

THE VALUE OF IMPROVED STREET LIGHTING IN RURAL AREAS

Final Report

for

Department for Transport

by

Ken Willis, Neil Powe and Guy Garrod

Centre for Research in Environmental Appraisal & Management

<http://www.ncl.ac.uk/cream/>



School of Architecture, Planning and Landscape and
School of Agriculture, Food and Rural Development
University of Newcastle upon Tyne

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EXECUTIVE SUMMARY

The aim of this study was to provide robust values of willingness-to-pay (WTP) for street light improvements in rural areas, to inform the determination of applications for PFI credits. It is also to consider the relative importance that factors such as personal safety, security of property, road safety, and reduced 'light pollution' had on households' demand for improved street lights.

Street light improvement is a 'public good' for which no market price is charged. The study employed a widely used stated preference technique, dichotomous choice, to value the benefits of improved street lights. This was based on a survey of over 1200 households in villages, market towns, and urban areas in Bedfordshire, North Yorkshire, and Wiltshire.

The results revealed that, over the sample as a whole, 32% of households were not willing to pay for street light improvements; and of the 63% who were willing to pay for improvements (the remainder were unsure), mean WTP was £12 per household per year. However, the WTP distribution was skewed, and the median WTP was £3 per household per year. This is the value at which 51% of residents would support the street light improvement scheme.

The willingness to pay by households in urban areas for street light improvements is greater than by households in both market towns and villages. The lowest willingness to pay was observed in villages. This difference was found to be statistically significant and consistent with the attitudes of the respondents.

Those in urban areas perceived the benefits of street lighting to be greater than market towns and villages. This was most noticeable in terms of the key benefits from improved street lighting: road safety; and issues of personal safety and crime. The analysis suggested that residents viewed road and personal safety together under a holistic label of 'safety'. 'Car crime', and 'reduced light pollution' permitting 'star gazing', came out as separate issues from generic 'safety', but the perception was that the street lighting improvement scheme would not help these issues.

Willingness to pay was found to be determined by many issues beyond the amount they would be required to pay. These include: the perceived improvement in the safety caused by street lights; trust / realism in the scheme and the payment;

disamenity from street lighting; a preference for not to have to pay so much for the scheme; those taking an interest in star gazing; those suggesting that they would not personally benefit; and perceived likelihood of car crime.

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1. INTRODUCTION

Street lighting provides a number of benefits such as reductions in on-street accidents and crime, amenity (a feeling of warmth and security), streetscape enhancements, and stimulation of the night-time trade. Some of these benefits are likely to be largely related to the density of population and the level of traffic.

Street lighting can also produce disbenefits or costs. The majority of existing street lights (over 80% of road and street lighting) use yellow/orange gas discharge lamps because they are most energy efficient. These lamps produce the uniform orange glow that is characteristic of Britain's cities and main roads (ODPM, 2002). These low-pressure sodium lights have very poor colour rendition, and are particularly common on rural roads and in village streets. Because of their design (a vertical glass tube) they produce 'light pollution' into the night sky, blurring the pale dimness of moonlight and obliterating pale stars. This leads to a loss of appreciation of the night sky, an urbanising effect on the countryside, and general loss of amenity value.

A recent survey showed that out of some 5 million existing street lighting columns, 600,000 are in need of urgent replacement; and that over the next ten years a further 50% will be 30 years old or more.

In March 2003 a bidding round was introduced to allow local authorities in England (except London¹) to bid for Private Finance Initiative (PFI) funding for street lighting project improvements. PFI credits are available for street lighting schemes for those councils that can demonstrate that the benefits of improved street lighting schemes exceed their costs. In the case of rural authorities the cost per household of such a scheme would be somewhere in the region of £18. For urban authorities, although no data was available, it is expected that, due to the greater density of service delivery, the cost per household is lower.

2. STUDY OBJECTIVES

The aim of this study is to:

- provide robust values of the willingness to pay for the amenity and community benefits of replacing and/or upgrading street lighting;

¹ The Government Office for London have implemented a similar bidding round.

- inform the determination of the application for PFI credits to predominantly rural authorities.

3. BACKGROUND

Under the PFI scheme each local authority can apply for a loan to improve its street lighting. The street light improvement work will be undertaken by a private contractor, on a fixed price basis over 25 years, under contract to the local authority. The private contractor is responsible for replacing obsolete street lighting and maintaining all street lights in a distinct local authority over the 25 year period. After this period responsibility for the street lights reverts back to the authority. The local authority repays the principal (of the loan) plus interest on the loan back to central government over these 25 years.

For areas currently lit by street lights, the scheme requires all obsolete columns to be replaced within 5 years by new modern efficient street lighting; and all street lights in the local authority to be replaced within 25 years (the replacement life of street lights). Under the PFI, existing street lights, and columns where necessary, would be replaced. If the existing street lighting, or new street lights, do not meet EU standards on luminance, new street lighting columns would be interspersed amongst the existing distribution of street light columns to bring the lighting up to the EU standard. [Luminance is the amount of light falling on a surface. It is measured in lumens per square metre or *lux*. Luminance is easy to calculate and is widely used. Direct sunlight is approximately 100,000 *lux*, normal daylight (filtered through cloud) between 5,000 and 10,000 *lux*, and moonlight around 0.25 *lux*. (ODPM, 2002)].

Modern street lights, such as high-pressure sodium lamps, are less energy efficient than their lower-pressure equivalents, however, they have a lower 'whole life cost' (ODPM, 2002). They also produce a white light and have good colour rendering properties. The design of their luminaries is such that their light is reflected downwards thus minimising the problem of light pollution into the night sky.

A number of studies into the influence of street lighting improvements on crime levels, fear, and pedestrian street use after dark has already been undertaken. Some early work from a Home Office-funded evaluation in Wandsworth concluded that street lighting had no effect on crime (Atkins *et al*, 1991). However, as more

evidence accumulated there were increasing indications that improved street lighting could have an effect in reducing crime.

Herbert and Davidson (1994) evaluated improved street lighting in Cardiff (Tremorfa area) and Hull (Dukeries area). Neither area was exceptional in terms of crime or social problems. Both cities were part of the British Parliamentary Lighting Group project in 1990-91. Surveys were conducted in selected areas of each city, followed by the installation of new street lighting in the surveyed areas to higher standards of lighting effectiveness. Six weeks after the installation of the improved lighting the areas were re-surveyed. In Hull, for example, the original low-pressure sodium (yellow) street lights were replaced with high pressure (white) sodium lights on new columns. While the impact of the improved street lighting on crime was difficult to assess, there were clear indicators that improved street lighting led to higher levels of community safety amongst residents of the two study areas. Fear of crime diminished, and a slightly greater number of pedestrians were recorded as using the streets particularly after 21.00 hours, after the lighting improvement.

Another study by Painter (1996) investigated street light improvements at sites in Edmonton, North London; Tower Hamlets; and Hammersmith and Fulham, in London. All three sites were urban streets, badly lit, running through mixed use locations, displaying, in varying degrees, observable signs of environmental and social incivility (litter, graffiti, damaged and dilapidated property; youths hanging around, roaming dogs, and signs of drunken and disorderly behaviour). In all three areas, the low pressure sodium (orange) lights did not meet the minimum British Standard BS5489, Part 3, category 3/3. The improved lighting schemes at each of the sites were designed to meet British Standard BS5489, Part 3, category 3/1. This gave an average 10 lux and minimum 5 lux. High pressure sodium (white) lights replaced low pressure sodium (orange) lamps at each of the study sites. Thus the lighting improvement made a significant difference to the night-time environment.

On street surveys were undertaken after dark, before the street light improvements and again six weeks after the improvements, between the hours of 17.00 and 23.30. Incidents of crime (mostly threatening and disorderly incidents) were markedly reduced in three of the four streets after the lighting improvements (from 21 to 4; and 18 to 4 respectively). There was also a marked reduction in the fear of attack and a corresponding increase in perceived personal safety (Painter, 1996). There was also

a significant increase in pedestrian usage of the street after the street light improvements.

A Home Office review identified a series of studies (eight American and five British), where improved street lighting was the main intervention, change in crime was measured as one of the outcomes, before and after the intervention, with each study having at least one experimental area and one control area, with at least 20 crimes recorded (Farrington and Welsh, 2002). The British studies showed that improved street lighting led to a significant 30% decrease in crime, and in two of the studies the financial savings from reduced crime greatly exceed the financial costs of the improved street lighting. A meta analysis of all 13 studies suggested that a 20% reduction occurred in the experimental areas after improved street lighting compared with the control areas. However, since these studies did not find that night-time crime decreased more than day-time crimes, this suggests that a theory of street lighting focusing on its role in increasing community pride and informal social control may be more plausible than a theory focusing on increased surveillance and increased deterrence (Farrington and Welsh, 2002).

Improved lighting may be more effective in reducing crime than CCTV. A review of CCTV studies by Welsh and Farrington (2002) revealed mixed results. In city centre and public housing settings CCTV led to a negligible reduction in crime of about 2% in experimental areas compared to control areas. They found CCTV had no effect on violent crimes, but significant reduced vehicle crimes by around 41% in car parks in experimental compared with control areas, although other measures were also operating in the car parks.

Considering the link between lighting and traffic safety, accident rates, defined as the number of accidents per vehicle miles driven, are significantly at night rather than during the day, even though the night-time traffic flow is only some 20-35% of the total flow (Simons, 1992). Although lighting columns, themselves, may constitute an additional hazard, may induce over-confidence and may increase glare, research has consistently found them to improve road safety (for a review see Scheuder, 1998). Based on early work by Transport and Road Research Laboratory a consensus was reached that for urban roads, with a mainly traffic function, a reduction in accidents involving injuries of 30% can be expected at night following the improvement in lighting from very bad to good (see, for example, Tanner, 1963; and Hargroves and Scott, 1979).

The results of previous studies considering crime prevention and road accidents have demonstrated that good street lighting is likely to lead to such benefits. However, the extent of the crime and accident reduction resulting from the street lighting improvement considered within this report is unclear.

