		.570	.722	.346	.612	.570	.004	.729	.408	.657	.010	.004	.570	.132
14. REARPYL2	CC	-.137	-.143	.131	.248	-.111	.057	-.072	.287	-.072	.302	-.049	-.319	-.046		-.021	-.056	-.030	-.034	-.037	.080	-.072	.117	-.041	.286	.173	-.056
	Sig. (2-tailed)	.040	.032	.107	.002	.174	.484	.378	.000	.378	.000	.548	.000	.570		.794	.488	.709	.676	.646	.325	.378	.150	.619	.000	.034	.488
15. REARPYL3	CC	-.047	-.122	.082	.156	-.115	.149	-.045	-.027	.126	-.013	-.031	-.200	-.029	-.021		-.035	-.019	-.021	-.023	.027	-.045	.105	-.025	.091	-.021	.171
	Sig. (2-tailed)	.487	.068	.313	.056	.156	.068	.581	.738	.122	.870	.707	.014	.722	.794		.664	.816	.794	.774	.745	.581	.199	.755	.264	.794	.035
16. REAPLY4	CC	-.221	-.228	.018	.412	-.024	.125	-.119	.033	.090	-.035	-.081	-.530	-.077	-.056	-.035		-.050	-.056	-.062	.143	-.049	-.136	.045	.151	.207	.327
	Sig. (2-tailed)	.001	.001	.825	.000	.773	.124	.144	.683	.270	.664	.319	.000	.346	.488	.664		.537	.488	.446	.080	.543	.095	.580	.064	.011	.000
17. REARPYL5	CC	-.069	-.004	-.144	.221	-.164	.078	.301	-.039	-.064	-.019	-.044	-.285	-.041	-.030	-.019	-.050		-.030	-.033	.206	-.064	-.073	-.036	.025	-.030	.391
	Sig. (2-tailed)	.303	.950	.076	.006	.043	.341	.000	.634	.432	.816	.592	.000	.612	.709	.816	.537		.709	.682	.011	.432	.370	.657	.761	.709	.000
18. REARPYL6	CC	-.186	-.188	.131	.248	-.184	-.063	-.072	.122	.037	-.021	.397	-.319	-.046	-.034	-.021	-.056	-.030		-.037	.232	-.072	-.082	-.041	.004	.380	.207
	Sig. (2-tailed)	.005	.005	.107	.002	.023	.437	.378	.135	.646	.794	.000	.000	.570	.676	.794	.488	.709		.646	.004	.378	.315	.619	.958	.000	.011
19. FORSC	CC	.162	.141	.001	-.009	.000	.151	-.079	.104	-.079	-.023	-.054	-.039	.235	-.037	-.023	-.062	-.033	-.037		-.161	-.079	-.090	-.045	.074	-.037	-.062
	Sig. (2-tailed)	.016	.035	.991	.909	1.000	.064	.332	.203	.332	.774	.509	.632	.004	.646	.774	.446	.682	.646		.047	.332	.269	.584	.366	.646	.446
20. FORS	CC	-.251	-.299	.394	.142	-.283	.123	.169	-.067	.009	.027	.224	-.288	-.028	.080	.027	.143	.206	.232	-.161		-.310	-.353	-.111	-.009	.232	.191
	Sig. (2-tailed)	.000	.000	.000	.081	.000	.132	.038	.412	.907	.745	.006	.000	.729	.325	.745	.080	.011	.004	.047		.000	.000	.174	.914	.004	.019
21. FORSF	CC	-.060	-.026	.235	-.004	-.156	-.070	.079	-.092	.309	-.045	-.025	.090	.067	-.072	-.045	-.049	-.064	-.072	-.079	-.310		-.173	.193	-.040	-.072	-.049
	Sig. (2-tailed)	.373	.699	.004	.958	.056	.389	.333	.260	.000	.581	.761	.269	.408	.378	.581	.543	.432	.378	.332	.000		.034	.018	.620	.378	.543
22. FORF	CC	-.109	-.157	.315	.153	-.231	.079	.037	.293	.037	.105	-.046	.092	-.036	.117	.105	-.136	-.073	-.082	-.090	-.353	-.173		.072	.281	-.082	-.136
	Sig. (2-tailed)	.102	.019	.000	.061	.005	.331	.647	.000	.647	.199	.571	.257	.657	.150	.199	.095	.370	.315	.269	.000	.034		.377	.001	.315	.095
23. RORSC	CC	-.034	-.025	.090	.296	.031	.129	.007	-.052	-.086	-.025	-.058	-.091	.211	-.041	-.025	.045	-.036	-.041	-.045	-.111	.193	.072		-.107	-.041	-.067
	Sig. (2-tailed)	.607	.705	.271	.000	.700	.112	.928	.525	.293	.755	.474	.266	.010	.619	.755	.580	.657	.619	.584	.174	.018	.377		.190	.619	.409
24. RORS	CC	-.182	-.281	.274	.654	-.117	.215	.009	.260	-.139	.091	-.129	-.377	.233	.286	.091	.151	.025	.004	.074	-.009	-.040	.281	-.107		-.090	-.148
	Sig. (2-tailed)	.007	.000	.001	.000	.150	.008	.911	.001	.087	.264	.113	.000	.004	.000	.264	.064	.761	.958	.366	.914	.620	.001	.190		.271	.068
25. RORSF	CC	-.087	-.064	.131	.248	-.111	-.063	-.072	-.043	.256	-.021	.100	-.319	-.046	.173	-.021	.207	-.030	.380	-.037	.232	-.072	-.082	-.041	-.090		-.056
	Sig. (2-tailed)	.191	.342	.107	.002	.174	.437	.378	.593	.002	.794	.220	.000	.570	.034	.794	.011	.709	.000	.646	.004	.378	.315	.619	.271		.488
26. RORF	CC	-.213	-.191	-.082	.412	-.071	-.105	.090	.033	.020	-.035	.109	-.530	.123	-.056	.171	.327	.391	.207	-.062	.191	-.049	-.136	-.067	-.148	-.056	
	Sig. (2-tailed)	.001	.004	.316	.000	.386	.197	.270	.683	.804	.664	.182	.000	.132	.488	.035	.000	.000	.011	.446	.019	.543	.095	.409	.068	.488	

APPENDIX XIII

INTERVIEWS

APPENDIX XIV

PUBLICATIONS DURING THE RESEARCH