The purpose of the current study was to derive a value for street light improvements in rural areas. Within this study crime and accident reduction benefits are left to the perception of the respondent. Other potential benefits such as:

- improvements in amenity (a feeling of warmth and security),
- streetscape enhancements, and
- increase in amenity due to reductions in light pollution,

, are also left to the perception of the respondent. Furthermore, the purpose was not to derive separate estimates of the benefits of improved street lighting but rather to derive a holistic value for all of these benefits to residents.

Nevertheless, the Department for Transport wished to have some information on the relative merits of these different attributes as perceived by residents. The study was therefore designed to provide information on the relative value of these different attributes.

4. ECONOMIC THEORY

The decision on the quality (luminosity and aesthetic appearance) (as well as the quantity) of street lights should depend upon household preferences. Preferences will in turn depend upon the perceived benefits, such as reductions in on-street accidents and crime, and increased amenity value, which street lighting provides. Perceived benefits may also depend upon the effectiveness and price of substitute goods (privately installed security lighting around the house, and other security devices), the extent to which households make journeys along streets at night, and the perceived vulnerability of household individuals undertaking such journeys.

The utility of existing street lighting to a household (and no council tax increase to pay for the PFI credit) can be represented by

$$V(Y, 0)$$

where V = utility from street lighting, Y = annual income and 0 = no street light improvements. The improved street lighting situation can be represented by

$$V(Y - \text{Tax}, 1)$$

where 1 = street light improvements (to the specified EU Directive standard), and Tax = additional council tax the household would have to pay to acquire the street light improvements.

The individual is asked to choose between

$$V(Y, 0) \text{ and } V(Y - \text{Tax}, 1)$$

If the individual chooses the second alternative then he is willing to pay at least the "Tax" amount for the improved street lighting. An analysis of such comparisons over various "Tax" amounts reveals the probability of supporting street light improvements as a function of the Tax payment required.

Different forms of welfare measure can be calculated from this information: compensating variation [the amount of money that can be taken away from a household after street lighting improvement and still leave the household at its original utility position (the utility position before improved street lighting was provided)]; and the amount of Tax that would result in 50% of households supporting the street light improvement program in their area. The compensating variation is equivalent to the consumer surplus that a household would receive if improved street lighting was provided, assuming no income effect.

5. STREET LIGHTING AS A PUBLIC GOOD

Under the market system anyone can provide a light in front of their house and pay the monthly electricity bill for its operation. However, a household will receive the benefit of a light provided by his neighbour and will have an incentive to avoid paying for a light on her own property in anticipation of deriving the benefit from her neighbours lights without paying for them.² As such, street lighting is a 'public good': it is non-rival in consumption (the fact that household A derives a benefit from street lights in the neighbourhood does not reduce the benefit that household B derives from the street lighting in the neighbourhood), and non-excludable (once provided the

² It is no accident that private lights surrounding a property are designed to benefit the property to which they are fitted and not neighbouring properties.

street lights can benefit all households). Because street lighting is a public good, although a household might have a positive benefit for street light improvements, there is an incentive to *free-ride*: i.e. each household has an incentive to understate its willingness-to-pay (WTP) in anticipation that other people will provide and pay for it. Since each resident has the same incentive (to free-ride) it is likely that no, or few, street lights would be provided without government intervention. The market outcome would not be Pareto optimal, in the sense that it would maximise the economic welfare of the community.

The household's preferences for street lighting are unknown to the researcher who is outside the household. But the household's preferences will be a function of the value of street lighting in the street outside their house, plus whatever benefit the household derives from street lighting elsewhere in their settlement and across other settlements in their local authority. The benefits of street lighting outside the household's street will depend upon how much the household uses roads at night (walking or driving) in the household's own settlement and in other settlements. Households will derive differential benefits for both street lighting outside their house, and street lighting elsewhere, depending upon their activities and preferences.

Pareto-optimality or the maximisation of economic welfare for a street light improvement scheme requires an incentive system that imitates the market system for private goods: where each household's payment contribution is proportional to the benefit received by the household. Pareto optimality is derived by maximising total benefits (summed across households) minus total costs. If each household reports the true benefit ($b_1 \dots b_n$) they receive from street lighting and each pays the tax fraction $Tax_i = b_i / (b_1 + b_2 + \dots + b_n)$ of the total cost of whatever street lighting amount is decided, then this provides a Pareto-optimal equilibrium. In the current study, varying quantities of street lighting is not the issue. The amount of street light improvement is not variable (it is the amount that meets the EU Directive); nor is the spatial distribution (it is for the whole local authority and nothing less). [Thus households have to pay for street light improvements not only in their own street but also in other areas of the local authority].

The revelation of preferences through an expressed preference process will provide a Pareto-optimal mechanism as long as households truthfully report the benefits they receive from street lights. The elicitation mechanism adopted in the contingent valuation technique reported below was chosen as the most incentive compatible

mechanism available to estimate each household's true benefit from improved street lighting.

6. ECONOMIC VALUATION METHODOLOGY

The framework used to consider the value of improved street lighting is based on economic theory. Economic benefits include those associated with reductions of on-street accidents, crime and light pollution, and increased amenity and stimulation of the night-time economy, as reflected in the attitudes, preferences and values of the general public.

Amenity and disamenity from street lights

The attitudes and preferences of the general public gained from street lights relate to the perceived amenity and disamenity from the lights.

Improved street lights were expected *a priori* to have the following amenity effects:

- Personal safety
- Security of property
- Ease of access
- Road safety
- Possible reduced use of personal lighting
- Less intrusion of the light into residential homes

Improved street lights were also expected *a priori* to have the following disamenity effects:

- Increased visibility of the night sky
- Urbanising effect on rural areas

Choice of methodology

There is no market for improved street lighting: it is a 'public good'. Households' expenditure on lighting around their homes will not adequately reflect the benefit they derive from improved street lighting elsewhere in their street, neighbourhood, town, or local authority. Since household preference for improved street lighting cannot be derived from revealed behaviour, a stated preference approach had to be adopted.

The stated preference approach asks respondents directly about their preferences for improved street lighting through a questionnaire survey. Perhaps the most commonly used stated preference method is contingent valuation (CV), which involves the construction of a hypothetical, though realistic, transaction to value street light improvements. CV exercises concentrate on the valuation of a particular scenario which presents a potential quality change. This necessitates providing adequate information about the street light improvement scheme for the respondent to make a reasoned judgement on the benefit of the programme to herself.

The essential elements of a stated preference scenario are the presentation of the information on street light improvements compared to the current situation; the payment vehicle; and the elicitation method.

Presentation of a good and scenario considered

In order for an economic transaction to accurately reflect respondent preferences it is important that the good purchased is well defined and understood by the consumer. When purchasing market products the nature of the good is usually spelled out by the packaging or through a sales assistant. In a political referendum information is usually provided on both sides of the argument through the media or another source. In a hypothetical CV transaction the interviewer provides this role, where the good definition or policy scenario is described. The CV approach differs from either the market or referendum transactions in that the role of the researcher is to provide information in as neutral a manner as possible.

Payment vehicle

Within any transaction, a sacrifice, usually monetary, is required on the part of the purchaser in order that trade is achieved. In the CV context the method by which the sacrifice is made is referred to as the payment vehicle. Due to the public good nature of the goods frequently valued using CV, attitudes towards the payment vehicle used are expected to affect valuation responses. In the case of a good with both non-rival and non-excludability characteristics, equity may be an issue and respondent preferences are likely to be influenced by who else pays. The choice of payment vehicle may also imply whether the issue is of local or national importance and may lead to a denial of responsibility from those living outside the area potentially affected. Where respondents do not agree with the value judgement made, they are less likely to be willing to pay for the scenario considered. Although

the scenario considered may predetermine the payment vehicle used, there may be little trust in the provider and a need to account for this within the analysis.

Elicitation method

The respondent expresses his preference through the CV question, which can come in many forms. The open-ended (OE) approach is perhaps the most straight forward elicitation technique as it merely asks the respondent for the maximum amount they would pay, or minimum compensation they would accept, in respect to the change in provision described. This approach has been the subject of criticism with respect to non-market goods.

The elicitation method for non-market goods recommended by the NOAA panel (Arrow, *et al* 1993) is the dichotomous choice (DC) or take-it-or-leave-it approach where the respondent can choose, between the 'with' situation at a given price or bid level (BL) and the 'without' at zero price. Using this DC approach, the associated starting BLs are varied between randomly chosen sub-samples such that the relationship between BL and probability of acceptance is observed. Based on random utility theory, the yes/no responses to the BLs are modelled using a given cumulative distribution function (CDF) for the WTP random variable³. Through making the appropriate assumptions welfare measures can be estimated using the coefficients of the fitted probability model. Due to the recent popularity of the DC approach and the NOAA recommendation, this elicitation approach was adopted.

Assessing the meaning of willingness to pay responses

Assessing the factors determining valuation responses can be important in terms of validity assessment, considering the extent to which the CV estimates relate to other measures as predicted by theory. This is commonly conducted using regression analysis and/or a comparison of mean WTP estimates under conditions which theory would suggest different values. Wider issues, such as trust in the provider, have also been considered using qualitative methods (Schkade and Payne, 1994; Blamey, 1998; and Brouwer *et al.*, 1999). The combination of regression and focus group analysis will be used to assess the meaning of the willingness to pay responses.

³ WTP is a random variable because, although the respondent is assumed to know their WTP with certainty, there is expected to be some error in measurement. Such error could be due to unknown respondent characteristics or some problem with the survey device.

In order to enhance the regression analysis, an approach recently borrowed from the psychology literature (Oppenheim, 1992) and successfully applied by Nunes (2002, 2003) was adopted. The factors motivating the valuation responses are obtained using the Likert technique, through a list of statements formulated with the assistance of focus groups. For each motivation factor, reflecting for example fear of crime or traffic safety, a series of statements were used to which respondents' attitudes were elicited. These responses were then analysed using factor analysis, with the orthogonal factor scores being included within the valuation function. The statistical significance of the motivational factor coefficients can be used to assess their importance as determinants of the value of improved street lighting, and the size of the coefficients determining the magnitude of the value. This provides meaning to the valuations made, and aids consideration of how tastes vary between rural and urban areas.

7. QUESTIONNAIRE DESIGN PROCESS

The questionnaire design process consisted of the development of a pilot questionnaire, and four focus group meetings.

Development of a pilot questionnaire

The pilot questionnaire was developed in consultation with DfT, prior to the focus group interviews. The questionnaire included the valuation questions proposed for the main study and open-ended questions reflecting the motivations for this valuation. A copy of the final questionnaire is appended in Annex 1.

Focus groups

The questionnaire was piloted using the focus groups. Focus groups have been widely used to improve information and questions within valuation questionnaires. They provide a more detailed understanding of respondents' thought processes, attitudes, and willingness-to-pay through some payment vehicle, than a conventional pilot questionnaire survey. The method can also identify potential pitfalls in the experimental design and in the questionnaire design. Focus groups also permit the stability of respondents' preferences to be assessed by monitoring these before a group discussion and after a group discussion on the subject in question. The focus groups were used to:

- gain a better understanding of how respondents think about, and conceptualise, the good being valued;
- gain a better awareness of respondents' thought processes during the transaction and the motivational factors for their responses;
- test the adequacy of the valuation process used and make iterative improvements between focus groups; and
- choose wording for closed ended responses in the main survey questionnaire.

Participants were asked to complete the pilot questionnaire prior to the discussion. Four focus groups were conducted, two within villages (one large, one small); one within a market town; and one in a large urban area. Participants were recruited using a market research firm, with a £25 incentive being offered to reduce sample selection bias. The meetings lasted between 1.5 and 2 hours and were led by an experienced facilitator. A total of 30 participants were involved in the focus groups, reflecting a mix of gender, age and income.

8. FOCUS GROUP RESULTS

Attitudes and preferences towards street lighting

All the participants had at least a level of lighting in their street. In response to the attitudinal questions, most participants (18 out of 30) thought the street lighting in their area was generally good, with only nine disagreeing. However, the majority of the participants (19) felt that they would benefit personally from the street lighting improvement scheme. The colour aspect of street lighting improvement was questioned, however, as a sizeable minority preferred orange to white lighting (10)⁴.

Road safety was the subject of debate within three of the four groups, where a number of participants viewed street lighting to have beneficial effects. These comments were reflected within the attitude statements, with most participants considering that improved street lighting would improve road safety for children (27) and would lead to less accidents (23). It was suggested, however, that improving the quality of the roads would be more effective in increasing road safety.

⁴ This question was, however, introduced before the information statement and the photos.

The issues of security of property / personal safety were important to the participants. Although lighting can also have amenity use, the participants recognised the security function of street lights. In terms of personal safety, approximately half of the participants considered that 'it wasn't safe to walk the streets after dark' (14). The majority of participants considered that improved street lighting would 'make private property more secure' (25) and would reduce crime (20). Positive comments were made within three of the four groups regarding the link between the street light improvement scheme and a potential reduction in crime ("if there is more chance of being seen you are less likely to do it"); and 'reassurance' ("you would be more likely to see who is lurking about"). Despite these positive comments some participants suggested that the crime would occur despite the street lighting: a possible negative effect in terms of crime may be that improved street lighting would encourage children to hanging out under lighting and causing mischief.

There was a feeling that the new lighting would reduce the possibility of accidents if the walking surface was poor; or if there were objects blocking the path they would be more visible. Another potential benefit was the possible reduction in the use of personal lighting.

As well as the possible positive effects of street lighting, there were also negative effects noted. Light pollution was one such potential effect. However, few participants showed an active interest in astronomy. A light pollution issue of more consideration was the intrusion of light into residential homes. Concern was raised that new lights would be worse in terms of light intrusion into the home.

Reaction and comment on the valuation questions

Only 19 of the 30 participants were willing to pay something towards improved street lighting, with only one person not in favour the scheme at all. A common response was that other non-lighting issues should be given a higher priority.

The reasons given by participants for being willing to pay something towards improved street lighting varied. Personal safety / security of property issue seemed to be the most important benefit of the scheme. Other issues raised were: light pollution, ease of access, generally making the place lighter and not an excessive amount compared to the benefits. In terms of road safety it was suggested by a few participants that road surfaces, footpaths and better education for the drivers were higher priorities. Reasons for not being willing to contribute to street light

improvement varied. The term 'I pay enough taxation already' was a common response, which could be interpreted as a denial of responsibility.

In response to the attitudinal question 'You can't trust the local government to use council tax revenue to finance the street lighting improvement scheme' 17 out of 30 participants agreed with this statement, suggesting trust to be an important issue. Respondents were concerned that the costs would escalate beyond those stated.

There was a common perception that there was also a need for additional lighting: indeed nearly half of the participants (12) considered their area to be inadequately covered by street lighting. Questions were also raised about the scheme in terms of equity, and quality of service provision. An issue raised in all groups was a concern that the council tax payers would be paying for the scheme before the improved lighting is actually delivered; or that as a village or town they would be the last area to be improved whilst street lighting in other areas would be improved first.

9. SURVEY and DATA COLLECTION

Final survey questionnaire

The revised final survey questionnaire (See Annex 1) opened by asking respondents whether they have street lighting in their street and their general attitudes towards street lighting. Following a question regarding their current council tax payments, the respondents were shown two show cards, with the first outlining the scheme and the second the payment. The before and after street lighting scenarios were illustrated using carefully chosen photographs. The double bounded dichotomous choice questions followed, for which there were four options to the first bound: pay the amount stated, not pay the amount stated, I am not willing to pay anything towards this scheme and don't know. The response relating to a zero payment was included to add more information to the model. In previous studies a significant proportion of respondents have been found to be willing to pay nothing for the schemes considered (Kriström 1997; Reiser and Schechter 1999; Powe and Bateman, 2004). As well as the usual socio-economic questions, based on issues raised within the pre-survey focus groups, at the end of the questionnaire all respondents were asked a variety attitudinal, behavioral and experience questions.

Survey undertaken

The sample survey comprised surveys of urban areas, market towns and rural villages in three shire counties: Bedfordshire, North Yorkshire, and Wiltshire. Table 9.1 documents the particular urban areas, towns, and villages that comprised the sample area.

Table 9.1: Sample survey areas.

<i>County, and settlement type</i>	<i>Settlement name</i>	<i>Sample size</i>
Bedfordshire		
Urban area	Bedford	132
Market town	Ampthill	130
Villages	Clifton, Lidlington, Wilstead / Duck End, Marston Moretaine, Westoning, Wootton.	138
North Yorkshire		
Urban area	Harrogate	155
Market town	Richmond	136
Villages	Catterick Garrison, Green Hammerton, Hampsthwaite, Leyburn, Middleham.	114
Wiltshire		
Urban area	Swindon	133
Market town	Malmesbury	137
Villages	Crickdale, Highworth, North Wroughton, Sutton Banger, Wooton Bassett.	139
Sample		1214

As house-to-house surveys were undertaken, it was not possible to perform a stratified quota random sampling strategy. Instead, a selection of representative areas was chosen for interviewing and households were selected randomly within these areas. Interviewing was conducted on afternoons and evenings both during the week and weekends to ensure a representative sample of households was selected in terms of socio-economic composition. The questionnaire survey was administered on a face-to-face basis in respondents' homes. It was undertaken by a market research company and conformed to the procedures laid down by the Market Research Society.

The survey was undertaken in August 2003⁵ with 1214 questionnaires being completed. As far as possible the survey was split spatially and by settlement type. Table 9.1 provides a breakdown of the survey undertaken. The response rate was extremely high: 90% of households who were approached participated in the survey.

The socio-economic profiles of the respondents and respondent households are reported in Tables 9.2-9.4. Table 9.2 shows the modal group of both the sample as a whole and each of the sub-samples to be 36-45 years of age, with the mean age being approximately 50 years. Figure 9.1 shows age range by settlement type, however, no cross sample statistically significant difference was found between average age ($p > 0.05$). Adjusting for the age of the population interviewed, the age distribution for England is provided in the right hand column of Table 9.2 (source Population Census 2001). The sample distribution compares favourably with the age distribution of England and the mean age was also similar.

Table 9.2: Respondent age for sample and by settlement type.

Respondent age	Sample (%)	Urban area (%)	Market town (%)	Villages (%)	England (%)
16-25	5.8	5.5	5.0	6.9	15.0
26-35	16.1	17.6	16.4	14.3	17.7
36-45	21.4	20.5	21.8	22.0	18.4
46-55	14.6	13.3	13.4	17.1	15.5
56-65	16.2	17.9	19.1	11.5	13.0
66-75	15.2	16.4	13.9	15.3	10.3
75+	9.9	8.3	9.2	12.3	9.3
Non - response	0.7	0.5	1.2	0.5	-
Mean age	51.0	50.8	51.0	50.2	46.8
Sample size	1,214	420	403	391	

Figure 9.1: Comparison of age range by settlement type

⁵ Although the participants were observed to have little difficulty recalling dark nights, as the survey was undertaken within the summer, the possibility of negative bias remains and, as such, the estimates should be regarded as conservative.

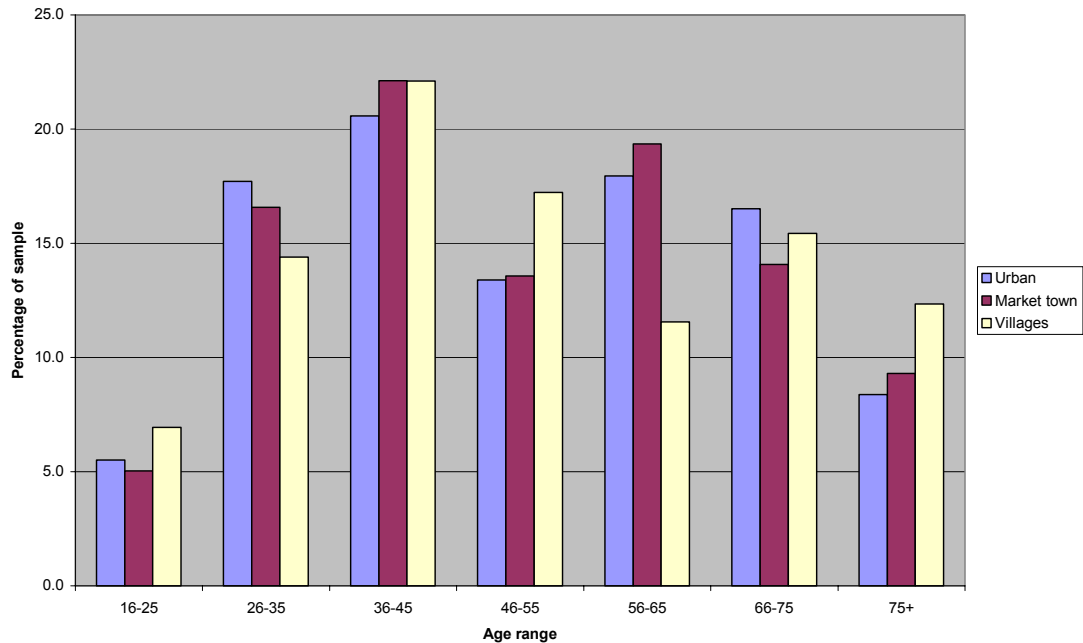
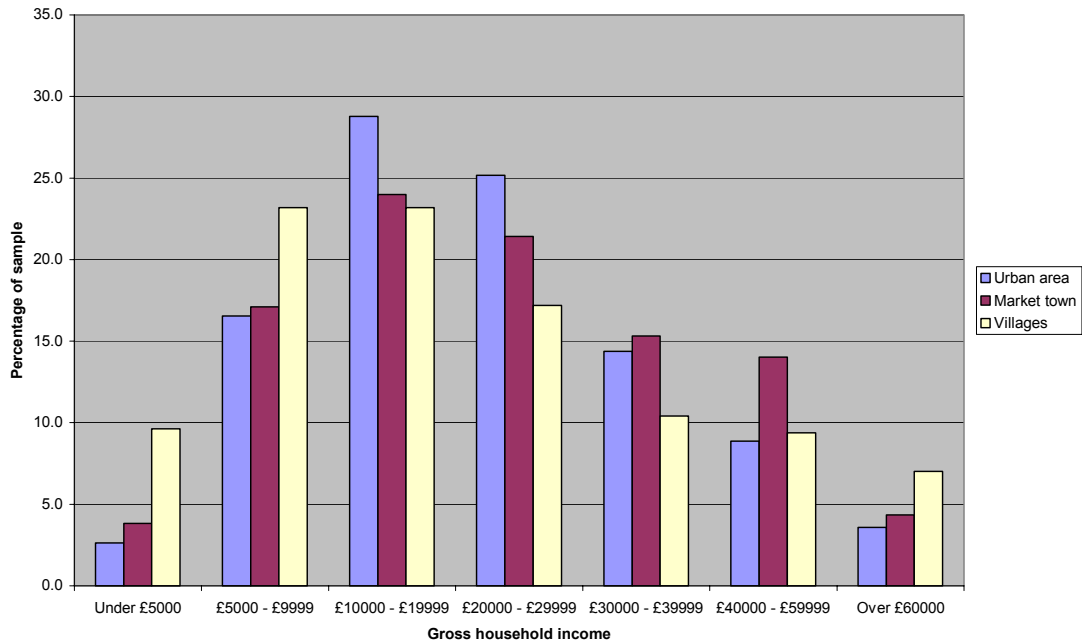


Table 9.3 shows the average gross household income of respondents to be approximately £32,000, with those living in the villages having the lowest income (approx £30,000). The mean income for respondents living in villages is significantly lower than for market towns ($p < 0.05$), but not for urban areas (see Figure 9.2 for a comparison). Average income for counties was also considered, with the ranking of income consistent with gross disposable income (National Statistics, 2002). Income in Wiltshire was found to be significantly lower than in both Bedfordshire and North Yorkshire ($p < 0.05$), with no statistical difference between the later. The implications in terms of aggregation are discussed below.

Table 9.3: Gross household income for sample and by settlement type.

Gross household income	Sample (%)	Urban area (%)	Market town (%)	Villages (%)
Under £5000	5.2	2.6	3.7	9.5
£5000 - £9999	18.5	16.4	16.6	22.8
£10000 - £19999	25.0	28.6	23.3	22.8
£20000 - £29999	21.0	25.0	20.8	16.9
£30000 - £39999	13.2	14.3	14.9	10.2
£40000 - £59999	10.5	8.8	13.6	9.2
Over £60000	4.9	3.6	4.2	6.9
Non - response	1.7	0.7	2.7	1.8
Mean income	£32,216	£32,441	£33,814	£30,341
Sample size	1,214	420	403	391

Figure 9.2: Comparison of gross household income by settlement type



Using a standard market research classification, the social class of the main income earner is presented in Table 9.4, where:

- A - Upper middle class (higher managerial, administrative or professional);
- B – Middle class (intermediate managerial, administrative or professional);
- C1 – Lower middle class (supervisory or clerical, and junior managerial, administrative or professional);
- C2 – Skilled working class (skilled manual workers);
- D – Working class (semi- and unskilled manual workers);
- E – Those at lowest levels (state pensioners or of subsistence widows (no other earner), casual or lowest grade worker, long term unemployed (no other earners)).

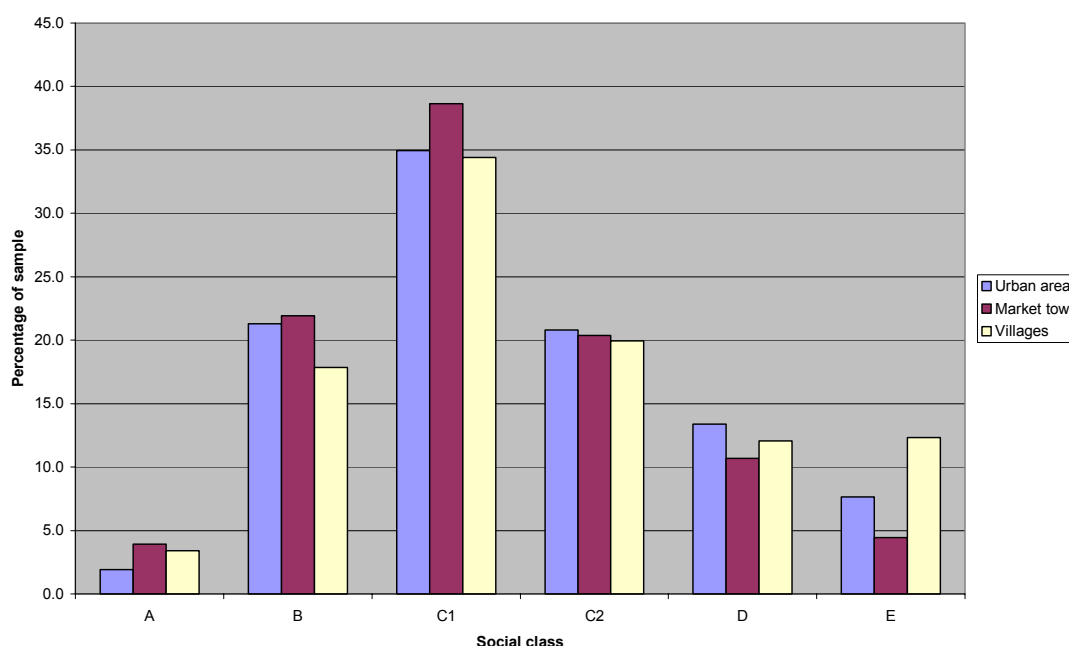
Compared to the nation as a whole, the sample may have a slightly higher representation of C1 and a lower representation of C2, D and E. However, as the sample was not of large cities this may account for some of this difference. A statistically significant difference was observed by social class between the three sub-samples ($p < 0.05$) (see Figure 9.3 for a comparison).

Table 9.4: Social class for sample and by settlement type.

Social class	Sample (%)	Urban area (%)	Market town (%)	Villages (%)	UK Households
A	3.0	1.9	3.7	3.3	3.1

B	19.9	21.2	20.8	17.4	15.7
C1	35.0	34.8	36.7	33.5	25.7
C2	19.9	20.7	19.4	19.4	26.0
D	11.8	13.3	10.2	11.8	17.0
E	7.9	7.6	4.2	12.0	12.6
Non - response	2.6	0.5	5.0	2.6	-
Sample size	1,214	420	403	391	-

Figure 9.3: Comparison of social class by settlement type



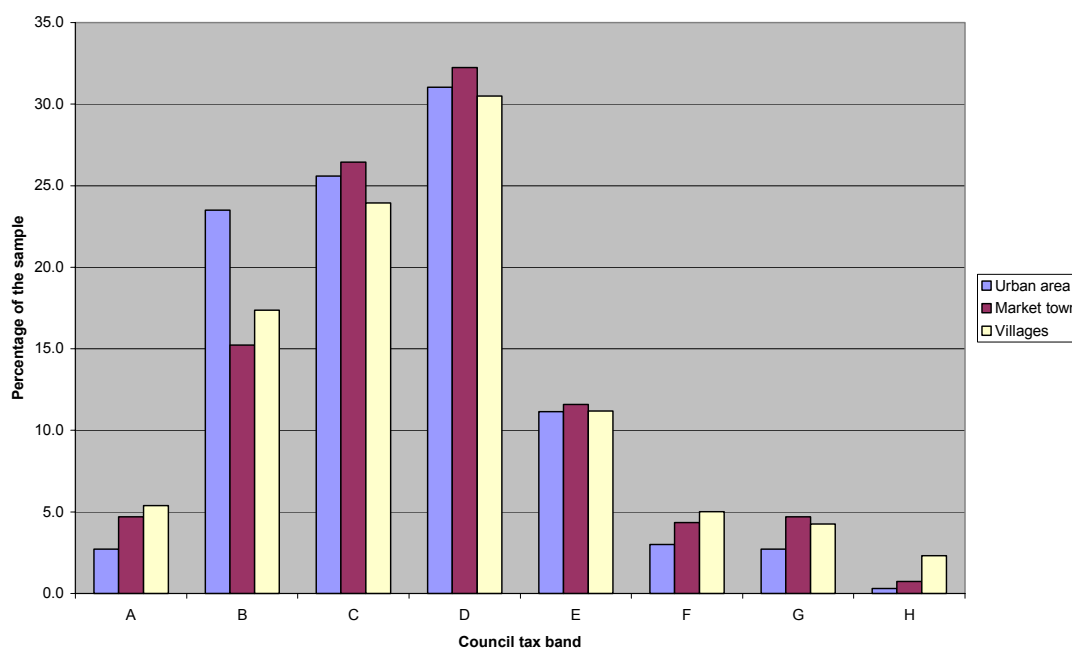
Further to the socio-economic data elicited above, respondents were also asked to state their council tax band (See Table 9.5). Although they also stated an approximate figure for their current council tax, the respondents generally considered their statement of band to be more accurate. Using a chi-squared independence test, no significant difference between sub-samples was observed ($p > 0.05$) (see Figure 9.4). As any difference may affect the split-sample comparison, this was an important result.

Table 9.5: Council tax bands for sample and by settlement type

Council tax band	Sample (%)	Urban area (%)	Market town (%)	Villages (%)
A	3.0	2.1	3.2	3.6
B	13.6	18.6	10.4	11.5
C	18.1	20.2	18.1	15.9
D	22.3	24.5	22.1	20.2
E	8.1	8.8	7.9	7.4
F	2.9	2.4	3.0	3.3
G	2.7	2.1	3.2	2.8
H	0.7	0.2	0.5	1.5
Don't know	28.3	20.7	31.0	33.8

Sample size	1214	420	403	391
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Figure 9.4: Comparison of council tax band by settlement type



10. ANALYSIS

Experiences and behaviour

Nearly the whole sample had street lighting within their street (97.0%), with the greatest proportion without in rural areas (urban area, 98.8%; market town, 96.9%; villages, 95.3%). In most cases, respondents also had a street light directly in front of their house (sample 71.7%; urban area, 77.9%; market town, 70.2%; villages, 66.8%). For a sizable minority of respondents, such street lighting was also shining directly into their bedroom (sample 34.3%; urban area, 34.3%; market town, 33.0%; villages, 35.8%), however, the extent to which this was perceived to be a nuisance was not explored.

As experiences with crime may also affect preferences for street lighting, data was also gathered on this issue. In terms of street crime, a small proportion of the sample had been robbed in the street (sample 5.4%; urban area, 6.9%; market town, 2.7%; villages, 6.4%), although preferences can also be formed by word of mouth. Indeed, a sizable minority knew someone who had been robbed in the street (sample 32.2%; urban area, 36.7%; market town, 32.5%; villages, 27.1%). Another form of street crime may relate to parking in the street. A sizeable proportion of respondents did park their car in the street outside their house (sample 26.8%; urban area, 30.0%;

market town, 26.4%; villages, 24.4%) and, a similar proportion, though not necessarily related, had had their car broken into (sample 27.2%; urban area, 29.1%; market town, 26.3%; villages, 26.2%). Although, the sample is split by location of residence, the respondents did not necessarily experience street crime within their own town / village. In order to alleviate the threat of crime to their own property, 50.0% of the sample as a whole had purchased lighting with a security role (urban area, 53.6%; market town, 44.7%; villages, 51.8%)

Another issue potentially affecting street lighting preferences, was whether the respondents' took an interest in astronomy. For the sample as a whole 15.9% took an active interest in astronomy (urban area, 11.9%; market town, 19.6%; villages, 16.4%).

Attitudinal data

Further to considering respondent experiences and behaviour, attitudinal data was also collected on a range of issues. The attitudinal statements and the proportion of respondents agreeing or agreeing strongly are presented in Table 9.6, with the results provided for the sample as a whole and by settlement type.

The attitudinal responses suggested that the majority of respondents were happy with the street lighting in their area in terms of it being generally good (64.1%) and adequately covered (64.9%). A sizeable proportion of the respondents, however, noted that the street lighting in their area was in a poor state of repair and / or often not working (21%), and found street lighting annoying (27.1%). Other respondents had never really noticed street lighting (25.2%). Just less than half of the respondents preferred the new 'white' lighting to those with an 'orange' glow (48.4%). Although this may suggest nostalgia for the old colour lighting, these responses were elicited at the start of the questionnaire and may not necessarily reflect preferences to the improvement scheme as presented in the photographs. The most noticeable difference in attitude by settlement type is that those in villages are less likely to perceive the service to be adequate and more likely to find them annoying.

A number of other attitude questions also followed the valuation exercise. Five questions related to reactions to the street lighting improvement scheme. The majority of the respondents were still found to be happy with the existing lighting (57.5%) and viewed street lighting as a relatively low priority compared to other council services (60%). 41.0% actually suggested that they would not benefit

personally from the street lighting improvement scheme, with the greatest proportion in rural areas. Other attitudinal responses related to the perceived realism of the photos provided. 52.3% of respondents considered their street lighting to be better than shown in the before photo and 26.8% doubted the realism of the after improvement photo.

The benefits / disbenefits of street lighting were considered primarily in terms of road safety, and issues of personal safety and crime, with 5 questions being asked for each. In terms of the latter, nearly half of the respondents considered the threat of crime such that it is unsafe to walk the streets after dark (48.4%), with this varying noticeably between urban (60.5%) and rural areas (market town 39.5%; village 44.4%). The crime reduction benefits of street lighting improvement, were perceived by the majority of the respondents (61.3% reduce crime; 66.4% make property more secure). Also improved street lighting would make the vast majority of respondents feel safer (75.4%). These benefits of street light improvement were consistently perceived to be greater for those living in urban areas. A minority of respondents also perceived a potential disbenefit in terms of improved street lighting encouraging more children to cause mischief (26.8%), however, this perception appeared to be unrelated to settlement type.

Road safety was also perceived to be a key benefit of street lighting improvement. Although 41.9% suggested the existing street lighting was inadequate to see pedestrians or cyclists, 68.7% thought that better street lighting would enhance drivers' field of vision, 73.6% that they would improve road safety for children and 68.7% that they would lead to less accidents. Consistently these benefits were perceived to be greatest by those living in urban areas. The focus groups had also identified another safety issue relating to access on uneven roads, 65.1% of people perceived this to be a benefit of better street lighting. Again the greatest benefit was perceived in urban areas.

Other benefits / disbenefits of street lighting were also considered. Although of concern, they were of lesser importance than road safety, and issues of personal safety and crime. 48.1% of the respondents considered street lighting to have an urbanising effect, but it is unclear whether the urbanising effect was perceived to be enhanced or not with the improved scheme. Improving the visibility of stars at night was important to 30.2% of the respondents. The urbanising and the visibility effects

were perceived more within the rural areas. Finally, only 21.6% of the respondents considered street lights to be unattractive during the day.

A series of attitudinal questions were devised to assess the question of trust in local authorities. Another series of attitudinal questions explored whether respondents had any concerns about the elicitation methodology employed. Nearly half of the respondents (48.1%) indicated that they could not trust local government to use or hypothecate the tax revenue raised to finance the street lighting scheme. A similar proportion of the respondents (46.1%) also suggested that the scheme should be funded through central government taxation. If respondents are concerned about local government controlling the financing of the scheme, the use of the double bounded approach to estimate their willingness to pay may have exacerbated this problem. In the double bounded approach respondents are not just presented with a single price, but also a further higher or lower price depending on their initial response. Perhaps reflecting this concern, 59.0% thought that if the local government were unsure about the amount that they would have to pay it made them worry how much the scheme was actually going to cost. However, when related to the actual questionnaire, only 33.6% thought the costs were unrealistic; but 36.1% stated they were surprised to be asked the second amount. Caution is required regarding the later statement because if the respondents were worrying about how much it is going to cost, they may well not be surprised to be asked the second amount. Regarding settlement type, the highest levels of trust were expressed within the urban areas.

Some respondents were reluctant to pay, or to pay so much, for the scheme. 35.5% of the respondents would have preferred a more modest scheme, with the greatest proportion in urban areas. An alternative funding approach, financing the scheme by reducing the quality of other services, was not popular, with only 16.1% of the respondents agreeing this approach.

Table 9.6: Attitudinal responses for sample and by settlement type

Statement	Sample	% agreeing strongly or agreeing		
		Urban area	Market towns	Villages
Street lighting (before valuation)				
The street lighting in my area is generally good	64.1	65.0	69.2	57.8
I prefer 'white' to 'orange' street lighting	48.5	56.0	46.4	42.7
The area in which I live is adequately covered by street lighting	64.9	65.7	68.7	59.4
I never really notice street lighting	25.2	30.5	22.5	23.4
Street lighting can be annoying	27.1	20.4	28.0	32.1
The street lighting in my area is in a poor state of repair and/or often not working	21.0	28.2	15.7	19.1
Street lighting and the improvement scheme				
I'm happy with the lights we have now	57.5	55.0	63.8	54.0
Improving street lighting is a relatively low priority compared to other council services	60.0	58.8	62.7	58.4
I will not benefit personally from improving existing street lighting	41.0	31.3	43.6	48.9
The street lighting improvement won't be as good as shown in the pictures	26.8	25.4	23.3	32.4
The street lighting in our area is better than shown in the photograph before improvement	52.3	43.4	61.0	49.9
Personal security / safety				
The threat of crime makes it unsafe to walk the streets after dark	48.4	60.5	39.5	44.4
Improved street lighting would reduce crime	61.3	66.9	60.3	59.4
Improved street lighting would make private property more secure	66.4	70.7	62.7	66.7
Street lighting makes me feel safer from crime after dark	75.4	78.5	73.1	73.2
Improved street lighting would just encourage more children to hang around in the evenings and cause mischief	26.8	29.6	23.4	27.4
Road safety				
With existing street lighting it is difficult for drivers to see pedestrians or cyclists	41.9	43.6	33.3	40.1
Better street lighting would improve road safety for children	73.6	78.9	70.7	71.2
The street light scheme would improve the ease of access for pedestrians	65.1	68.8	64.4	62.0
Improved street lighting will lead to less accidents on the roads	63.8	65.9	61.2	64.4
The street light improvement scheme would enhance drivers' field of vision	68.7	71.9	64.6	69.5

Other benefits / dis-benefits of street lighting				
Improving the visibility of the stars at night is important to me	30.2	25.0	32.0	34.2
Street lighting has an urbanising effect in rural areas	48.1	46.3	49.1	50.0
Street lights look unattractive during the day time	21.6	24.8	17.1	22.9
Trust / realism				
You can't trust local government to use council tax revenue to finance the street lighting improvement scheme	48.1	47.5	49.3	47.5
The lighting improvement scheme should be funded through raising central government taxation instead of council taxation	46.5	42.1	51.8	45.8
If the council are unsure about the amount that we will have to pay for the lighting improvement scheme, it makes me worry how much this is actually going to cost	59.0	54.2	60.9	62.3
The cost of the scheme to me is unrealistic	33.6	33.1	33.3	33.6
Having stated my opinion regarding the first increase in council tax I was surprised to be asked to state my opinion again for another amount	36.4	32.6	33.7	43.3
Prefer not pay				
The street lighting improvement scheme should be funded by reducing the quality of other services rather than increasing council tax	16.1	16.5	17.1	16.1
I would prefer a more modest improvement scheme that cost less	35.0	39.6	32.4	32.7
Sample size	1,214	420	403	391

Valuation responses

Although double bounded valuation responses were elicited, considering initially the first valuation responses provides an indication of the preferences of the respondents. Table 9.7 illustrates that the most popular response was to pay the amount stated (45.9%), with Table 9.8 showing how the percentage agreeing declines with bid-level (BL). A sizeable minority were not willing to pay anything for the scheme (31.5%); indeed this was the second most popular response.

Table 9.7: First bound valuation responses for sample and by settlement type

Options	Sample (%)	Urban area (%)	Market town (%)	Villages (%)
Pay the amount stated	45.9	53.3	45.4	38.4
Not pay the amount stated	16.8	20.2	14.1	15.9
I am not willing to pay anything towards this scheme	31.5	23.3	35.0	36.6
Don't know	5.8	3.1	5.5	9.2
Sample size	1214	420	403	391

Table 9.8: Percentage of respondents willing to pay by bid amount for sample and by settlement type

Bid level (£)	Sample (%)	Urban area (%)	Market town (%)	Villages (%)
1	62.4	59.6	69.2	57.6
2.5	64.6	78.0	67.2	48.3
5	49.2	67.2	37.5	40.7
10	38.6	46.0	30.4	38.5
15	39.8	45.2	40.0	33.3
20	28.1	37.9	29.6	16.9
25	35.5	38.6	35.4	32.0
Sample size	1214	420	403	391

Factor analysis

The questionnaire survey produced approximately 50 variables based on attitude, experiences, behaviours and socio-economic characteristics, a number of which were significantly related to the valuation responses. In order to achieve parsimony, factor analysis was used to reduce the set of interrelated variables into a smaller number of uncorrelated factors through the calculation of factors scores. The initial factor loading or interrelatedness was calculated using varimax orthogonal rotation,

which maximises the extent to which the variables are loaded onto a given factor, aiding factor identification (Hair et al., 1995; Field, 2000). Factor scores were calculated using the Anderson-Rubin regression method which ensures the factor scores are uncorrelated (Field, 2000). Using both the scree plot and the conventional eigenvalue cut off point of 1.0 as a guide, 12 factors were extracted for consideration. Those that were found to be statistically significant within the valuation model, are reported below.

Double bound discrete choice models

The welfare measures were estimated from full regression models which included the factor score variables, which represent the composite score for each individual on a particular factor. A spike model approach was adopted to integrate together both the payment principle and DC valuation question responses (Kriström 1997). Here the likelihood function consists of two separate components: $WTP = 0$ and $WTP > 0$. This approach has recently been extended to the double bounded approach (Yoo and Kwak 2002). As the two model components (payment principle and valuation) are separate, there is no requirement for any correspondence between the variables included (Reiser and Schechter 1999). Models using a log-logistic functional form were found to provide a marginally better fit to the data than a number of alternative specifications.

Table 9.9 reports models of payment principle and DC valuation responses for the various samples. These models show that responses are affected by a number of issues beyond the BL, with a subjective label given to each of the factors used. Table 9.10 provides the eigenvalues for these factors and the factor loadings which were over 0.35 (Field, 2000). Consistent with an observation within the focus groups, respondents appear to have identified the benefits in terms of improved safety from crime and road safety similarly, under a more holistic term of safety.

Table 9.9: Log-logistic spike models of valuation responses

	Whole sample	Urban areas	Market towns	Villages
EL = 0				
<i>Constant</i>	-0.76 (10.10)**	-1.25 (-8.01)**	-0.56 (-4.18)**	-0.56 (-4.27)**
<i>Safety</i>	-0.70 (-9.04)**	-0.87 (-5.25)**	-0.77 (-5.78)**	-0.54 (-4.33)**
<i>Trust / realism</i>	0.72 (9.18)**	0.81 (5.03)**	0.49 (3.62)**	0.70 (5.37)**
<i>Disamenity</i>	0.24 (3.27)**	0.05 (0.74)	0.37 (2.89)**	0.27 (2.21)*
<i>Prefer not pay</i>	0.30 (4.14)**	0.45 (2.89)**	0.56 (4.34)**	0.11 (0.95)
<i>Star gazing</i>	0.24 (3.12)**	0.34 (2.07)*	0.34 (2.61)**	0.14 (1.10)
<i>Not personally benefit</i>	0.53 (6.98)**	0.41 (2.75)**	0.71 (4.83)**	0.41 (3.50)**
EL > 0				
<i>Constant</i>	-2.41 (-13.93)**	-2.95 (-8.34)**	-2.72 (-7.96)**	-1.92 (-7.33)**
<i>Ln (BL)</i>	0.86 (12.91)**	1.08 (8.13)**	0.92 (7.14)**	0.71 (7.13)**
<i>Safety</i>	-0.74 (-6.46)**	-0.85 (-3.80)**	-0.91 (-4.30)**	-0.41 (-2.37)*
<i>Trust / realism</i>	1.11 (9.58)**	1.69 (7.62)**	0.99 (4.74)**	0.60 (3.17)**
<i>Car crime</i>	0.40 (3.92)**	0.55 (3.07)**	0.20 (0.33)	0.33 (2.01)*
<i>Prefer not pay</i>	0.50 (4.96)**	0.78 (3.83)**	0.32 (1.93)*	0.49 (2.83)**
<i>Not personally benefit</i>	0.49 (4.75)**	0.52 (2.63)**	0.43 (2.45)*	0.52 (3.03)**
Log-likelihood ratio	0.17	0.24	0.19	0.11
% 'don't know'	11	9	11	13
Median	3.14 (1.80 – 5.38)	11.26 (8.14 – 16.47)	2.57 (1.44 – 4.88)	0.54 (0.18 – 1.28)
Lower bound mean	11.87 (10.32 – 13.47)	15.91 (14.11 – 17.85)	11.32 (9.77 – 13.13)	9.22 (7.92 – 10.60)
Sample size	1080	384	357	339

Note:

1. ** $p < 0.01$; * $p < 0.05$

2. The log-likelihood ratio figures are for model improvement from the basic double bounded spike model with only the bid level as an explanatory variable

3. The confidence intervals for the welfare estimates are shown within the brackets.

Table 9.10: Factors and factor loadings

	Factors	Factor loading
Safety		
Eigenvalue		5.38
<i>Improved street lighting will lead to less accidents on the roads</i>		0.74
<i>Improved street lighting would reduce crime</i>		0.73
<i>Improved street lighting would make private property more secure</i>		0.72
<i>Street lighting makes me feel safer from crime after dark</i>		0.71
<i>Better street lighting would improve road safety for children</i>		0.68
<i>The street light scheme would improve ease of access for pedestrians</i>		0.68
<i>The street light improvement scheme would enhance drivers field of vision</i>		0.64
<i>The threat of crime makes it unsafe to walk the streets after dark</i>		0.46
<i>With existing street lighting it is difficult for drivers to see pedestrians or cyclists</i>		0.47
Trust / realism		
Eigenvalue		2.41
<i>If the council are unsure about the amount that we will have to pay for the lighting improvement scheme, it makes me worry how much this is actually going to cost</i>		0.65
<i>The cost of the scheme to me is unrealistic</i>		0.64
<i>The street lighting improvement scheme should be funded by reducing the quality of other services rather than increasing council tax</i>		0.51
<i>Having stated my opinion regarding the first increase in council tax I was</i>		0.47

<i>surprised to be asked to state my opinion again for another amount</i>	
<i>You can't trust local government to use council tax revenue to finance the street lighting improvement scheme</i>	0.47
<i>The street lighting improvement won't be as good as shown in the pictures</i>	0.40
Car crime	
Eigenvalue	1.75
<i>Do you park your car in the street?</i>	0.45
<i>Have you ever had your car broken into?</i>	0.72
Disamenity	
Eigenvalue	1.44
<i>Street lighting can be annoying</i>	0.45
<i>Street lights look unattractive during the day</i>	0.64
Prefer not pay	
Eigenvalue	1.26
<i>I would prefer a more modest improvement scheme that cost less</i>	0.49
<i>The street lighting improvement scheme should be funded by reducing the quality of other services rather than increasing council tax</i>	0.45
Star gazing	
Eigenvalue	1.11
<i>Improving the visibility of the stars at night is important to me</i>	0.54
<i>Do you take an active interest in astronomy?</i>	0.54
Not personally benefit	
Eigenvalue	1.08
<i>I will not benefit personally from improving the existing street lighting</i>	0.42
<i>Improved street lighting is a relatively low priority compared to other council services</i>	0.38
<i>I'm happy with the lights we have now</i>	0.35

The second column of Table 9.9, reports the model for responses regarding the whole sample. Considering initially the WTP = 0 component of the model, the decision whether to be willing to pay anything towards the scheme was found to be highly significantly ($p < 0.01$) determined by factors that have been interpreted to reflect: the perceived improvement in the safety caused by street lights; trust / realism in the scheme and the payment; disamenity from street lighting; a preference for not to have to pay so much for the scheme; those taking an interest in star gazing; and those suggesting that they would not personally benefit. Of these responses, only in the case of improved safety (from crime and on the roads) does the model suggest that a higher value of the factor would lead to a higher likelihood of the respondent being willing to pay something towards the scheme. Interestingly, although the scheme will reduce light pollution, those taking an active interest in astronomy and/or suggesting preference for improved visibility of the night sky were more likely to not be willing to pay anything for the scheme. The factors 'safety', 'trust / realism', 'prefer not pay' and 'not personally benefit' also were statistically significant determinants of the amount respondents were willing to pay. The perceived likelihood of car crime was found to be an additional determinate of willingness to pay, where those having experienced car crime were less willing to pay

more towards the scheme. This is consistent with a finding within a focus group where a participant who had experienced car crime expressed the feeling that the crime was inevitable regardless of street lighting.

Confirmation of the meaning of the factors was provided by entering the original variables independently into the model. Although a variable for natural log of income was statistically significant ($p < 0.05$) when entered in the model individually, a factor for socio-economic / income characteristic of the respondent was not significant and hence was excluded from the model. Similarly, those of 65 years of age and above were willing to pay more for the scheme, but this did not come out within the factor analysis.

Table 9.9 also reports models of the valuation responses for the various sub-samples. These models also show that responses are affected by a number of factors in addition to the bid level (BL); and a degree of consistency in this respect was observed across sub-samples. The third column, reports the model for responses regarding those living within urban areas. This model provided the best statistical fit of the sub-samples and only the disamenity factor was not statistically significant ($p < 0.05$). In the case of market town respondents the car crime factor was not significant. For village residents, "prefer not to pay" ($WTP = 0$) and, perhaps surprisingly, star gazing factors were not significant.

Estimating willingness to pay

The welfare measures were estimated using conventional methods (Hanemann and Kanninen 1999). Here estimates of mean values were calculated by applying the Simpson method (Duffield and Patterson 1991) to the models reported in Table 9.9, with the distribution censored at the highest BL offered. This approximation implies that the estimates represent a lower bound of the mean (LBM). Alternatives to censoring at the maximum BL are available, however they all depend on an arbitrary choice of the upper truncation point and their adoption generally increases the standard error of the estimates (Ready and Hu 1995; Haab and McConnell 1998). A non-parametric bootstrapping approach (Efron and Tibshirani 1993) using 1000 iterations was adopted to estimate confidence intervals for the mean and median values. This approach avoids further parametric assumptions and is versatile in that it can be used to provide estimated distributions for any welfare measure required and so provides the basis for examining differences between measures.

The results in Table 9.9 suggest the median for the whole sample to be approximately £3 and the lower bound estimate of the mean to be approximately £12. The degree of certainty in these estimates is illustrated using the confidence intervals presented in brackets. Considering the results more generally, the median values are considerably lower than the mean estimates indicating positively skewed distributions typical of CV data. Within each of the sub-samples we can see that the values for urban areas are greater than those for market towns, which, in turn, are greater than those for villages. These differences were found to be statistically significant ($p < 0.05$) for the mean values (based on a Z-test) and the median distributions were found not to overlap ($p < 0.05$). This pattern of difference by settlement was also consistently observed for the valuations of individual counties and using a single rather than double bounded approach. Given that those living in urban areas perceived the greatest benefits in terms of personal and road safety, greatest level of trust, less likely to find street lighting annoying, considered star gazing to be less important and most likely to benefit personally, this result is consistent with the attitudinal findings. Only the issues of car crime and a feeling that street lights look unattractive during the day counteracted this finding.

11. AGGREGATION ISSUES and CBA

There are a range of issues that are conventionally considered within the aggregation of values to a relevant population. These include:

- double counting;
- choice of relevant population ;
- making sure the valuations are appropriately weighted;
- accounting for socio-economic differences;
- distance decay effect.

This study on the value of improved street lighting in rural areas elicited a holistic value for the perceived benefits of the specific street lighting improvement programme. Other studies, reported above in Section 3, have alluded to the benefits of street lighting in terms of an actual reduction in crime. However, unless there is total separability in utility between actual and perceived crime, adding the value of actual reductions in crime to the perceived benefits of street light improvements

elicited within this study will lead to double counting. This would also be likely to be true for actual and perceived road accident reductions.

Given that the survey was based on household council tax payments, the aggregation of individual household values should be based on the number of households within a given local authority. Three counties were chosen for the study and perhaps the best estimate of willingness to pay for a given local authority should come from the pooled estimate from all three counties.

However, whether a 'pooled' WTP value should be used will depend on how much willingness to pay is likely to differ between counties. The sample size permitted a test of this hypothesis. The willingness to pay in Wiltshire was significantly lower than both Bedfordshire and North Yorkshire ($p < 0.05$), though there was no significant difference between Bedfordshire and North Yorkshire ($p > 0.05$). As noted above the mean gross household income in Wiltshire, as observed in the survey, was significantly lower than in both Bedfordshire and North Yorkshire. Moreover, further consideration of the factors showed that for each of the variables composing the safety factor, the benefits of improved street lighting were consistently perceived to be less in Wiltshire than in the other counties.

A further complication comes from the sampling strategy adopted, where the use of the stratified approach by settlement type implies that there is an over representation of rural residents within the survey. Given that willingness to pay is lower for rural areas, this would lead to an underestimate of the average willingness to pay for an area. Thus any aggregation of individual household values should reflect the distribution of households in urban areas, market towns, and rural areas, within each local authority.

Counties vary in terms of the distribution of income, socio-economic characteristics of the population and other factors such as age distribution of individuals. Although the valuation responses are consistent with income (i.e. WTP increases with income), the socio-economic characteristics' factor was not significant within the model. This would suggest there is no requirement to aggregate on the basis of socio-economic characteristics of the population, and as such it is recommended that this further complication need not be added to the aggregation process.

Many environmental goods, and improvements, are 'local public goods'. That is they have increasing numbers of substitutes with increasing distance from the specific environmental good being valued. The aggregate value of these goods over space is derived by applying a 'distance decay' function. This implies that households' WTP for a 'local public good' declines with distance from the good. However, since street lighting is ubiquitous there is no need to account for any distance decay effect, which is often required by many valuation studies of public goods. The value of street light improvements is what each household within a local authority is willing to pay for it.

12. CONCLUSIONS

This study surveyed the preferences and WTP for improved street lighting by residents within three shire counties. The study provides robust values of the willingness to pay for the benefits of the improved street lighting scheme from this survey. It also considers and discusses how such WTP figures can be used to inform the determination of the application for PFI credits.

In general, residents in urban areas perceived the benefits of street lighting to be greater than residents of market towns and villages. This was most noticeable in terms of the key benefits from improved street lighting: road safety; and issues of personal safety and crime. Factor analysis suggested that residents viewed road and personal safety together under a holistic label of 'safety'. Only 'car crime' and 'star gazing' came out as separate issues from the generic 'safety', but the perception was that the street lighting improvement scheme would not help these issues.

WTP for improved street lighting was found to be determined by a number of factors that characterised respondents' tastes. These include: the perceived improvement in the safety caused by street lights; disamenity from street lighting; a preference for not to have to pay so much for the scheme; those taking an interest in star gazing; those suggesting that they would not personally benefit; and perceived likelihood of car crime. WTP amounts were also influenced by factors such as the trust or realism of the scheme and the payment.

Willingness to pay by households in urban areas is greater than households in both market towns and villages, with the lowest willingness to pay being observed in villages. This difference was found to be statistically significant and consistent with the attitudes of the respondents.

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ANNEX 1

QUESTIONNAIRE



UNIVERSITY OF NEWCASTLE UPON TYNE GENERAL PUBLIC SURVEY

Good morning/afternoon/evening. My name is ... from Newcastle University. We are carrying out a survey for Newcastle University on behalf of the Department for Transport about people's attitudes and opinions on the street lighting in your area. Can we start with a few general questions about your experiences with lighting?

1. Do you have street lighting in your street? <i>(please circle the appropriate number)</i>				1. yes	2. no
2. Using the categories given on the card, can you tell me how strongly you agree or disagree with each of the following statements? <i>(Please circle the appropriate number)</i>					
a. The street lighting in my area is generally good.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
b. I prefer 'white' to 'orange' street lighting.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
c. The area in which I live is adequately covered by street lighting.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
d. I never really notice street lighting.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
e. Street lighting can be annoying.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
f. The street lighting in my area is in a poor state of repair and/or often not working.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know

3. Looking at the card, can you tell me approximately how much your council tax is each year? (Circle one answer)			
less than £1000	1	£2000 to £2500	5
£1000 to £1250	2	over £2500	6
£1250 to £1500	3	Don't know	7
£1500 to £1750	4	Refused to answer	8
Which council tax band do you have to pay? (A-H)			

Street light improvement

The scheme (SHOW CARD 1)

- Your County Council is proposing an improvement to street lighting throughout the County. This would include all public lighting for roads and footpaths, whether provided by the county council, district council or parish council; but excludes private lighting.
- If implemented it would mean the replacement or upgrading of all existing lighting to a European Standard, with a priority given to the worst lights, which will often include the post/column. For example, all orange lights will be replaced within 5 years.
- To meet this standard, typically more lights are required. Usually 15% more, in areas with existing lights.
- This improvement would mean (See PICTURES 1 and 2);
 - brighter lighting and you would be able to see colours more clearly (improving visibility in the streets and footpaths at night).
 - no light shining upwards: as the new lights are better directed and covered, you should be able to see the stars better and it is less likely that lighting will shine into your first floor bedroom windows at night.
- The scheme will not provide new street lighting in areas which do not currently have street lights.

Payment for the scheme (SHOW CARD 2)

- It is estimated that the street lighting improvement scheme would lead to a rise in your council tax of between £ ___ and £ ___. This would last for the period of 25 years, increasing only with the rate of inflation (currently 2% per year). A final calculation has yet to be completed, but it will fall within the above range.
- These amounts will cover installation and maintenance of the street lights over the next 25 years. Once the contract is signed, a private firm will bear the risks of any future cost increases, above the rate of inflation (there will be no job losses). The money paid to the Council for this scheme would be contractually ring-fenced for the street light improvement and would be independently audited.
- This council tax increase, if implemented, would be independent of any additional increases in your council tax for the provision of other services in future years.

4. Taking the middle value of the cost range stated, if the scheme would lead to £ ___ increase in the council tax which your household pays, given the choice, would you rather pay this amount and have the lighting improvement scheme or not pay this amount in which case your lighting would not be improved?

Please choose the one option which most closely resembles your view

- Pay the amount stated = 0
- Not pay the amount stated = 1
- I am not willing to pay anything towards this scheme = 2
- Don't Know = 3

IF ANSWER IS 0

5a. Please state which category best describes why you would pay the amount: (select only one)

- reduce light pollution = 0
- improve road safety = 1
- crime prevention / personal safety = 2
- improve ease of access = 3
- I get satisfaction from giving to a good cause = 4
- I don't think I will have to pay this amount, but merely saying I'm in favour of the scheme = 5

5b. Taking the upper value of the cost range stated, if the scheme would lead to £ ___ increase in the council tax which your household pays, given the choice, would you rather pay this amount and have the lighting improvement scheme or not pay this amount in which case your lighting would not be improved?

- Pay the amount stated = 0
- Not pay the amount stated = 1
- Don't Know = 2

IF NO, please state which category best describes why you would NOT pay the amount: (select only one)

- the scheme is not worth the amount stated = 0
- I cannot afford the amount stated = 1
- by asking for a higher amount I can't trust that the cost won't be further increased = 2
- by asking for a higher amount, than previously asked, I feel I'm being conned = 3
- there are higher priorities for expenditure from my council tax = 4

GO TO QUESTION 10 ON PAGE 5

IF ANSWER IS 1

6a. Please state which category best describes why you would NOT pay the amount: (select only one)

- I support the scheme but it is not worth the amount stated = 0
- I support the scheme but I cannot afford the amount stated = 1
- I support the scheme but I don't trust the council to deliver = 2
- I support the scheme but not if I have to pay for it = 3
- NOT support the scheme and am not willing to pay anything towards it = 4

6b. Taking the lower value of the cost range stated, if the scheme would lead to a £ ___ increase in the council tax which your household pays, given the choice, would you rather pay this amount and have the lighting improvement scheme or not pay this amount in which case your lighting would not be improved?

Pay the amount stated = 0
Not pay the amount stated = 1
Don't Know = 2

If pay the amount, please state which category best describes why your answer was pay the amount: (select only one)

the scheme is worth the amount stated = 0
I support the scheme and can afford the amount stated = 1
by asking for a lower amount I feel I'm getting better value for money = 2
by saying yes to the lower amount I am encouraging the council to keep costs down = 3

GO TO QUESTION 10 ON PAGE 5

IF ANSWER IS 2

7a. Please state which category best describes why your answer was NOT pay anything towards the scheme: (select only one)

I support the scheme but I can't trust the council to spend the money on it = 0
I support the scheme but there are higher priorities for government expenditure = 1
I support the scheme but I don't trust the council to deliver = 2
NOT support the scheme = 4

7b. If the scheme had been funded through central government taxation would you have been willing to pay £ ___ every year towards the street lighting improvement scheme? (circle the appropriate number)

Pay the amount stated = 0
Not pay the amount stated = 1
Don't Know = 2

GO TO QUESTION 10 ON PAGE 5

IF ANSWER IS 3 GO TO QUESTION 10 ON PAGE 5

10. Using the categories given on the card, can you tell me how strongly you agree or disagree with each of the following statements? (Please circle the appropriate boxes)					
a. The street lighting improvement won't be as good as shown in the pictures.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
b. If the council are unsure about the amount that we will have to pay for the lighting improvement scheme, it makes me worry how much this is actually going to cost.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
c. The cost of the scheme to me is unrealistic.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
d. The lighting improvement scheme should be funded through raising central government taxation instead of council taxation.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
e. Having stated my opinion regarding the first increase in council tax I was surprised to be asked to state my opinion again for another amount.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
f. You can't trust local government to use council tax revenue to finance the street lighting improvement scheme.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
g. The street lighting improvement scheme should be funded by reducing the quality of other services rather than increasing council tax.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
h. I would prefer a more modest improvement scheme that cost less.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know

i. The threat of crime makes it unsafe to walk the streets after dark.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
j. With existing street lighting it is difficult for drivers to see pedestrians or cyclists.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
k. Improving the visibility of the stars at night is important to me.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
l. Better street lighting would improve road safety for children.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
m. Improved street lighting would just encourage more children to hang around in the evenings and cause mischief.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
n. Improved street lighting will lead to less accidents on the roads.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
o. Street lighting makes me feel safer from crime after dark.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
p. Improved street lighting would make private property more secure.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
q. I will not benefit personally from improving existing street lighting.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
r. The street light improvement scheme would enhance drivers' field of vision.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know

s. Street lighting has an urbanising effect in rural areas.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
t. Street lights look unattractive during the day time.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
u. Improved street lighting would reduce crime.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
v. The street light scheme would improve the ease of access for pedestrians.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
w. I'm happy with the lights we have now.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
x. Improving street lighting is a relatively low priority compared to other council services.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know
y. The street lighting in our area is better than shown in the photograph before improvement.					
5. Agree Strongly	4. Agree	3. Neither agree or disagree	2. Disagree	1. Disagree Strongly	0. Don't know

C. PERSONAL QUESTIONS

Finally, I need to ask some details so that we can characterise your household.

12. How long have you lived in this county?		Years	
13. Is your house rented?	1. yes	2. no	
14. Does street lighting shine directly into your bedroom?	1. yes	2. no	
15. Have you been out after dark in the last month?	1. yes	2. no	
16. In the winter will you go out after dark at least once a month?	1. yes	2. no	
17. Is there street lighting at the front of your house?	1. yes	2. no	
18. Have you purchased security lighting for the front of your house?	1. yes	2. no	
19. Is there street lighting at the rear of your house?	1. yes	2. no	
20. Have you purchased security lighting for the back of your house?	1. yes	2. no	
21. Have you ever been robbed in the street?	1. yes	2. no	
22. Do you know anyone that has been robbed in the street?	1. yes	2. no	
23. How many cars does your household have?			
24. Do you park your car on your street?	1. yes	2. no	3. Don't have a car
25. Have you ever had your car broken into?	1. yes	2. no	3. Never had a car
26. Do you take an active interest in astronomy?		1. yes	2. no
27. Do you have any children?		1. yes	2. no
<i>if yes how many?</i>			
28. SHOWCARD A (SEE NEXT PAGE) Into which of the groups on the card does your age fall?			
29. Including your self, how many people in your household are:			
Under 16			
Over 16			
30. SHOWCARD B (SEE BELOW) Looking at the card can you tell me which of these categories best describes the stage where you left or you have reached with regard to formal education?			
31. SHOWCARD C (SEE BELOW) Into which of the groups on the card does your total annual household income (before tax) fall?			
Sex of the respondent		1. male	2. female
Town / village of interview			

The scheme (SHOW CARD 1)

- Your County Council is proposing an improvement to street lighting throughout the County. This would include all public lighting for roads and footpaths, whether provided by the county council, district council or parish council; but excludes private lighting.
- If implemented it would mean the replacement or upgrading of all existing lighting to a European Standard, with a priority given to the worst lights, which will often include the post/column. For example, all orange lights will be replaced within 5 years.
- To meet this standard, typically more lights are required. Usually 15% more, in areas with existing lights.
- This improvement would mean (See PICTURES 1 and 2);
 - brighter lighting and you would be able to see colours more clearly (improving visibility in the streets and footpaths at night).
 - no light shining upwards: as the new lights are better directed and covered, you should be able to see the stars better and it is less likely that lighting will shine into your first floor bedroom windows at night.
- The scheme will not provide new street lighting in areas which do not currently have street lights.

Payment for the scheme (SHOW CARD 2)

- It is estimated that the street lighting improvement scheme will lead to a rise in your council tax of between £ ___ ___ and £ ___ ___.
- This would last for the period of 25 years, increasing only with the rate of inflation (currently 2% per year). A final calculation has yet to be completed, but it will fall within the above range.
- These amounts will cover installation and maintenance of the street lights over the next 25 years.
- Once the contract is signed, a private firm will bear the risks of any future cost increases, above the rate inflation (there will be no job losses).
- The money paid to the Council for this scheme would be contractually ring-fenced for the street light improvement and would be independently audited.
- This council tax increase, if implemented, would be independent of any additional increases in your council tax for the provision of other services in future years.

SHOWCARD A

1. 16 - 25

2. 26 - 35

3. 36 - 45

4. 46 - 55

5. 56 - 65

6. 66 - 75

7. 75+

SHOWCARD B

- 1. Left school before completing secondary education**
- 2. Completed secondary education**
- 3. Took 'A' Levels or GNVQs**
- 4. Educated to HND or Diploma Level**
- 5. Educated to Degree Level**
- 6. Educated to Postgraduate Level**

SHOWCARD C
INCOME GROUPS

	<i>per year</i>	<i>per week</i>
a.	Under £5,000	Under £96
b.	£5,000-£9,999	£96 - £192
c.	£10,000-£19,999	£192 - £385
d.	£20,000-£29,999	£385 - £577
e.	£30,000-£39,999	£577 - £769
f.	£40,000-£59,999	£769 - £1,154
g.	Over £60,000	over £1,154

Before lighting improvement

Photo 1: A street scene



After lighting improvement

Photo 2: A street scene

